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Simulator Training applied to the Solution of Problems in Two-Dimensional Vector Algebra.

José Raúl García León, Instituto Tecnológico Superior de Irapuato, México
Eduardo García Herrera, Instituto Tecnológico Superior de Irapuato, México
Juan Carlos Rodríguez Campos, Instituto Tecnológico Superior de Irapuato, México

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Abstract
Education today faces challenges that put into question the value of their purpose, content and process, consequences of complexity in the academic process, one of the concrete manifestations of what should be the teacher is teaching acting. The construction of learning products, which developed under different factors, conditions and educational practices deal with the daily work of teachers in the laboratory, classroom, workshop. Also acquire or improve skills to understand, innovate and generate knowledge. Therefore an educational software for the analysis and solution of vector algebra in two dimensions is designed to contribute to the effective acquisition of specific skills in the field of physics in career Computer Systems Engineering from the Higher Institute of Technological Irapuato provide reinforce the knowledge acquired in class and decrease the failure rate and promoting their use and school performance.
Presentation

This project is the development of an educational software called "didactic simulator applied to solving problems of vector algebra in two dimensions", which aims to attack the low performance in the field of General Physics Engineering in Computer Systems, providing a tool that allows them to reinforce the knowledge acquired in class, this software offers a step by step explanation of how it has to solve a problem by the method you selected. With the development of this simulator problems currently existing practice involves the solution of vector algebra in two dimensions, and thus have the ability to solve them are resolved. During the implementation of this project evaluations to a group of test were performed to verify that the developed system could really help the improvement and understanding of the methods of vector algebra in two dimensions, and found that the tool really helps students better understand the topics covered in class.

The Physics I class in the computer systems engineering career from Instituto Superior Tecnológico de Irapuato (ITESI), which is within the curriculum of the reticle 2004, and the class of General Physics reticle 2010, have been a high failure rate in regard to the issue of vector algebra, it has been presented for the last 8 semesters has taught the subject since 2006 until 2012. Table[1] low approval ratings over that time period is.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Year</th>
<th>Number of students</th>
<th>Students Reprobate</th>
<th>Index of Reprobation</th>
</tr>
</thead>
<tbody>
<tr>
<td>January – June</td>
<td>2006</td>
<td>34</td>
<td>20</td>
<td>62.5%</td>
</tr>
<tr>
<td>August - December</td>
<td>2007</td>
<td>32</td>
<td>21</td>
<td>61.8%</td>
</tr>
<tr>
<td>August – December</td>
<td>2008</td>
<td>28</td>
<td>17</td>
<td>61%</td>
</tr>
<tr>
<td>August – December</td>
<td>2009</td>
<td>26</td>
<td>25</td>
<td>96%</td>
</tr>
<tr>
<td>August – December</td>
<td>2010</td>
<td>35</td>
<td>28</td>
<td>80%</td>
</tr>
<tr>
<td>August – December</td>
<td>2011</td>
<td>27</td>
<td>18</td>
<td>66.6%</td>
</tr>
<tr>
<td>August – December (Group A)</td>
<td>2012 – A</td>
<td>10</td>
<td>8</td>
<td>80%</td>
</tr>
<tr>
<td>August - December (Group B)</td>
<td>2012 – B</td>
<td>40</td>
<td>18</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table [1] -. Disapproval Index, the first part of the matter of General Physics Computer Systems Engineering.

Disapproval rates above are due to several factors, among which are the lack of teaching materials and insufficient time spent by students and others, resulting in a low rate of utilization. Hence the idea for this project arose because the above material does not have a dedicated educational software to vector algebra, and therefore intended to give the student a tool to help you to better assimilate the issues. Although there are several tools focused on the teaching of mathematics, they tend to skip intermediate steps and throw only the final result, which prevents the student to assimilate the entire process of problem solving, and therefore self-learning its solution.

- Create an educational software that allows you to monitor the solution step by step exercises vector algebra in two dimensions, by means of the techniques, procedures and corresponding theorems.
• Provide students a tool that allows them to self-learn and reaffirm solving algebra problems, with the aim of raising the pass rate.
• Develop a software that can be used on any computer that has a "Windows" operating system that has the characteristics of functionality, usability and robustness, in order to facilitate self-learning students.

Analysis

In searching for information related to the research, some related thematic studies were found, through which it aims to achieve an orientation and a theoretical basis for sustaining the problem, among them are: In Argentina, Ruben A. Pizarro, in his thesis "Information Technology Applied to Education" refers to the development and implementation of educational software brings, in addition to improving the teaching and learning, the ability to rescue and preserve the cultural values of society where to deploy, scored a reasonable improvement where his research after the implementation of the software obtained an 83% approval rating compared to 37.50% as before using the software. Norberto Pilar Ramírez in his thesis "The use of the educational software" describe in Peru learning problems in mathematics because teachers teach according to the traditionalist model of routine and tedious way, do not apply methods, techniques and strategies appropriate learning and not trained according to technological advances.

The theoretical framework is a process of immersion in the existing and available knowledge that can be linked to our problem statement and a written compendium of articles, books and documents describing the past and current state of knowledge about the problem under study (Sampieri, Fernández, Baptista 2007).

Operating System

The author in his book William Stallings Operating Systems defines a system as organized set of parts or related items and interacting with each other to achieve a goal. Systems receive (input) and provide data (output) information.

Application Software

Application software programs that are written for users or are written by them, in order to apply the computer to a specific task is described. (Amaya, 2008).

Programming Language

A programming language can be defined as a system of conventional signs adopted to express certain mathematical concepts, to write instructions or commands to the computer useful and necessary for the performance of a particular process. It is called the source language the programmer who writes orders, which are translated into machine language of the computer. Every programming language has its own grammar or language. (García Roque 2007).

Software Life Cycles

The software lifecycle as a logical approach to the acquisition, supply, development, operation and maintenance of software is defined. (Leyva, Sampalo Garzon 2006). Regardless of the model selected process, software engineers have chosen traditional means a generic framework for the process, which includes the following activities within the framework: communication, planning, modeling, construction and
development. A model is called descriptive because they prescribe a set of process elements: activities under the work of software engineering activities, tasks, work products, quality assurance and control mechanisms. All software process models conform to the generic activities of the framework, but each applies a different importance to these activities and defines a workflow activity that invokes each framework differently. (Roger Pressman 2005).

Vector algebra
Vector Algebra is the branch of mathematics that is concerned with managing operations with vector magnitudes, either addition, subtraction or multiplication. A physical vector is a physical quantity characterizable by a point source or application, a module, an address and a sense, or alternatively by a number of independent components such that components are measured by different observers systematically relatable.

Vector Addition
If \( \mathbf{a} = \langle a_1, 2 \rangle \) and \( \mathbf{b} = \langle b_1, b_2 \rangle \) are vectors, then: \( \mathbf{a} + \mathbf{b} = \langle a_1 + b_1, a_2 + b_2 \rangle \)

Multiplicación de vectores por escalares
Si \( A = \langle a_1, 2 \rangle \) y \( c \) es un escalar, entonces: \( c \mathbf{a} = \langle ca_1, a_2 \rangle \)

Los números \( a_1 \) y \( a_2 \) en \( \langle a_1, 2 \rangle \) se llaman las componentes del vector. Así, para sumar dos vectores sumamos sus componentes correspondientes.

Vector multiplication by scalar
If \( A = \langle a_1, 2 \rangle \) and \( c \) is a scalar, then: \( c \mathbf{a} = \langle c a_1, a_2 \rangle \)

The numbers \( a_1 \) y \( a_2 \) \( \langle a_1, 2 \rangle \) are called the components of the vector. So, to add two vectors add their corresponding components.

Multiplication by a scalar
They are called scalars to real numbers, when you're working with vectors in the Cartesian plane. All vector \( \langle a, \rangle \) can be multiplied by a scalar \( c \), ie by a real number \( c \).

Scalar
The dot product is also called dot product or inner product. Importantly \( a \* b \) is a scalar, not a vector.

If \( a = \langle a_1, 2 \rangle \) \( b = \langle b_1, b_2 \rangle \) then the scalar product \( b \* a \) is given by: \( b \* a = \langle 1.2 b b a 1 2 \rangle \)

Angle between two vectors
The angle between two vectors \( u \) and \( v \) is given by the expression: \( \cos \alpha = (u \* v \* 1 + 1) + (2 \* u \* v 2) / \sqrt{(12 + u u 22) * \sqrt{(12 + v v 22)}} \)

Projection of a vector on all
If \( A \) y \( B \) two different vectors are zero vector, then the projection on \( A B \) scalar defined as \( \| B \| \cos \), where \( \theta \) is the angle between \( A \) and \( B \).

The scalar projection of vector \( B \) on table \( A \) is: \( (A \* B) / A \| B \|

The vector projection of vector \( B \) on table \( A \) is: \( ((A \* B) / A \| B \|) \)
**Vector product**

Unlike the dot product, which is a scalar, the product $a \times b$ vector two vectors $a \cdot b$ produce another vector. A determinant of order 2 is defined as: 25.

Where all the letters represent real numbers. $|a_1 a_2 b_1 b_2| = a_1 b_2 - a_2 b_1$

**Development**

For this project two phases of which the first is the planning requirements surveys are conducted, as shown in table [2], and manipulation of data collected by the system, and finally display the results statistics, the use of software as a teaching tool.

**Methodology**

<table>
<thead>
<tr>
<th>Requirements Analysis (software, hardware)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility study</td>
</tr>
<tr>
<td>Technical, operational, cost feasibility</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Coding</td>
</tr>
<tr>
<td>Implementation</td>
</tr>
</tbody>
</table>

**Table [2] - Methodology Lifecycle Software**

Table [3], one can observe the functional requirements of the system. These requirements depend on the type of software that is developed, potential users of the software and the general approach taken by the organization in drafting requirements. The training simulator shall contain the following:

**Functional Requirements**

<table>
<thead>
<tr>
<th>Parallelogram method</th>
<th>Scalar multiplication.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector product</td>
<td>A panel for plotting vectors</td>
</tr>
<tr>
<td>Scalar Product</td>
<td>A panel to input vectors.</td>
</tr>
<tr>
<td>Scalar and Vector Projection</td>
<td>Help Button</td>
</tr>
<tr>
<td>Getting the angle between two vectors</td>
<td>Solved exercises will set an example for the user.</td>
</tr>
</tbody>
</table>

**Table [3] - Functional software requirements**

The home interface must the methods by which you want to work, and must be selected, as shown in Figure [1], and start working with the software.
Figure [1] - Menu options

Figure [2], the explanation of how the method of vector product is performed, showing step by step how you should solve the method.

Figure [3], the solution of the method of projection of a vector on another, along with its explanation is displayed, and the formula that was used.
Figure [3] -. Solution step method "projection of a vector on another"

Figure [4] shows graphically the resulting vector, and the right side shows the values of the vector.
Results

A didactic software for the analysis of methods of vector algebra in two dimensions, which will serve as an educational tool that supports student learning of General Physics Engineering in Computer Systems in ITESI developed. Getting the desired results as it allows to observe step by step troubleshooting of vector algebra in two dimensions, with their respective procedures and theorems, providing a better understanding of the topics covered in class.

The developed system has good performance and is fully functional, because it meets the requirements set, usable for its architecture design, sturdy for good support system in terms of performance. The project was developed in the Department of Computer Systems belonging to ITESI applying language technology of object oriented programming in C# branch handling graphics and other aspects such as Forms interfaces.

To test the effectiveness of the software two screening tests were applied to a test group to check the efficiency of the software. The first review was previously applied to the use of software, and the second was applied to the same group after using the software, where the following results were obtained as shown in Table [4] and can appreciate the improved statistics in the use of software.

<table>
<thead>
<tr>
<th>Num Students</th>
<th>Evaluation I (Before Software)</th>
<th>Evaluation II (Post-Software)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>84</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>32</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>92</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>32</td>
<td>84</td>
</tr>
<tr>
<td>10</td>
<td>16</td>
<td>68</td>
</tr>
<tr>
<td>11</td>
<td>46</td>
<td>84</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>74</td>
</tr>
<tr>
<td>14</td>
<td>80</td>
<td>84</td>
</tr>
<tr>
<td>15</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>16</td>
<td>56</td>
<td>84</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>38.75</strong></td>
<td><strong>84.56</strong></td>
</tr>
</tbody>
</table>

Table [4] - Results use, before and after the software

Figure [5] and [6] the rate of adoption of selected test group previously shown to obtain statistical data, which is subsequently used to compare the results before and after the use of educational software.
With the results obtained during the assessments of a test group can be noticed that there was a marked improvement in meaningful learning and decreased failure rate of students who were a pre-test performed without the use of software, and a post-use assessment tool developed was applied. With these results it was concluded that teaching helps to assimilate and understand the two-dimensional vector algebra tool.
Conclusion

As a result of project development, the creation of a didactic software for circuit analysis of direct and alternating current, which will serve as an educational tool for achieving meaningful learning of students taking the subject of General Physics, was achieved Engineering in Computer Systems in ITESI.

The project was expected since it allows to observe step by step troubleshooting of vector algebra in two dimensions using alternate techniques, and procedures for the vector calculus theorems, and provides the student actual and immediate information that helps you have a better understanding of the topics covered in class and this results that students have acquired knowledge and firm improve its profile graduate. The system was also observed, it has a good performance and is fully functional because it meets the requirements set, usable by the architecture design for portable course because your code can be compilable on any Windows platform and robust by good support system for performance. It should be mentioned that the project was developed in the Department of Systems belonging to ITESI applying language technology of object oriented programming C # on branch handling graphics and other aspects such as are GUI interfaces, allowing a design visually appealing to users.
References


Contact email: jogarcia@itesi.edu.mx
A Hybrid Digital Watermarking Method using Sectioning and DWT Technique in Chrominance Channel

Komwit Surachat, Prince of Songkla University, Thailand
Wanicbut Wattanamatiphot, Prince of Songkla University, Thailand

Abstract
In this research, we proposed a hybrid method to improve performance of extraction process of the digital watermarking by applying the multiple sections embedding technique and DWT digital watermarking method in the embedding process. The YCbCr colour space was selected for embedding and extracting a watermark signal. Also, a new pixel prediction method is presented for improving the accuracy of extraction process by using adaptive filter depended on pixel variance of the prediction area. A set of experiments is created to support the proposed concepts including image under attacked conditions and non-attacked condition. The results of the experiments show the improvement of the extraction performance in terms of normal correlation (NC). Also, the improvements in terms of robustness against various types of attack e.g. JPEG compression attack, blurring attack, brightness adjustment attack, etc. are significantly increased. Especially in cropping attacks and compression attacks, the results strongly improve in terms of NC value compared to previous proposed algorithm.
Introduction

The copyright protection of digital media data becomes an important issue and attracts many researchers to solve this problem. Digital watermarking is a kind of standard technology to maintain access control for the documents. Good introduction on digital watermarking including its essential requirements can be found on [1].

Currently, many image watermarking methods have been proposed and proved to be robust against various kinds of noises and attacks. Such methods can be classified into frequency and/or spatial domain based watermarking. In the frequency domain, the watermark embedding can be accomplished by modifying the image coefficients from its transformed domain. For instance, Patra et al. [2] presented a based Chinese Remainder Theorem (CRT)-based Discrete Cosine Transform (DCT) domain. In addition, [3] and [4] are also proposed the watermarking schemes in frequency domain recently. They presented the method based on applying DCT and DWT to embed and retrieve the watermark signal. They also claimed that the proposed schemes are strongly robust again compression attack. However, many researches demonstrated that the frequency domain based approach was not robust enough against geometrical attack, e.g. cropping. It can survive most image compression standards e.g. JPEG compression standard, though. In contrary, for the spatial domain based approach, it is obvious that the processes of watermark embedding and extraction are simple to perform by modifying the image pixels directly.

For example, M. Kutter et al. [5] presented a method to embed a watermark signal into an image by modifying the pixel using either additive or subtractive depending on the watermark bit, and proportional to the luminance of the embedding pixel. According to their method, the blue colour channel was selected to carry the watermark bit since it is the one that human eye is least sensitive to.

Later, T. Amornraksa et al. [6] proposed some techniques to enhance its watermark retrieval performance by balancing the watermark bits around the embedding pixels, tuning the strength of embedding watermark in according with the nearby luminance, and reducing the bias in the prediction of the original image pixel from the surrounding watermarked image pixels. However, all the methods mentioned above encountered a deficiency when implemented with an image having a large number of high frequency components.

Our approach develop a new method based on the previous proposed in [6] by implementing a hybrid method. The descriptions of the proposed method are given in the next section. Section 3 describes the experimental results. The conclusion is finally drawn in section 4.

Spatial Domain Digital Watermarking

The watermark pixels are first converted from \{0,1\} to \{1,-1\} by changing the value of the zero bits to be the one bits. Then, the watermark balance and security are improved by using the XOR operation to permute the watermark bits with a pseudo-random bit-stream generated from a key-based stream cipher. The scaling factor \(s\) is used to adjust and control the watermark strength of the output previous process outputs. Then, the embedding process is started by modifying the image pixel in the
blue channel $B(i,j)$, in a line scan fashion. The result $B'(i,j)$ are either additive or subtractive, depending on $w(i,j)$, and proportional to the modification of the luminance of the embedding pixel $L(i,j)$. In addition, the modification of luminance $L'(i,j)$ is calculated from a Gaussian pixel weighting mask. The representation of the watermark embedding process can be expressed by

$$B'(i,j) = B(i,j) + w(i,j)L'(i,j)$$  \hspace{1cm} (1)$$

To extract the watermark signal, the following steps are used to estimate the embedded watermark bit at $(i,j)$. Firstly, each original image pixel in the chosen channel is predicted from its neighboring watermarked image pixels in the same embedding channel. Each original image pixel in the chosen channel is predicted from its neighboring watermarked image pixels in the same channel. The predicted original image pixel $B''(i,j)$ is determined by

$$B''(i,j) = \frac{1}{8} \left( \sum_{m=-1}^{1} \sum_{n=-1}^{1} B'(i+m,j+n) - B'(m_{max},n_{max}) \right)$$  \hspace{1cm} (2)$$

where $B'(m_{max}, n_{max})$ is a neighboring pixel around $(i,j)$ that most differs from $B'(i,j)$. Then, the embedded watermark bit $w'(i,j)$ at a given coordinate $(i,j)$ can then be determined by the following equation

$$w'(i,j) = B'(i,j) - B''(i,j)$$  \hspace{1cm} (3)$$

where $w'(i,j)$ is the estimation of the embedded watermark $w$ around $(i,j)$. Since $w(i,j)$ can be either 1 and -1, the value of $w'(i,j) = 0$ is set as a threshold, and its sign is used to estimate the value of $w(i,j)$. That is, if $w'(i,j)$ is positive (or negative), $w(i,j)$ is 1 (or -1, respectively). Notice that the magnitude of $w'(i,j)$ reflects a confident level of estimating $w(i,j)$.

**Frequency Domain Digital Watermarking**

The host image is processed with the following steps;

**Step 1:** The blue channel of the host image is decomposed into $n$ levels using discrete wavelet transform. The $HL_n$ of $LL_{n-1}$ transformed sub-band is selected for watermarking embedding.

$$[a_n, q_n, b_n, r_n] = dwt(LL_{n-1})$$  \hspace{1cm} (4)$$

where $a_n, q_n, b_n, r_n$ is wavelet coefficient value of $LL_n, HL_n, LH_n$ and $HH_n$ sub-band, respectively.

**Step 2:** Watermark pixels are converted from \{0,1\} to \{1,-1\} by switching the value of the zero bits to the one bits.

**Step 3:** The watermark balance and security are improved by using the XOR operation to permute the watermark bits with a pseudo-random bit-stream generated from a key-based stream cipher.

**Step 4:** The embedding process is started by modifying the dwt coefficient values in the $HL_n$ sub-band $q'(i,j)$, in a line scan fashion. The result $q''(i,j)$ are either additive or subtractive, depending on $w(i,j)$, the result is then adjusted by a scaling factor $s$ to
control the strength of watermark for the entire $HL_n$ sub-band. The representation of watermark embedding process can be expressed by

$$q''_{n(i,j)} = q'_{n(i,j)} + w_{(i,j)}s$$  \hspace{1cm} (5)$$

Then, the final embedding process is applied by using inversed DWT, set $n$ equal to decomposition level at the first place.

$$LL_{n-1} = idw[a_n, q''_{n}, b_n, r_n]$$  \hspace{1cm} (6)$$

The watermarked image can be extracted by with the following steps;

**Step 1**: The watermark image $I'$ is decomposed into $n$ levels using discrete wavelet transform.

**Step 2**: Each original transformed image pixel in the chosen sub-band is predicted from its surrounding scaled coefficient values. The predicted original image pixel $q'''_{(i,j)}$ is calculated by

$$q'''_{(i,j)} = \frac{1}{9} \left( \sum_{m=-1}^{i} \sum_{n=-1}^{j} q''_{(i+m,j+n)} \right)$$  \hspace{1cm} (7)$$

**Step 3**: The embedded watermark bit $w'_{(i,j)}$ at a given coordinate $(i,j)$ can then be determined by the following equation

$$w'_{(i,j)} = q''_{(i,j)} - q'''_{(i,j)}$$  \hspace{1cm} (8)$$

where $w'_{(i,j)}$ is the estimation of the embedded watermark $w$ around $(i,j)$.

**Step 4**: Since $w_{(i,j)}$ can be either 1 and -1, the value of $w'_{(i,j)} = 0$ is set as a threshold, and its sign is used to estimate the value of $w_{(i,j)}$ as follows:

$$w'_{(i,j)} = \begin{cases} 0 & q'' - q''' < 0 \\ 1 & q'' - q'' \\geq 0 \end{cases}$$  \hspace{1cm} (9)$$

**Experimental Results**

In the following experiments, two standard colour images, namely ‘Lena’ and ‘Bird’ with the size of $256 \times 256$ pixels were used as the original images. We also used the $32 \times 32$ pixels black & white image containing a logo ‘ICT’. In addition, ‘Haar’ wavelet filter were selected and used in discrete wavelet transform. The level of wavelet decomposition ($n$) and was set to 3. We used both previous algorithms in our method those are the spatial domain embedding and the frequency domain embedding using DWT.

In all experiments, we evaluated the quality of watermarked image by measuring its PSNR (Peak Signal-to-Noise Ratio). The following equation defines the PSNR value:

$$PSNR(dB) = 20 \log_{10} \sqrt{\frac{255^2}{\sum_{i=1}^{M} \sum_{j=1}^{N} (B'_{(i,j)} - B_{(i,j)})^2}}$$  \hspace{1cm} (10)$$
where $M$ and $N$ are the numbers of row and column of the images; $B(i,j)$ and $B'(i,j)$ are the original host image bit and the retrieved watermark image bit at coordinate $(i,j)$. Note that the higher the $PSNR$ value, the better the quality of watermarked image. Furthermore, Normal Correlation ($NC$) value was measured to evaluate the quality of extracted watermark. The calculation of $NC$ value can be expressed by:

$$NC = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} w(i,j)w'(i,j)}{\sqrt{\sum_{i=1}^{M} \sum_{j=1}^{N} (w(i,j))^2 \cdot \sum_{i=1}^{M} \sum_{j=1}^{N} (w'(i,j))^2}}$$

(11)

In this experiment, the performance of the proposed method was evaluated in terms of the quality of watermarked image and extracted watermark. The PSNR of watermarked image was fixed around 40 decibel. Then, the NC value was evaluated. The obtained results are shown in figure 1 and 2.

![Figure 1. The resultant watermarked image at PSNR = 40 decibel](image1)

![Figure 2. The resultant extracted signal NC = 0.954 and NC = 0.965, respectively](image2)

The robustness of our proposed watermarking method was then evaluated by using three different types of attack. The NC values from the attacked images were then computed and compared. A list of the attacks in the experiment consisted of additive Gaussian distributed noise with zero mean at various variances, JPEG compression at various percentage and the salt and pepper noise at various densities. The experimental results are illustrated in table I.

<table>
<thead>
<tr>
<th>TABLE I. ROBUSTNESS AGAINST VARIOUS ATTACK TYPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attack Types</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>JPEG Image</td>
</tr>
<tr>
<td>Quality = 90%</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td><strong>JPEG Image</strong>&lt;br&gt;Quality = 80%</td>
</tr>
<tr>
<td><strong>JPEG Image</strong>&lt;br&gt;Quality = 70%</td>
</tr>
<tr>
<td>Gaussian distributed noise&lt;br&gt;Variance = 0.001</td>
</tr>
<tr>
<td>Gaussian distributed noise&lt;br&gt;Variance = 0.005</td>
</tr>
<tr>
<td>Salt and Pepper&lt;br&gt;Noise density = 0.01</td>
</tr>
<tr>
<td>Salt and Pepper&lt;br&gt;Noise density = 0.02</td>
</tr>
<tr>
<td>Salt and Pepper&lt;br&gt;Noise density = 0.05</td>
</tr>
</tbody>
</table>

**Conclusion**

This paper has described a scheme for digital watermarking based on discrete wavelet transform and pixel modification. In the proposed method, the embedded watermark logo can be recovered without accessing to the original image by applying DWT in the chroma blue channel of $YCbCr$ color space and editing pixel in the spatial domain directly. In the extraction process, the mean filter is used to recover the watermark bits. The experimental results have shown the strength in every types of attack including the non-attacked cases. Especially in the JPEG compression attack, even though the original image is compressed about 70%, the extracted watermark signal is still clearly readable with a high NC value.
References


Institutional strength and strategic use of e-government to improve government collaboration: A study on the implementation of e-audit in Audit Board of The Republic of Indonesia

Pingky Dezar Zulkarnain, Waseda University, Japan

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Abstract
Government institutions have used information and communication technology (ICT) not only to improve public service delivery but also to fight against corruption on top of the concept of e-government. However, government institution alone is not enough to overcome corruption. This study argues that corruption in a country is a systemic crime which could be overwhelmed by a synergistic collaboration among government institutions. This research presents an innovative use of ICT by Audit Board of the Republic of Indonesia (BPK) under a nation-wide program namely e-Audit, an e-government initiative in BPK. E-Audit has strengthened BPK’s authority in term of accessing and collecting the data from other government institutions. This research has analysed 755 government financial data obtained through system walkthrough process. This study adopts a qualitative-interpretive method by analysing the various relevant policies and the use of e-audit system by auditors in Supreme Audit Institution. The interviews have targeted government auditors with differing levels of seniority who actively use e-audit. This study employs an interpretative approach to analyse qualitative data obtained from interviews, system documentation, and a system walk through. Findings from this study enriches the discussion within the e-government area on the context of its role and effectiveness for combating corruption and fraud. Through the construct of innovative e-government development, this study proposed that the e-audit initiative could be disseminated to other government institutions based on their functionality. Therefore, not only does the e-government will be able to deliver a better public service, but also a better strategy for combating corruption.
Introduction

Information Technology (IT) with its rapid growth is increasingly influential in the daily activities of individuals, business, and government. Particularly in the government sectors, as well as in the business sectors, the importance of IT requires organizations to integrate IT within their business process at all organizational levels (Gates, 2001). In fact for governments, IT has been seen as the indispensable key component in the changes that affect the working practice, structure, and performance in order to provide the stakeholders with a better service. These transformations can be achieved through e-government (Janssen & Shu, 2008).

E-Government refers to any use of information technologies by government institutions that enable them to transform their way to communicate and interact with citizens, businesses, and other government institutions (World Bank, 2011). E-Government enables government institution to serve a variety of different outcomes; better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management (World Bank, 2011). E-Government enables government institution to be more collaborative with stakeholders and with other government institutions (Zussman, 2002). In addition, the resulting benefits of e-government can be less corruption, increased transparency and accountability, and cost reductions. The importance of e-government further escalates with the recognition that e-government can be used to help gain competitive advantage (Obi, 2007). Andersen (2009) argues that e-government can be considered a solution for the corruption faced by developing countries (Andersen, 2009). However, according to ACFE on its Report-to-the-Nation (RTTN) 2014, IT only contributed 1.1% in detecting fraud, including corruption.

Recent issues related to corruptions, frauds, and demands on government to work more transparent and accountable have increased the imperative of e-government (Ionescu, 2013). Like other IT, however, effective use of e-government depends on several factors such as technology, stakeholders, environment, and organizational culture (Luna-Reyes, Gil-Garcia, Romero, & Felipe, 2012). Governments can take the benefits of e-government to strengthen democracy and to promote efficiency and effectiveness by establishing a system of transparency, public participation, and collaboration (Obama, 2009). Yet, collaboration among government agencies is one of the common issues faced by governments in developing countries (Waseda Institute of e-Government, 2014).

Supreme Audit Institution (SAI) refers to a government organization in each country that has mandate to conduct audit on government institutions and thereby, sets standards for government audit works (OECD, 2013). In order to accomplish their tasks objectively and effectively, SAI is required to be independent of the audited entity and are protected against outside influence. However, since SAI is part of the state as a whole, SAI cannot be absolutely independent. Therefore, SAI is requested to have the functional and organizational independence to fulfil the mandate (INTOSAI, 1998). Audit Board of the Republic of Indonesia (BPK) is the name of SAI in Indonesia.
Lima Declaration was founded on top of the rule of law and democracy which are essential foundations for independent and accountable government auditing. Independence, accountability, and transparency of SAI are essential prerequisites in a democracy and enable SAIs to lead by example and enhance their credibility. These elements can improve governance, promote accountability, and therefore can help SAIs in fighting corruption (INTOSAI, 2010). SAIs has a responsibility for combating corruption and actively involved in eradicating corruption activities. ISSAI 20 Principle No.4 states that SAIs prevent internal conflicts of interest and corruption and ensure transparency and legality of their own operations.

While connecting the government information system are commonplace permitting real-time data communication among governments and the current state of e-government application enables one government to receive some information online from other governments, the utilization of such capability is still immature among developing countries (Waseda Institute of e-Government, 2014). The more common practice is for one government to receive the information from others, generally by request, by using email or secondary storage devices such as compact disc or flash disk. These practices, based on author’s experience when conducting audit, create unnecessary delay for concerning agency to process further. The delayed data may also create the possibility that it was manipulated or fraudulent data (Lanza, 1998).

Using the case of BPK in synergizing all of its auditee, this study is aimed to investigate how to create such collaboration through institutional strength and e-government. In addition, this study looks for the opportunity to propose the e-Audit as a platform for connecting all government information system.

**Literature Review**

Open government is considered as a prerequisite for democracy society by promoting government transparency and accountability (Bertot, Jaeger, Munson, & Glaisyer, 2010). On January 21, 2009, Barrack Obama endorsed a memorandum about transparency and open government to the head of executive departments and agencies. He gave directions for strengthening democracy and promote efficiency and effectiveness in government by establishing a system of transparency, public participation, and collaboration (Obama, 2009). The following list explained briefly these three principles of open government.

- **Transparency**
  Government should provide the citizen with the information about what the government is doing, thus promoting government accountability.

- **Public Participation**
  Government should engage citizens for participating in the policymaking process and to provide government with the collective expertise and information, hence improving the quality of government’s decisions.

- **Collaboration**
  Government should cooperate among themselves and with stakeholder such as non-profit organization, business, and individual, thus creating opportunities of innovation while improving the level of collaboration.
Transparency can be regarded as the availability of information concerning government activities to the public timely, relevant, and reliable (Ferranti, 2009). The ultimate goal of transparency is to provide the public with government’s data and information so that the public will have the opportunity to assess government action and exercise voice in decision making process (Florini, 2007). Through transparency, government enables the individuals to become more knowledgeable. They may considered their public participation more effectively (Rucinsky, 1991). Transparency and public participation are the important elements for helping government to solve the problem of legitimacy (Fung, 2006).

Collaboration is slightly different from transparency and participation which are frequently associated with democratic political action. It is an arrangement of democratic participation (Noveck, 2009) so that the decision is deliberated in connected circumstances. This circumstances require continuous interaction among governments for integrating their functions into the governance process (Peters, 2011) thus constructing transgovernmental networks. Works of transgovernmental networks are appropriate in the domain of commercial, financial regulation, environment protection, and in legislative areas of government (Slaughter & Hale, 2011). Such inter government network established a cybernetic government in which one government may effectively deliver the task with help of other governments (Wiener, 1948)(Ashby, 1956).

In 2014, Waseda Institute of e-Government has released the 10th International e-Government Ranking. Waseda has consistently published a yearly e-government ranking in ten years. During a decade of doing the ranking, Waseda always take the global trend of information and communication technology into account. For this 10th edition, Waseda uses ten indicators to score e-government development. These indicators are as follow.

- Network Infrastructure
- Management and Optimization
- Online Services
- Government Chief Information Officer (GCIO)
- e-Government promotion
- e-Participation
- National Portal
- Open Government Data
- Cyber Security

Among these nine indicators, open government data is the indicator which articulates the open government initiative.

Open government data is the indicator which represents the spirit of freedom of information in many countries (Yu & Robinson, 2012). The availability of the Freedom of Information Act (FoIA) and open data portal in a country are the significant sub-indicator for measuring the level of open government in the country’s e-government score. FoIA is considered as the basic requirement that must exist prior to further implementation of open government data while open data portal is considered as a media that can be accessed by citizen to obtain government data without restrictions.
On the press release report of the ranking, there is an interesting finding that some countries like United States, Singapore, and Estonia have created a certain mechanism to connect government information system for improving the public service delivery (Waseda Institute of e-Government, 2014).

**Research Methodology**

This research will use the implementation of e-audit at Supreme Audit Institution in Indonesia as the case study for the analysis and discussion. E-audit represents the e-government application that emphasize the synergy of one government institution with other government institutions. In addition, recent research conducted by Research Institute of e-Government, Waseda University, has acknowledged a connected government as the new wave for the next e-government development around the world.

The data collection within this research was conducted through document analysis and interview (Patton, 2001). This approach of data collection typifies an interpretive study in which the author gains an understanding of the good practice and phenomena through the observation. As the research conducted is related to the designing appropriate strategy within a particular social context, which in this case is the government collaboration strategy, the research methodology will be based on the qualitative data. Therefore, the result of the research will be descriptive in nature.

The qualitative data that is gathered through interpretive technique will be presented in the case studies. The case studies will be analysed, and the findings from the investigation process will be discussed based on the theoretical basis. The approach is expected to portrait extensive information and to point out significant findings in the e-audit implementation.

Since this research uses the case study which covers all government institutions in Indonesia, there will be some constraints imposed during conducting the research. The major constraint will be the limited time scale in which the research has to be completed. Other obstacles will be the limitation in accessing to some of the data required and the limitation of opportunities for clarifying the further investigation of the data. Therefore, there are some possible issues during the research that will not be covered in depth. Those matters will therefore be recommended for future research.

**Context Case**

As an institution of 5621 audit professionals with state-wide coverage including 33 regional offices and tight audit schedules, the SAI Indonesia (BPK) needs an IT Solution that is expected to improve audit efficiency, to promote audit consistency, to provide a centralized repository for audit program and result, and to automate testing and analytical procedure.

In 2010, BPK had announced a national project named a National Strategy of Information System (SNSI) for collecting electronic data from all BPK’s auditees and matching the data across auditees. The purposes of this project are to improve the whole audit process and to equip the BPK for accessing information of auditees with the advanced utilization of Information and Communication Technology (ICT).
According to Article 10 of the Audit on State Finance Management and Accountability Act 2004 (No. 15/2004), in performing the audit, BPK has the authority to:

- Request any mandatory documents to the respective officers regarding the audit on state finances
- Access all data stored in any media, assets, location, and all types of assets or document managed and controlled by auditee or other parties as needed for the audit purposes
- Put sealing to any custody of money, goods or documents related to the state finance management
- Request information to relevant people or parties
- Take picture, record and sample for the audit evidence purposes.

Under this project, BPK has built a national database which is a very large database of national financial data. The database will consist of the financial-related electronic data from 2000+ auditees which is scattered all over 33 provinces in Indonesia. IT Bureau, as an organization unit in BPK that is responsible to provide BPK with IT solution to support core activities of BPK, is assigned to define and to deploy the appropriate platform and technology for BPK concerning the SNSI Project.

In addition, through the SNSI project, BPK build an automated analysis and measurement so that BPK’s auditors could validate every batch of data thus providing BPK with Early Warning System (EWS) on the system. Due to the existence of this EWS, BPK will be able to notify the auditee when, in some circumstances, the anomaly occurred.

Using SNSI, the BPK’s auditors could have a valid and complete preliminary data for preparing their audit assignment. As a result, when in the field audit, auditor will have adequate time to complete their audit cycles including preparing audit working paper and audit reporting. On these cycle, SNSI is expected to improve some audit processes such as confirmation technique, audit correspondence and follow-up the audit recommendation.

SNSI is supported by a primary component called e-Audit. E-Audit is a combination of three components; Consolidator Application, Data Model, and Portal. Each component has its own individual function. Consolidation Application is a pair of two applications; Consolidation Agent (AK) and Master Consolidation Agent (MAK). AK is the application service that is installed on auditee’s premise. Its job is to extract, compress, encrypt, and send the data from auditee’s database to the MAK. MAK is deployed on BPK’s premise. Its job is to receive the packet from AK, decrypt it, decompress it, and load to the operational database.

Once the data resides in the operational database, the system will transform and load the data into a data warehouse schema which is available for auditors. The data warehouse schema is formulated using auditor’s analytical procedure as a reference. Auditors access the information through the portal. The Portal provides the auditor with a list of functions that represented the audit program which is commonly used by auditors. Using the portal, the auditor will get an instant result of a particular audit...
program. The analysis that was previously conducted by auditor using several steps can be executed by all auditors with only one click on the portal.

The following diagram shows the architecture of e-audit.

![Diagram of e-audit architecture]

*(BPK RI, 2011)*

*Modified by author*

### Analysis and findings

As of June 2014, BPK has connected 593 out of 756 targeted auditees including local government, central government, and state owned enterprises with BPK’s data centre. Periodically, these auditees submit the financial data automatically using ICT. E-Audit system processes the incoming electronic data and releases the data to the on-duty auditor. The rest 197 auditees are mainly located in the rural area which has a handicap on telecommunication and electricity infrastructure.

In order to speed up the development process of e-Audit, BPK use its institutional strength to influence the auditee for participating in e-Audit project. According to the Audit on State Finance Management and Accountability Act 2004 No. 15, BPK has right to access all data and information related to government auditing process. The refusal of BPK’s right will be considered as a criminal act and subject to the criminal law. In addition, BPK is considered as the state supreme institution in term for government auditing function.

BPK has a higher level of both enforcement and stability than its auditees have. As a result, BPK has successfully ratified 756 Memorandum of Understanding (MoU) with its auditees within three years. For comparison, Ministry of Information and Communication Technology (MICT) launched a policy program called IGASIS (Inter Government Access Sharing Information System), a similar initiative with e-Audit, in 2004. Conversely, this program is considered discontinue due to the fact that the Institutional Strength of MICT is not stronger than that of other ministries.
Institutional Strength is measured using two dimension; stability and enforcement (Levitsky & Murillo, 2009). The following is the table for comparing the Institutional Strength of BPK and its auditee.

<table>
<thead>
<tr>
<th></th>
<th>Stability</th>
<th>Enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPK</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>State Office</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Central Government</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Local Government</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Compiled by author. The score is based on Hierarchy of Laws.

However, some institutions have the higher institution strength than BPK in term of privacy such as Ministry of Finance for taxpayer privacy protection and banking institution for customer’s financial privacy protection. As a result, BPK does not have right to access the taxpayer nor the bank’s customer information directly from Ministry of Finance and banking institution by law.

The endorsement of MoU to its auditees is considered as an innovative use of BPK’s institutional strength for persuading them to participate in e-audit program. Although the Act No.15/2004 has stated clearly that BPK has the authority to access all kind of data related to the audit, BPK decided to propose MoU as a suitable policy arrangement for transforming the way of BPK in collecting the data from auditee. In addition, MoU is benefited as tool for raising the awareness of auditee on e-audit program.

According to the result of interview conducted with government officers in charge as the counterpart for connecting their information system to BPK, e-audit uses the simple yet secure technology in which they are not required to create new system nor modify their existing information system. As a result, this kind of ICT solution has diminished the resistance of auditee from the technical perspective of e-audit. For example, it is not necessarily to spend plenty of time for discussing the data standardization thus eliminating one factor of the failure of information system collaboration initiative (Igari, 2014).

The following table shows the summary of connected auditees categorized by institution type.

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Connected</th>
<th>MoU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional-Owned Company</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>State-Owned Company</td>
<td>47</td>
<td>143</td>
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<tr>
<td>Ministry</td>
<td>21</td>
<td>34</td>
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<tr>
<td>State Office</td>
<td>36</td>
<td>49</td>
</tr>
<tr>
<td>Local Government</td>
<td>484</td>
<td>524</td>
</tr>
</tbody>
</table>

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1 Decree of the People’s Representative Assembly (Ketetapan MPR) No. III/2000 states that the hierarchy of Laws in Indonesia is as follow by its degree; 1945 Constitution, Decree of MPR, Laws, Government Regulation in lieu of a law, Government Regulation, Presidential Decree, and Regional Regulation.
E-Audit is a method for not only receiving electronic data from government information system but also providing the government institution with specific information as part of an audit correspondence such as anomaly of financial report, indication of misconduct, and progress of recommendation completeness (BPK RI, 2010). E-Audit has successfully connected most of its auditees for creating the synergy on the government information system by utilizing the ICT. E-Audit is recognized as the strategic use of e-government by BPK in the area of collaboration and integration. Strategic means that the initiative is considerable large and long range planning and development yet secure and offer the value-added (Mintzberg, 1978). E-Audit is strategic because it has a high level coverage which includes not only central government but also local government and government owned enterprises. It has strengthened the BPK’s authority by transforming the procedure of collecting data from a manual and an on-demand to an automatic and a scheduled data collection. E-Audit requires significant resources and a full attention from all BPK’s elements (BPK RI, 2010) (BPK RI, 2011).

Referring to user's activity log of e-audit portal, there are 4000+ auditors have accessed the e-audit portal during the audit assignments including the audit planning and executing phase. In the planning phase, auditors use e-audit to conduct an analytical procedure on financial transaction for validating the cohesiveness of these transactions and detecting the potential occupational fraud such as asset misappropriation and over/under statement of asset/revenue. During the execution phase, auditors use e-audit mainly to execute confirmation procedures. Feature of online confirmation on air ticket hold 75% of the e-audit usage, followed by online confirmation on tax transaction note (NTPN).

Before the implementation of e-audit, only certain audit teams are able to completely execute confirmation procedure. Complete execution means that the audit teams received the feedback from the third party. In many cases, audit teams are unable to get the answer. The time limitation, audit team's capacity, and responsiveness of third party's counterpart are the cause of an incompleteness of confirmation procedure.

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Connected</th>
<th>MoU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Total</td>
<td>593</td>
<td>755</td>
</tr>
</tbody>
</table>

Source: Data gathered by author.
These conditions create a capability gap among audit team in which some audit team are able to conduct confirmation procedure completely while the other teams are unable to do so.

According to SAS No. 67 in AU Section 330 of Professional Standard of Auditing, the confirmation process includes the following tasks:

- Selecting items for which confirmations are to be requested.
- Designing the confirmation request.
- Communicating the confirmation request to the appropriate third party
- Obtaining the response from the third party
- Evaluating the information, or lack thereof, provided by the third party about the audit objectives, including the reliability of that information.

Auditors around the world, not only those in public accounting firm but also those in Supreme Audit Institution, follow these guideline systematically. The common steps of such processes are as follow.

i. Gathering the information that would be submitted to the third party
ii. Creating the confirmation letter
iii. Submit the confirmation letter along with the information that should be acknowledged by the third party
iv. Accepting the response
v. Review these information
vi. Write the confirmation result.

In fact, there is an uncertainty of time needed from step (iii) to step (iv) due to some bureaucratic and clerical task needed at the third party's premise. In case auditors did not receive any responses from the third party, they may have to perform alternative procedures which rely on auditor team's capability and time allocation.

Using e-audit system, the related third parties periodically submit the data to BPK. As a result, in the execution phase for executing the confirmation procedure, it is not necessary for auditors to contact them directly. Instead, they use e-audit to conduct confirmation process and get the result straightaway. This is an innovative use of ICT by BPK to cut the formal bureaucratic procedure thus reducing the time needed for completing the confirmation process.

Cressey (1953) posits that there are three factors of people committing fraud. They are pressure, opportunity, and rationalization. Any fraud activities share these three factors. It is commonly known as the Fraud Triangle (Cressey, 1973). While Cressey believes that all three factors exist in any fraud, American Institute of Certified Public Accountants (AICPA) states that only one of these factors needs to be present in order for fraud to be committed. According to Statement of Auditing Standard (SAS) No. 99 about the Consideration of Fraud in Financial Statement Audit, there are three categories of proxies for opportunity to commit fraud; nature of industry, ineffective monitoring, and organizational structure (AICPA, 2002).

Aligned with those in SAS No. 99, e-audit is aimed to strengthen BPK’s monitoring on government financial transaction. Using e-audit, BPK gain more control on
government financial data thus enabling its auditor to detect some irregularities and anomalies on government transaction records. This ability, through interview with selected seven senior auditors, has narrowed the opportunity of government officers to commit fraud such as fabricating the transaction record, forging up the travel allowance, and delaying the transaction recording process.

The following table shows an interesting audit finding within three years on fraud cases specifically on travel allowance. The audit findings are reported publicly on the website twice every year in the form of the Semester’s Audit Report Summary (IHPS).

![Fraud Cases: Travel Allowance Fraud 2010-2014](image)

**Cases of Fraud on Travel Allowance, compiled from IHPS 2011-2013**

**Conclusions**

This study has found that BPK has successfully utilized its institutional strength for implementing e-audit. BPK has introduced e-audit as its e-government flagship that highlights inter government collaboration for improving its audit authority, efficiency, and effectivity thus strengthening its role in monitoring government financial transaction. As a result, BPK has established a collaboration system that addressed to wipe out fraud in government institution.

E-Audit can be viewed as a model of context-based governmental collaboration. The collaboration model, considering its simplicity and scalability, is feasible to be implemented by other government institutions based on their specific institution strength. It offers a quasi-real-time process for data confirmation across participating institutions. Therefore, not only does the model improve the public service delivery, it also minimize the government officer’s opportunity for committing fraud.

Finally, the BPK’s experience in the development of e-audit as its e-government platform shows that government collaboration can be achieved using institutional
strength and ICT by reducing technical complexities which is commonly found in any government collaboration initiatives.
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Teaching Science in The Basic Education Levels in Nigeria: Challenges and Way Forward

Dahunsi T.O., Federal Capital Territory, College Of Education, Nigeria
Funmilayo Nike Oyedeji, Federal Capital Territory, College Of Education, Nigeria

Abstract
This paper thus looked into the teaching of science in the basic education levels in Nigeria: challenges and way forward. Government and other stakeholders should endeavor to improve the system by assisting, improving and supporting science teaching for national development. The challenges noticed include poor funding, lack of appropriate and adequate teaching materials, lack of qualified teachers, poor attitude of pupils/students to science. Some recommendations were made which includes: taxable adults to contribute financially to funding education, pupils should be encouraged to do science at the higher levels, but primary and junior secondary schools to be made accessible to pupils in villages and hamlets, government should employ qualified teachers to these remote areas with special salaries and other incentives.

Keywords: Basic Education, Improvement, Science, Skills, Teaching
Introduction

Science is derived from Latin word scientia, "scire" which means to know. This term is used in a broad sense to denote systematized knowledge in any field. This can be narrowed down to knowledge about the structure and behavior of nature and physical world based on the facts that can be proved. Science can be further divided into these subheadings (Encarta Encyclopedia, 2004).

a. Pure or Natural Science
b. Social Science
c. Applied Science
i. Pure or Natural Science - This can be divided into physical and biological science (study of life) while physical science are studies of astronomy, chemistry, geology and so on.
ii. Social Science - Social science is the study of origin and development of human society and institutions, relationships, and ideas involved social life and so on.
iii. Applied Science - Knowledge gained from science used in solving real life problems, this is applied science that is. field of study like engineering, medicine, space explorations, information technology and so on.

Science Education in Nigeria

It is always difficult to state categorically when science education developed in any civilization, but one can state when major breakthroughs were made. Remarkable changes were made in science education/teaching in Nigeria as stated here:-

(A) Establishment of Missionary Secondary Schools
In 1859, science education/teaching was introduced in missionary secondary schools in Lagos and nature study was taught on the environment including outdoor observation of plants, animals and non-living things. Although science teaching progressed with further establishment of more missionary schools in Nigeria, the quality of teachers and teaching of science and the number of pupils/students interested in science education lacked a lot of things at this period, (Ayodele 1999). These include:-
   i. Lack of science laboratories.
   ii. Lack of qualified science teachers.
   iii. Lack of interest or enthusiasm shown by the colonial government.
   iv. Lack of instructional objectives in science teaching.
   v. Lack of funds to promote science education.
   vi. Lack of science text books.

(B) Colonial Government Participation in Science Education
Within the period 1883 - 1930 the position changed when the then colonial government passed education ordinance bill of 1908. The bill stipulated certain condition, for government to give grants to missionary schools. With these grants,, some of the missionary schools were able to acquire science equipment for laboratory instruction.
(C) Local Community Participation and Government Effort
Before 1931, science education did not progress much because most parents were not literate enough to understand the benefits of science education. Those that were literate preferred their children to study abroad and preferred fields of study like: law and humanity. The trend continued until 1932 when literate parents put pressure on government to establish Yaba College (up graded in 1963 to Yaba College of Technology) with the objectives to provide teachers to teach basic science subject in secondary schools, in addition to providing qualified assistances in medical, engineering and other vocational education. The period 1931-1959, witnessed, a lot of local community effort at spreading science education.

The enactment of the 1948 education ordinance further enhanced science education in Nigeria; other notable events that promoted science education in Nigeria are:

i. Establishment of university colleges Ibadan in 1948;
ii. Introduction of high school certificate 1951;
iii. Setting up of an examination board letter known as (West African Examination Council) in 1952;
iv. Inauguration of Science Teacher Association of Nigeria (STAN) in 30th November 1957;
v. Introduction of free universal primary education in western region in 1955 and free universal primary education in eastern region 1957;
vi. Establishment of federal college of arts and science and technology at Ibadan in 1950, Zaria in 1952 and Enugu, 1954;
vii. Establishment General Certificate Education GCE in 1958

A lot of committees, commissions, and institutions were created between 1958 and 1960 to enhance science education.

(D) Curriculum Innovations in Science Education that Promoted Rapid Development
There are other remarkable invocations that enhanced science education between 1960 and to the year 2004 that are worth mentioning. They are:

i. Establishment of federal government colleges otherwise known as unity schools in 1973. These unity schools were highly equipped with spacious science laboratory thereby affording students the opportunities to learn science.
ii. Another major event is the establishment of national youth service corps (NYSC) programme in June, 1973. Science graduates were posted to compliment the acute shortage of science teachers in many schools of the federation - Adesina (2000).
iii. A new National Policy on Education was established in 1977. The basic aim of the policy was technological transfer or awareness. Education in this programme is free and compulsory for every citizen of school age that is the first nine years in school- for the basic education levels (FME, 2004).

Relevance of Basic Science

One of the important goals of schooling is to teach science students to think positively and school subjects taught should help to accomplish this goal and if basic science
lessons can be planned towards achieving the set goals the followings might be attained, Piadilla (1990)

- Basic Science forms the foundation of all the sciences like Biology, Physics and Chemistry that the students study at a later stage of their education.
- It helps cultivate and develop in the students the skill of inquiring, knowing and rational mind for the conduct of a good life and democracy,
- It enhances better understanding of the immediate environment.
- It helps to promote a change in disposition or behavior that is relatively permanent overtime and brought about by experience (Adeyanju, 2003).

If Basic Science is to be used to achieve national objectives, then the use of good teaching methods through which these knowledge and skills can be conveyed to learners easily must be adopted. This met study is premised on teaching science in the basic education levels in Nigeria challenges a hod of teaching becomes a very important companion for effective teaching and learning in this case.

**Empirical Study on the Teaching of Basic Science**

The target of the study is premised on teaching science in the basic education levels in Nigeria: challenges and way forward. Science has been accepted in the entire world as the vehicle for technological advancement, Adeniran (2005). Science plays an important function in educational system of all the nations of the world including Nigeria, because science has the power of overwhelming force that can lead to decision making in the life of individual student which might affect the nation. The place of science is widely recognized and has made science to be globally outstanding and distinct among other subjects and as important tool for technological development and advancement. Considering the importance of science in the development of the individual and the nation, this has led to the special position and recognition given to science in the curriculum of both the primary and junior secondary schools levels as a core – subjects in Nigeria. Science should be taught well and to attain the level of desired scientific and technological height, effective science teaching must be put in place.

Science should be taught to assist in contributing to knowledge through its uniqueness – skills, with emphasis on hypothesizing, encouraging the students to use and manipulate things in their immediate environment, by observing, making inferences based on previously gathered data, obeying the rules of being precise in quantity to be used, using the appropriate words or symbols, classifying objects accordingly and state the results honestly and precisely.

**Basic Science Process Skills includes the followings:**

Observing – imploring the senses to collect and gather relevant information and obtain objective of events.

Inferring – bringing in or introducing some information gathered relating previously gathered data or information.
Measuring – quantity, size, weight, distance, capacity of a substance using both standard and nonstandard (unspecific) measures to ascribe or describe the dimension, quantity of a substance.

Communicating – the use of symbols, words, diagrams, pictures, words to illustrate, describe an events or actions.

Classifying – divide, put or arrange into classes or grouping objects or events into categories based on characteristics or properties.

Predicting – to make something known in advance especially using inference, stating the result of a future event based on a specific pattern of evidence, Dahunsi (2014)

A reasonable portion of the science curriculum should emphasize process skills, according to the federal government science curriculum produced by the federal ministry of education (2004). Teachers need to select curricula which emphasize science process skills. Importance and emphasize should be made on the implementation of this and there should be special provision for materials needed for this purpose.

Theoretical Frame Work

Science students need to improve in skill acquisition, decision making and have better understanding of principles and concepts in science and inquiry based learning is concerned with the need for good methods used in science teaching, this can be promoted through the use of adequate and appropriate teaching methods at all levels. Science students are expected to be capable of formal logical reasoning and abstract thinking and these can be developed through inquiry.

Inquiry theory of teaching help science in posing questions or problems rather than presenting already known facts or ideas of the teacher which may also lead to easier method of acquiring knowledge without involving much thinking. Questions are asked that will allow for developing scientific attitudes.

This teaching method of science discussed is inquiry/problem solving and it involves:

- Allowing them create question on their own.
- Let them arrive with presentable proof to answer the questions.
- Ability to explain the presentation.
- Creating room to linking knowledge achieved from the finding process.
- Giving room for contribution and supporting finding with reasonable explanation.

Here science students/pupils must be involved in formulation of questions, making observations, performing experiments and to find out what information/findings already known or recorded.

It involves four levels –

**Confirmation inquiry level**- (the materials are known but students only work further leading to new knowledge).
Structured inquiry – students are to provide answers to questions posed by the teacher and the teacher provides outline on how to carry out the findings.

Guided inquiry – students are given question – they design and follow their own procedures for testing.

True inquiry – students get questions, design, develop procedure and get their results.

For a successful use of inquiry method, the following must be considered:

- Students should not be encouraged to memorize.
- Allow them to develop new knowledge that builds in previous knowledge.
- Lead them to develop new understanding with the use of previous understanding of concepts and of new scientific knowledge.
- Encourage team/ peer group learning.
- Allow freedom of acquiring knowledge, Wikipedia (2014)

Challenges Facing Science Teaching in Nigeria

Despite the fact that the government has a claim of having invested a lot in science education, there are some persistent challenges as stated here below Ayodele, (1999):

Inadequacy of Science Textbooks
Science text books are not adequately available; the ones available are written by foreigners, with their language and cultural background, making it difficult for indigenous students to understand. Although indigenous teachers/authors tried to compliment by writing science text books but the books cannot bridge the existing gaps to meet scientific standard of the outside world, Ribadu & Yusuf (2006).

Inadequacy of Science Laboratory Apparatus and Equipment
Most laboratories are ill-equipped, schools rely more on imported laboratory apparatus and equipment and the grants are never enough. Although government took a giant step by establishing science laboratory manufacturing industries and these industries do not have enough raw materials and man power.

Large Class Sizes in Science Teaching
One teacher to 20 students as recommended still remains a dream in schools. Classes are over populated to the tune of 40 and above.

Inadequacy of Science Teachers
Science teachers are not sufficient. Most science teachers are not professionally trained. The few available should be encouraged and allowed to go for in-service training, workshops, seminars and conference and the back up with reasonable incentives should be a continuous issue.

Approaches to Science Teaching
Science is an abstract course and will only be understood through the use of adequate and appropriate teaching methods. Some science teachers do not put extra effort in improvisation of teaching materials.
Students’ Attitude and Aspirations
Some students/pupils have made up their mind that they are not going to study science, therefore will not waste time on the subjects.

Poor Funding of Science Teaching
Inadequate funding of science is one of the obstacles to effective management of schools in the country. Improper management of the little funds available has also contributed to the big and seems to be incurable problem in Nigeria educational system, and overcoming these holds the key to educational development and success in the country, www.onlinenigeria.com (2014).

Way Forward

• Government to encourage and assist science teachers the principal executors of the curriculum to produce books for pupils’ use with the financial assistance of stakeholders because they are conversant with the content and know the instructional material needs and requirements of their pupils. Government, parents and other stakeholders should buy good science books, science teaching materials with laboratory apparatus and equipment Ajayi & Adeosun (2004) for schools with the involvement of subject teachers.

• Funding of schools should be taken seriously, in a situation where government claims to spend a lot on science education and nothing to show for it and the cry for fund is getting louder daily. Allocation should be closely monitored to prevent embezzlement by the people charged with responsibility of managing it. Also taxable adults to contribute financially to education and any damage made on any facilities and equipment should be replaced or repaired immediately.

• Provision of more science schools should be of paramount interest of the government. State and local governments should put up more classrooms and laboratories to achieve the stipulated ratio in order to avoid overcrowding, which is harmful to effective teaching and learning Kankia (2007).

• Schools should be planned very close to the people as neighbor as stated in the National Policy on Education, FME (2004), to relieve students from trekking long distance before getting to schools.

• More science schools automatically mean more qualified science teachers; government should make provision and prepare for re-training of qualified science teachers in Nigeria. In this regard, all institutions designed to train and upgrade science teachers should wake up to their responsibilities in giving adequate and qualitative training to the prospective teachers. As much as there is need to train more science teachers to fill the classes; quality must be the watchword. Science teachers should also be positively motivated to ensure dedication and conditions of service to be improved to keep them on the job and for better results.

• Government to enlighten parents and guardians on the importance of science to development and they in return are to encourage their wards to do and take science subjects seriously.

• Community members should be charged with the responsibility of encouraging the pupils/youths to study science subjects in future, Dahunsi (2007).

• Inspectors of education should visit schools and ensure that good teaching methods and appropriate instructional materials are used for teaching science, Abidoye (2005). Science teachers’ allowances should be revisited upward and paid along with salaries.
Conclusion

Conclusively, other problems that can be deduced on the teaching of science are: ignorance of the importance of science by the masses; government policies on education which affects funding; poor motivational factor of parents or guardians of pupils in schools who tend to discourage their children feeding them with the ideas that science is difficult and an abstract subject; qualified science teachers posted to remote areas to be paid special salaries and allowances and incentives like holiday trips to a comfortable place in and out of the country with reasonable allowances attached to the trips to be paid promptly..

Recommendations

The following recommendations are made.

- This image of science teachers reflects much on the pupils’/students' interest in a course. Government should improve the standard of living of science teachers to make them concentrate on teaching profession alone rather than engaging in odd jobs to make ends meet, Adeyemo, Oke & Ishola (2009). Government should appoint professional teachers to educational posts rather than politicians who will eventually politicize education.
- Frequent organization of train the trainers' workshops for science teachers will aid them to acquire new skills and exchange ideas and views on how to improve science education, Onuigbo & Eze (2012).
- Science teachers should be trained on how to improvise laboratory equipment to supplement government effort and up with the need for basic equipment for science education. In addition, all the established science equipment manufacturing sectors should be encouraged to produce enough science equipment, Onuigbo & Eze (2012).
- Science class size should be reduced to about 20 pupils/students per teacher, Talata (2012).
- The policy that established the 6-3-3-4 system of education should be revisited and the target reviewed so that at the end of primary education the candidate would have learnt basic technology like wood work, masonry, applied art and so on.
- More practical approach should be adopted towards teaching science students to give room for application of what learnt in science classes so as to appreciate the subject. Government should make provisions for the supply of materials for practical to schools in good conditions with power supply that should be made available in schools & in regular supply for practical classes, Dahunsi (2014).
- Indigenous scientists should be encouraged to write more science books with our cultural background and rich in expected science norms and ethics.
- Governments can greatly improve the quality of science education system if they can increase funding of all levels of education. Funding of science should be provided on the basis of needs and not what the government can afford. Higher quality science education can be accomplished, cost of education be improved and increased in – takes of pupils be encouraged and promoted, Dahunsi (2010).
References


Exploring Learner’s Patterns of Using the Online Course Tool in the University Classes

Yoshihiko Yamamoto, Ritsumeikan University, Japan
Akinori Usami, Ritsumeikan University, Japan

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Abstract
Online course tools such as WebCT or Manaba+R are popularly used in university classes and enhance learners’ understanding of their course contents. In addition, teachers try to utilize these online course tools for their students such as giving their students online discussions, providing students with additional materials and so forth. However, based on the authors’ observation of students, students often do not see these additional materials and messages on Manaba+R. The authors encourage their students to use it and, in fact, they put a lot of additional materials of the course or useful messages for their students on Manaba+R. The aims of this study are here. Firstly, this study investigates what extent students actually use Manaba+R through the semester. Secondly, it tries to find suggestions of how teachers can promote their students to maximize making use of Manaba+R. To collect the data, coding actual access to Manaba+R by students and questionnaires were used. The total of 335 responses of questionnaires were collected and total of 380 were coded for actual access to Manaba+R. The questionnaire results show that many students showed positive attitudes towards using Manaba+R. The results of coding numbers of access reveal that using Manaba+R was part of their assessment of their course, students tended to use it.

Keywords: online course tools, university education
Introduction

Thanks to rapid growth of technological devices such as smart phones and tablet devices, these technological devices are widely used in university classes. Online course tools such as WebCT, Moodle or Manaba+R are often used for many courses at university. These online course tools provide both teachers and students with a better learning opportunity when they are used effectively (For example, Harris, 1999; Mende, 1999; Morss, 1999 and Burgess, 2003). Although online course tools are useful for both teachers and students, several studies report problems with these tools such as lack of student’s motivation (Ngai, Poon and Chan, 2007) and technical problems which make student’s access unavailable for using online course tools (Petrides, 2002). The authors of this study encourage their students to use Manaba+R in their classes. They also post some messages and homework on Manaba+R. However, the authors of this study realize that some students often access (delete word) Manaba+R but other students hardly access to it throughout the semester. Thus, there are two aims of this study. Firstly, this study investigates to what extent students actually use Manaba+R throughout the semester. Secondly, it tries to find ways teachers can promote the use of Manaba+R to their students so they maximize its use.

Literature review

Past studies of use of online course tools for university students explains several advantages of these online course tools. For example, Ngai, Poon and Chan (2007) explains that online course tools such as WebCT allow students to access learning tools such as discussions boards, chat rooms and course content management. Hagler (2004) suggested the benefit of WebCT is like building rapport with other students through discussions and chart features. Picciano (2002) also claims the advantage of using online course tools for students. They provide students with a sense of being in and belonging in their course, and the ability to interact with their classmates and their lecturers outside a face-to-face class. Willette (2002) points out the flexibility of using online course tools. For example, if students cannot come to the class or if they miss things in class, then they can access online course tools to check lecture notes anywhere online access is available. Also instead of using Emails or phone calls, if a lecturer thinks a question by one of students is useful for other students, then the question and answer can be posted on bulletin board at anytime. Petrides (2002) found that online discussion rooms provide students with an opportunity to discuss more details with other students than face-to-face interactions.

However, online course tools sometimes do not work effectively for students. Ngai, Poon and Chan (2007) found that their student’s attitude towards online course tools was important for them to use online course tools. They conclude that their students used WebCT because their lecturers told them to use it as a specific subject requirement. Therefore, if lectures do not ask students to use online course tools, then students may not show their interest in using online course tools. In addition, Ngai, Poon and Chan (2007) point out that using online course tools should be easy for students to use. If those online course tools are too difficult for students to use, then students loose their interest in using them. Further et al. (2002) argued that unless a Web-based learning tool was professionally developed, implemented, maintained and administrated, the positive support to learning could go in a different direction.
Petrides (2002) found that some students were disadvantaged due to technical problems. Some students had slow modems at home which made it difficult for them to participate in online discussions. Other students were only able to access the Internet outside of the class at their workplace and thus it was difficult for them to use online course tools outside of the class.

**Methodology**

In order to collect the data for this study, the authors used questionnaires for their students and counted numbers of views of Manaba+R by participants. All questions on questionnaires are listed below.

Q1: How often did you bring your PC in class?
1: every time, 2: almost every time, 3: sometimes, 4: hardly, 5: never

Q2: How often did you use your PC in class?
1: every time, 2: almost every time, 3: sometimes, 4: hardly, 5: never

Q3: How often did you use Manaba+R?
1: every time, 2: almost every time, 3: sometimes, 4: hardly, 5: never

Q4: Did you have homework through Manaba+R?
1: every time, 2: almost every time, 3: sometimes, 4: hardly, 5: never

Q5: Did you read messages on Manaba+R?
1: every time, 2: almost every time, 3: sometimes, 4: hardly, 5: never

Q6: Reasons for Q5

Q7: Do you think Manaba+R is useful for your classes?
1: Strongly agree, 2: agree, 3: not really, 4: never

Q8: Where do you normally look at Manaba+R?
1: in class, 2: at home, 3: outside the class but on campus, 4: on a bus or train, 5: others

Q9: Do you think Manaba+R is useful to communicate with your teacher?
1: strongly agree, 2: agree, 3: not really, 4: never

Participants in this study are mainly both 1st and 2nd year students at a private university in Japan who are majoring sport and health science and economics. Due to repeating the same course, 3rd year students are included in Economics department classes. Each department has different programs. In the sport and health science department, two English subjects: project-based English and skills workshop are offered for students. The data is collected from all project-based English subject. In economics department, there are English classes covering the four skills, such as Listening, Reading, CALL and Communication & Writing. The data is taken from Listening and CALL classes. In addition, the data is also collected from the Introduction of Economics in English 1 (for 2nd year students).

A total of 380 responses to questionnaires were collected. Questionnaires were distributed to students who belong to both the Sport and health science department, and the Economics department. The authors of this study coded numbers of the total access to Manaba+R. The total of 159 (80 first year students and 79 second year students) students of Sport and health science department and 220 (121 first year students, 61 second year students and 38 third year students) Economics department were coded. The total of 379 students from both departments were coded to show the numbers of actual access to Manaba+R.
Results

Results of questionnaires
Results of all questions are put into graphs below. Hereafter, SPORT for Sport and health science department, and ECON for the department of Economics are used.

Graph 1 (Results of Q1)

Graph 1 shows the results of Q1 (how often did you bring your PC in class?). It shows a significant difference between the two departments. Most of those who belong to SPORT brought their PC into their class. 81% of students answered every time and 13% of students answered almost every time. On the other hand, most of those who belong to ECON did not bring their PC into their class. 94% of them answered that they never brought their PC in their class and 4% of them answered that they hardly brought their PC.

Graph 2 (Results of Q2)

Graph 2 shows the results of Q2 (how often did you use your PC in class?). The results of this question links with the results of Q2. SPORT students used their PC a lot in their class. 80% of them answered every time and 16% answered almost every time. Since SPORT students answered 94% brought their PC into their class in Q2, the ratio of using PC in class was very high. As opposed to ECON students, 71% of them answered they never used their PC in class which is linked with their answers in Q2. In Q2, 94% of them never brought their PC into their class which made them unable to use their PC in class. However, there is an exception for ECON students in Q2. 17% of them answered that they used PC every time. This is because these
students were in CALL classes where each student accessed a PC provided by their university.

**Graph 3 (Results of Q3)**

Graph 3 shows the results of Q3 (how often did you use Manaba+R?). Similarly to the results of both Q1 and Q2, SPORT students lead ECON students in Q3. 93% of SPORT students answered every week. However, positive results for ECON students are seen here. 49% of ECON students answered every week and 17% of ECON students answered almost every week. Over 66% of ECON students checked Manaba+R frequently through the semester.

**Graph 4 (results of Q4)**

Graph 4 shows the results of Q4 (did you have homework through Manaba+R?). Once again, 94% of SPORT students answered every time and only 4% of SPORT students answered almost every time. There is an interesting trend for ECON students. While 43% of ECON students answered every time, 31% of ECON students answered never. This depends on English classes. Some English classes for ECON did not require students to do homework and thus students did not have to do their homework on Manaba+R. As for SPORT students, homework was assigned every week on Manaba+R and thus a quite high ratio of positive answers were seen in this question.
Graph 5 shows the results of Q5 (did you read messages on Manaba+R?). 45% of SPORT students answered every time and 34% of SPORT students answered almost every time. In total, 79% of SPORT students frequently read messages by their teachers on Manaba+R. Messages for SPORT students on Manaba+R were something important for their study, such as some tips for their assessments and feedback for their presentations and homework by their teacher. As for ECON students, 35% of ECON students answered never and 15% answered hardly. Thus 50% of ECON students negatively answered this question. This is because their teacher did not often post messages on Manaba+R as Table (shown earlier) in the section of coding actual access shows.

### Table 6 (Q6: reason for Q5- Sport)

<table>
<thead>
<tr>
<th># of comments</th>
<th>%</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>42%</td>
<td>The teacher put useful information for this class.</td>
</tr>
<tr>
<td>18</td>
<td>18%</td>
<td>It shows some important tips for assignments in this class.</td>
</tr>
<tr>
<td>9</td>
<td>9%</td>
<td>Every week, there is homework on there.</td>
</tr>
<tr>
<td>9</td>
<td>9%</td>
<td>To make sure if there is any message or homework.</td>
</tr>
<tr>
<td>9</td>
<td>9%</td>
<td>I didn’t understand some parts in class but Manaba+R explained them.</td>
</tr>
<tr>
<td>6</td>
<td>6%</td>
<td>To download lecture notes.</td>
</tr>
<tr>
<td>5</td>
<td>5%</td>
<td>It shows about presentations which I have to do.</td>
</tr>
<tr>
<td>2</td>
<td>2%</td>
<td>If I don’t check it, then I’ll be in trouble later.</td>
</tr>
</tbody>
</table>

### Negative

<table>
<thead>
<tr>
<th>%</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>It made me annoyed to check it, I was being lazy.</td>
</tr>
<tr>
<td></td>
<td>It was too much messages for me and I was being lazy.</td>
</tr>
<tr>
<td></td>
<td>Explanation in class was enough for me without checking Manaba+R.</td>
</tr>
<tr>
<td></td>
<td>I don’t really know how to use it.</td>
</tr>
<tr>
<td></td>
<td>I was being lazy.</td>
</tr>
</tbody>
</table>

TOTAL: 105 comments

Table 6 shows that reasons for Q5. The total of 226 reasons were written (SPORT: 115 and ECON: 121 comments). SPORT students tend to answer positive reasons more than negative reasons. For instance, 42% of SPORT students said “the teacher put useful information for this class”. 18% of SPORT students said “It shows some important tips for assignments in this class”. These two reasons suggest that Manaba+R helped student’s study. 9% of SPORT students answered “every week,
there is homework on there”. This reason suggests student’s external motivation to check Manaba+R. 6% if SPORT students answered “to download lecturer notes”. There are also negative reasons from SPORT students. Mostly they showed their laziness on their answers. For example, “it made me annoyed to check it, I was being lazy”, “it was too much messages for me and I was being lazy”.

Table 6 (Q6: reason for Q5- Sport)

<table>
<thead>
<tr>
<th># of comments</th>
<th>%</th>
<th>ECON</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>17%</td>
<td>To check the class information.</td>
</tr>
<tr>
<td>14</td>
<td>12%</td>
<td>To check test score.</td>
</tr>
<tr>
<td>12</td>
<td>10%</td>
<td>I must submit homework through Manaba+R</td>
</tr>
<tr>
<td>3</td>
<td>2%</td>
<td>Important information was posted on the Web.</td>
</tr>
<tr>
<td>15</td>
<td>12%</td>
<td>I didn’t know how to use it, what to do.</td>
</tr>
<tr>
<td>14</td>
<td>12%</td>
<td>No chance to use Manaba+R</td>
</tr>
<tr>
<td>14</td>
<td>12%</td>
<td>No need to check it.</td>
</tr>
<tr>
<td>11</td>
<td>9%</td>
<td>No information was posted.</td>
</tr>
<tr>
<td>17</td>
<td>16%</td>
<td>Others</td>
</tr>
</tbody>
</table>

As for ECON students, there are both positive and negative reasons. Concerning positive reasons, 17% of ECON students answered “to check the class information”. This is a similar answer to SPORT student’s “the teacher posted useful information for this class”. 10% ECON students answered “I must submit homework through Manaba+R”. 12% of ECON students answered “to check test score” which was not seen among SPORT students. This is because SPORT students did not have any test type assessments through their subjects. On the other hand, there were negative reasons among ECON students. 12% of ECON students said “I didn’t know how to use it, what to do”. 12% answered “no chance to use Manaba+R” and 12% answered “no need to check it”. 9% answered “no information was posted”. There were some reasons such as “I can’t use computer in class” from ECON students, “I didn’t know how to use Manaba+R” from both departments.

Graph 7 (Q7)

Graph 7 shows the answer for Q7 (do you think Manaba+R is useful for your class?) Both SPORT and ECON students gave positive answers. The total of 97% (61% for
strongly agree and 36% for agree) of SPORT students answered this question positively. As for ECON students, 92% (31% for strongly agree and 61% for agree) answered this question positively. Thus based on the results of this question, students think online course tools are useful for their study.

Graph 8 (Q8)

Graph 8 shows the answer for Q8 (where do you normally look at Manaba+R?). Interestingly, both SPORT and ECON students checked Manaba+R at home the most. 61% of SPORT students and 53% of ECON students answered at home. As for SPORT students, most of them brought their PC in class as seen in graph 1 they tend to check Manaba+R at home at most. In addition, 19% of them checked Manaba+R outside of their class while only 14% of them checked Manaba+R in class. This result suggests that although students were able to access to Manaba+R in class, they did not check it in class. As for ECON students, because most of them did not bring their PC in class as seen in graph 1, the result of this question makes sense.

Graph 9 (Q9)

Graph 9 shows the results of Q9 (Do you think Manaba+R is useful to communicate with your teacher?). Both SPORT and ECON students answered this question positively. The total of 83% of SPORT students (24% for strongly agree and 59% for agree) see Manaba+R as a useful communication tool with their teacher. Also a total of 81% of ECON students (15% for strongly agree and 66% for agree) see it as the same way as SPORT students do.
Coding numbers of actual access to Manaba+R by students

Table explains names of subjects which the authors used for this study. For Sport and Health Science department, although there are only two kinds of subjects, there are seven classes in total (P1: 3 classes and P3: 4 classes). For the Economics department, three kinds of subjects were examined but the total of six classes are examined (L1:3 classes, CALL1: 1class and Economics in English: 2 classes)

Table 1

<table>
<thead>
<tr>
<th>Name of the subjects</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 (Project English 1 for 1st year students)</td>
<td>Sport &amp; Health Science</td>
</tr>
<tr>
<td>P3 (Project English for 2nd year students)</td>
<td>Sport &amp; Health Science</td>
</tr>
<tr>
<td>L1 (Listening English 1 for 1st year students)</td>
<td>Economics</td>
</tr>
<tr>
<td>CALL1 (for 1st year students)</td>
<td>Economics</td>
</tr>
<tr>
<td>Introduction of Economics in English 1 (for 2nd year students)</td>
<td>Economics</td>
</tr>
</tbody>
</table>

Table 1 summarizes actual access to Manaba+R by students. First of all, there is a trend that when teachers posted messages on Manaba+R, students tend to access to manaba+R more than when teachers did not post messages (seen as P1:A, B, C, P3:A, B, C, D, E(EEb and EEd)). Messages on the tables were something which were useful for students to get higher marks on their assignments.

Secondly, when teachers posted homework which was as a part of assessments, students tended to access to Manaba+R more compared to when teachers did not post homework on Manaba+R (seen as P1:A, B, C, P3:A, B, C, D, E(EEb and EEd)).

Figure 1 shows the rate of access to Manaba+R per student through the semester. Students who access the Internet in class tend to check Manaba+R frequently. For instance, those who are in classes such as P1:A, B, C, P3: A, B, C, D and CALL, access Manaba+R over 400 times through the semester. In these classes, teachers encouraged students to use computers in class. However, those who are in classes
such as D:L1A and B, and EEd did not access Manaba+R frequently. In these classes, students did not have an opportunity to access their computer in class.

**Discussions**

First of all, Manaba+R tends to support student’s study, as results of Q6 (reasons for whether students read messages on Manaba+R?) show. There are positive reasons such as “the teacher put useful information for this class” and “It shows some important tips for assignments in this class”. These positive answers suggest that Manaba+R helps student’s learning and it was effectively used by students.

On the other hand, there were negative answers such as “I didn’t know how to use it” and “I can’t use the computer in class”. The authors of this study explained how to use Manaba+R at the beginning of the semester in class and also students should have had an opportunity to learn how to use it over orientation week. In order to make sure whether every student understands how to use online course tools, teachers need to confirm every student knows how to use it at the beginning of the semester and try to encourage them to use it through the semester. As for the reason “I can’t use computer in class”, it can be a problem for students to use online course tools. Fortunately, the university where the authors of this study work offers both students and staff free WIFI connection everywhere on campus. Therefore, when those who have a device to access online, they can use Manaba+R anywhere on campus. However, some universities do not offer such an environment which discourages students to use online course tools. As a result, in order to encourage students to use online course tools, it is important for educational institutions to provide an environment for students where they can easily access online course tools.

Secondly, based on the results of the numbers of access to Manaba+R by students, there are some trends of student’s access to Manaba+R. Students tend to access Manaba+R when something, which is related with their final grades, was posted on Manaba+R. For example, when homework, test results, quizzes and important messages for their assessments are posted on Manaba+R by their teachers, then students tend to check Manaba+R. This result is a similar result of Rovai’s study (2003). Rovai (2003) found that when online discussion was adopted as a part of final grades, students were motivated to post their discussions. He emphasizes the importance of students’ motivation to engage in online discussions. As Rovai explains, students in this study also showed their motivation to get higher scores or to pass their subjects by checking Manaba+R.

On the other hand, the results of numbers of access Manaba+R showed, when students’ external motivation is lost, students tend to miss their opportunity to use these modern technology devices for their study. In addition, the results of Q7 (Do you think Manaba+R is useful for your classes?) show that students see the value of usefulness of online course tools for their study. However, once again, the numbers of access to Manaba+R showed, they only tend to use these online course tools when something which was a part of their final grades was posted by their teachers.

Thirdly, there is another trend that when Manaba+R was not effectively used as a part of course assessments, students did not tend to check it as much as they were expected. As both figure and table of actual access to Manaba+R showed, when the teacher posted more important messages, more access to Manaba+R by students was
seen. More homework was posted on Manaba+R, more access to Manaba+R by students was observed. Thus, based on our results, students' external motivation to use online course tools was important for them to use online course tools. As Sánchez's (2004) claimed, the teacher can be a determining factor for utilization of WebCT. In other words, it is important for teachers to use online course tools effectively and frequently. In particular, as the results of coding numbers of actual access showed, when teachers use online course tools as a part of course assessments, these online course tools tend to be used effectively by students.

Fourthly, there was a trend that when computers are available for students in class, where either, computers are provided in class or students are encouraged to bring their own computer to class by their teachers, students tend to check Manaba+R more than those who do not access computers in class. The results of Q8 on our questionnaires (Where do you normally look at Manaba+R?) shows that many students in this study are able to access Manaba+R outside of the campus. This is probably because many students own their mobile phones which allow them to use internet almost anywhere as long as internet is available. However, the results of Q8 also suggest that both SPORT and ECON students tended to miss opportunity to use online course tools in class. In particular, most of SPORT students had their own PC in class but they did not see much online course tools.

In addition, the university where the authors of this study work, offers both staff and students free Wi-Fi anywhere on campus. Therefore, students can connect to Internet on campus as long as they have access to computers. As the results showed, in the environment where free Internet connection is available, when teachers encourage students to use online course tools in class, students tend to use online course tools. Thus, it is important for teachers to utilize the environment where online course tools are available in order to encourage students to use them.

Conclusion

This study investigated the use of online course tools by Japanese university students. In order to collect data, both questionnaires and coding numbers of actual access to the online course tool were used. There were two aims of this study. Firstly, this study investigated what extent students actually used Manaba+R through the semester. Secondly, it tried to find suggestions of how teachers could promote their students to maximize making use of Manaba+R. Results of both questionnaires and coding numbers of access to Manaba+R give answers for the aims.

The results of questionnaires showed many positive answers by participants in this study. Many of students answered that Manaba+R was useful for their subjects and was a useful tool to communicate with their teachers. In particular, many of SPORT students in this study answered that messages on Manaba+R were important for their assessments and therefore they read those messages.

Coding numbers of access to Manaba+R showed some interesting results. First of all, when teachers posted messages which were useful for assessments of the course, students tended to read these messages. However, when teachers did not post those messages on the online course tool, students did not tend to check them. Secondly, when homework which was part of the assessments towards the final grade, students
tended to access Manaba+R. However, when homework was not posted to Manaba+R, then students did not tend to access to it. As a result, to use online course tools effectively for the class, it is important for teachers to extract students’ external motivation. It is also important for educational institutions to create an environment for students where they can easily get access to online course tools.
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Contact email: yoshi-y@fc.ritsumei.ac.jp
Social media technology as a disruptive and/or complementary technology in Higher Education: A case study of Vhembe Further Education Training College

Manzira Francis Mungofa, University of Venda, South Africa
Tsvara Peter, University of Venda, South Africa

Abstract

Social media technologies are being widely used by students in institutions of higher learning and these are transforming their way of learning, social conduct, communication and networking. Complements and disruptions of social media technologies appear to be blurred in the technologies that are currently on the market. It was with this intend that this research was conducted to determine whether the use of social media technologies by students in higher education are being considered as disruptive or complimentary technologies in the context of further education training college. Another goal of the study was to establish how the students are benefiting from these technologies in a rural environment where technological changes lag behind as compared to urban areas. A random sample of 105 students was involved in the study and theses were obtained from Business/Finance, Engineering, Hospitality and Tourism departments of the institution that was used as study site. Analysis of the collected data was executed through application of a statistical package of SPSS. Findings show that social media technology has infused a new culture of learning among students. In addition, social media applications which are on the increase in usage by students for activities that include studying, access of education content, social communication are Facebook, Whatsapp, Twitter and Youtube.

Keywords: Learning culture, Social media, Social networking technologies
Background of study

Trends in technology developments are altering the course of some existing models and methodologies of enhancing student learning to those who are who are engaged in both formal and informal education. Most initiatives for educational technologies are affected by a broad range of challenges that include weak bandwidth, lack of qualified personnel in the field of technology and old infrastructure, (Carr & Czerniewicz, 2011). Social media technology usage has increased in the past five years due to a combination of factors that entails affordability of the mobile devices and increased internet bandwidth amongst the consumers. (Bell, 2010; Selwyn, 2012). This paper will address the concept of social media technology as a disruptive technology or complementary to existing technologies being used in the field of higher education. Social media is being widely used through desktop computers and mobile devices. Trubitt and Overholtzer (2009) indicated in their research that social networks have been embedded in people’s cultures resulting in creation of personal and professional networks. The most popular interfaces being used are Facebook, Flicker and Twitter although the list of some is endless. Users can connect in cyberspace, creating groups that enable sharing, exchange of information and ideas. According to Zanamwe, Rupere and Kufandirimbwa (2013), social networking technologies were received with mixed reactions by academics in developing countries although the trend seems to be in their favour of adoption. The social networking technologies improve computer skills of a student who may not have had access to formal introductory computer courses. The increase of social media tools has contributed towards an increase in user generated content through use of self-help tutorials that are freely available from the internet.

Research Objectives

This research seeks to establish whether social media technologies are being considered as disruptive or complimentary technologies in the context of Further Education Training College located in the rural environment. Another aspect will focus on how the technologies are benefitting students in the rural environment where technological changes lag behind unlike in the urban areas.

Literature review

Social media technology is becoming an essential requirement in people’s daily lives contributed by a combination of factors that include growth of affordability of mobile computing devices, improved internet wireless bandwidth, social media technologies and several other web 2 technologies, Lenhart et.al (2010). In social media, people use the web based and mobile applications for social interaction. In addition, individuals and organisations can generate new content, share existing content in the cyberspace. A number of interfaces used for social media have increased with Twitter, Facebook, Whatsapp, Myspace, Flicker being among the top, Davis III et.al (2012).

The social media tools and networking sites enables students to engage with one another, express and share their creativity. There are drawbacks associated with social media technology especially when students develop a continuous usage of internet which encompasses reduction in higher-order reasoning processes. In addition
continuous internet use is likely to exposes students to interactive, repetitive, and addictive stimuli that produce permanent changes in brain structure, WCER (2011).

International universitites have embraced social media for international recruitment of students due to increased competition and reduced funding by the governments. In order to meet the recruitment targets, it is important for colleges and universities to adapt to changes as the social media technology platforms enable reaching out a large target of potential students across the world, Choudaha (2013). The use of websites by the institutions reduces communication costs over geographic distances and in addition, disintermediation will reduce the communication channel since students are able to connect directly. However institutions need to remain guarding against loss of information control due to the unlimited number of social applications available. It should be noted that social media conversations are informal which requires high interaction for the parties involved which enables deep engagement with prospective students intending to enrol at a given institution.

Zanamwe, et. al (2013), Greenhow and Gleason (2012), Junco, Elasky and Heighberger (2012) revealed in their research, that students improved in their communication, technology and research skills, assist in helping student connection with application concept, student engagement increases in course material, through use of social media which are critical in their development. This is an indication that social media technologies contribute positively behind the classroom but to a student’s life experience, knowledge and skills that develops over a period of time. Application of social media in education would imply that learners have to take lead by participating, producing knowledge rather than consuming only which in turn contribute towards support of personal life goals and needs (Lee & McLoughlin, 2010). A point to note is that learners do not only engage in social interaction on the social media but contribute in the shaping of their career and personal life that form key components of personal development.

Disruptive technologies in higher education

Higher Education Institutions (HEIs) have significantly invested in electronic learning technologies such as Blackboard, Moodle, but they have not been have not been universally adopted and used by students and staff. Instead, other technologies such as social media or social networking technologies which are not owned or controlled by the institutions are widely used to support learning and teaching, Flavin (2012). Disruptive technologies are those that disrupt established practices, often starting with a small number of users, but growing over time to the extent that they displace a previously dominant, incumbent technology Christensen's theory of Disruptive Innovation, emphasizes that the disruptive technologies are not designed explicitly to support learning and teaching in higher education, but have educational potential. The theory propounded by Christensen (1997) shows that new technology can disrupt existing practices which may run a risk of rejection, but also that the new technology can go on to change the practice itself.

Complementary technologies in Higher Education

Social media supported learning seems to be occurring more outside the formal higher education system as opposed to the internal systems since several platforms are being
used to distribute learning content and courseware, a list among them include YouTube, EDU, iTunes U, Academic Earth. Applications used by students do differ from across the continent although there is a list of popular interfaces widely accessed, (Selwyn, 2011). In the South African context, MXit which is an indigenous mobile social networking platform, has played a crucial role in the spread of the mobile Internet in South Africa (Bosch, 2008; Chigona, Chigona, Ngqokelela, & Mpofu, 2009; Nitsckie & Parker, 2009). The cost of social media technology is minimal to such an extent that students can be able to afford both the devices and amount of data required to access applications such as Whatsapp, Facebook, and Twitter, Mixit. For example, more than 7.4 million registered MXit users (Worldwideworx, 2014) in South Africa pay only 1 South African cent (US$.0012) per instant message. A latest encouraging trend among the general population that will entail the overall population of students was the announcement by CNBCAFRICA (2014) that will give East African customers free access to Facebook social networking site across all mobile networks after a strategic partnership with Tigo. A very positive development will be its ability of the Facebook site to be offered in English and Swahili, the national language of Tanzanians and the majority of people in East, Central and Southern Africa. Below was a quote from the general manager, Diego Gutierrez.

“Facebook has been a fantastic driver of data on mobile networks. With this unique partnership, we are making Tigo stand out from the crowd and giving many customers their first taste of the internet and social media, including in Swahili. That’s what creating the digital lifestyle all is about, and it reinforces our strategy to encourage more Tigo customers to use data as part of their daily communications activity.”

Past research indicates that incorporation of social media in learning and teaching has the power to bring new ways of enquiry, communication, collaboration, knowledge development; in addition it can have negative or positive cognitive, social and emotional impacts. (Gao, Luo & Zhang, 2012; Greenhow & Burton, 2011; Pimmer, Linxen & Grohbiel, 2012; Ranieri, Manca & Fini, 2012).

**Methodology**

Case study approach was considered most suitable for this study as it seeks to “build up a rich picture of an entity, using different kinds of data collection and gathering the views, perceptions, experiences and/or ideas of diverse individuals relating to the case.” (Hamilton, 2011). Yin (1994), defined a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident and it relies on multiple sources of evidence”. This enhances the understanding of the reality in the rural settings thereby enhancing the development of conclusion that will enable to determine the contribution of social media technology in higher education.

This research covered Vhembe Further Education Training College. A questionnaire was used to collect primary data. It comprised of three sections namely demographics, experience in the use of social media and benefits of using social media technology. A random sample of 105 students from all the departments (Business and Finance Engineering, Hospitality and Tourism) at the institution were drawn that formed
sample size of the population. Thirteen students were used to pre validate the questionnaire. A mixed methodology approach for this research was adopted and a combination of quantitative and qualitative data was collected, through use of a case study that involved questionnaires being administered. A single case study was used as this enabled data to be collected data from a wider range of different subjects which in the case are students. The case study approach allows for multi perspective analysis in such that there is the interaction of the researcher and a relevant group of actors involved (Tellis, 1997).

**Results and Discussion**

This section shows the analysis and discussion of results of the study that was conducted after the survey. In this analysis, there were various presentation graphical tools used to illustrate varying responses that were solicited from the survey.

<table>
<thead>
<tr>
<th>Table 1: gender of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>male</td>
</tr>
<tr>
<td>female</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The table shows the demographic information of the participants. A total number of 105 students participated in the survey and their gender showed that there were 55.2% male and 44.8% female students as shown in table 1.

**Figure 1: Social media application usage**

![Social media application usage chart](image)
Figure 1 shows the responses of the students and their frequencies to the use of various social media applications. High usage of the applications can be noted on Facebook which has 87%, and WhatsApp (87%) which are at par, followed by Twitter (69%), YouTube (54%) and Google+ (48%). Although there are other applications included in the survey, their usage among students is below 30% and these include LinkedIn, Myspace, Skype, Hangout.

Figure 2: Devices used to connect to internet by students

Figure 2 shows the devices used by students to access internet connectivity. The highest percentage is depicted on cellphones which tops 56%, followed by laptop (49%) and desktop (42%). This indicates that students access internet from their mobile devices through the use of 2G or 3G networks. All other remaining handheld devices that include tablets, iPads, and smartphones, rank low in terms of their usage by students (below 20%).

Figure 3: Social media usage
A result depicted in Figure 3 indicates that students use the social media application in their various study activities which are listed along the horizontal axis. Highest response confirms that social media is being widely used for studying purposes followed by research, reading both news and notes.

Figure 4: Time spent on various social application media.

Figure 4 shows the frequency of access to a wide range of social media applications used by the students who were involved in the study. It can be deduced that they spent more time on the social networking sites. Whatsapp is being the popularly used application on a daily basis. Facebook is the second in category and twiiter being on third position. However results indicate that there are applications which were rarely used and these point to myspace, hangout and skype.
The results in Figure 5 shows that summarises the benefits gained by students through the use of social media technologies. 22% of the respondents highlighted that social media enabled them to learn from the past experiences of their current and former counterparts who shared information, 20% indicated the easy access to content. 16% of the respondents indicated that they either used social media as source of educational learning content or its affordability with less training required. Geographic distances and costs are reduced as indicated by the 14% population of the respondents who participated in the study.

Conclusion

Research findings indicate that the popularly used social media applications by the students are Facebook, Whatsapp, Twitter and Youtube. Furthermore the results showed that students spent quite a considerable amount of their time as shown by the frequencies of access to these applications. These findings conform to the results of Reuben (n.d), Pewinternet (2013) which reflects a growing number of Facebook users on comparative basis of year 2012-2013. Whatsapp which has become the most popular tested application as it is distributed among various smart-phone platforms is being widely used by the students because of reasons that include affordability of smartphones, decreasing data costs and improved internet bandwidth, (Schrittwieser, Frühwirt, Kieseberg, Manuel, Mulazzani, Markus Huber, & Weippl, 2012).

Findings show that social media technology has infused a new culture of learning among students which is in line with the research of Thomas and Seely-Brown
(2011). In addition, students attending institutions in the rural settings are benefiting from use of technology through interaction and exchange of information online with counterparts from within the local community and outside the geographical boundaries. It is evident that internet is replacing traditional publishing, digital camera on handheld mobile devices is replacing film photography, and downloadable media such as movies from Youtube are replacing theaters, mobile cell phones are replacing pay phones and hardwired home phones, massive online open courses (MOOCS) are replacing the traditional classroom, Redding and Walberg (2012). Furthermore results from the study indicate that students have adopted the new technologies which are enhancing their learning and networking process in college setting.

Limitations

This research was confined to a single institution focusing on Further education training of students. As a result there was not opportunity to carry out a comparative analysis of more than one institution which would have enabled the researchers to gain a broader view of the aspects under investigation. Further research is required to cover the whole region of South Africa.
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Summer 2011.

Contact emails: francis.manzira@univen.ac.za, tsvarap@webmail.co.za
Institutional Framework of Science and Technology in Indonesia: 
Encourage Interaction Academics, Business, and Government

Prakoso Bhairawa Putera, Indonesia Institute of Sciences, Indonesia  
Dini Oktaviyanti, Indonesia Institute of Sciences, Indonesia  
Amelya Gustina, Research and Development Center of The Attorney General's Office of the Republic of Indonesia, Indonesia.

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Abstract

Act No. 18 year 2002 about National System of Research, Development, and Application of Science and Technology (S&T) form the basis for the implementation of S&T in Indonesia. It become an instrument in the implementation of the national innovation system (NIS) in Indonesia. NIS in the concept of Kuhlmann and Arnold (2001) has institutional element which is become a key of NIS implementation. Based on this premise, this study is then dissected science and technology institutions in Indonesia through Act No. 18 year 2002. To analyze the data this study using content analysis approach. Based on a content analysis of Act No. 18 year 2002 on the National System of Research, Development, and Application of Science and Technology is known that institutional of science and technology become one of the main issues in provision 6-10. Description of these article mentions that the institutional elements of science and technology in Indonesia include universities, R&D institutions, agencies and supporing institutions. This is in contrast with the institutional model introduced by Kuhlmann and Arnold (2001) by entering the political system including the legislature as an integral part in shaping the policy framework of the system. Not only was the concept developed by Kuhlmann and Arnold (2001), elements of education and research becomes an inseparable unity, whereas Act No. 18 year 2002 both roles are run separately by universities and R&D institutions. Based on these conditions this study has advised to put political system in the model of science and technology institutions in Indonesia.

Keywords: Institutional, Science and Technology, Interaction, National Innovation System, Technologies.
Introduction

S&T has an important key to reach the goal of the nation. Zuhal (2008) reveals that science is a variety of systems related to the physical world and its phenomena are derived from objective observation by systematic experiments, while the technology is a system that is associated with the engineering of some of the science appropriate to increase the value of added of hardware products, software and intelligence. Both of these explanations imply that S&T can strengthen the economic foundation especially for the industrial sector. The industrial sector into an engine of progress of a nation in modern times.

Since 2002, Indonesia already have a national policy governing S&T, and it policy becoming the form of legislation as known as Act No. 18 Year 2002. It act concern on System of National Research, Development, and Application of S&T (Sisnas P3 Iptek). Sisnas P3 Iptek provide regulation of resources in building a national innovation system in Indonesia, through research, the development and application of S&T.

The existence of this Act into a container that holds and be a problem solver for all matters that related to innovation namely research, development and application of S&T (Mulatsih and Putera, 2009). Build a national innovation system is certainly not easy. There are a number of obstacles and constraints in terms of institutional, program, resource, etc. Research institutes, universities, industry and other stakeholders is a key actor in the development of the NIS.

Content of Act No.18 year 2002 includes 9 chapters, 32 clauses and explanations, including two chapters about sanctions and transitional provisions. Politically this Act has qualified in the drafting process so that this legislation has also been enacted since July 29th, 2002. Ideally, this national policy was become the guidance for every S&T actor in Indonesia (Mulatsih dan Putera, 2009).

Actor in the understanding of Act No. 18 year 2002 is institutional. Institutional contemplated in Article 6 Clause (1) that S&T institutions is composed of elements from universities, R & D institutions, business entities, and supporting institutions. Clause (2) states that the institution referred into clause (1) serves a) to organize the formation of human resources, research, development, engineering, innovation, and technology diffusion, and b) shaping climate and provide the necessary support for the implementation of the control, utilization, and the promotion of S&T. The existence of S&T institutions are becoming more important to institutional maketh as one of the goals of S&T development in accordance with the National Medium Term Development Plan (RPJMN) 2010-2014 (Presidential Regulation No. 5 of 2010), especially Book II, Chapter IV S&T area.

The existence of S&T’s institutional in innovation system in order to be important in Indonesia to be assessed by review of the policy content of the Act No. 18 year 2002. Examine the contents of the policy become a choice because it is still rarely used method in reviewing the policy. Yet, an understanding of the content of the policy becomes important to be able to implement a regulation or legislation.
Institutional Theory Perspective in National Innovation System

NIS is the purpose of the Act No. 18 year 2002. Innovation system then written in the policy document in Appendix Presidential Regulation No. 5 year 2010 on the National Medium Term Development Plan (RPJMN) 2010-2014. Innovation system written in Book II "Strengthening Synergies between fields Development" in Chapter IV on S&T area. In the introduction of Chapter IV states that "In order to support S&T to national development can take a part in a consistent and sustainable, NIS as a vehicle for S&T development will be strengthened through institutional strengthening, resource, and network science". This content indicates that NIS is a form of support S&T to national development that is consistent and sustainable. In addition the NIS to become a vehicle of S&T development with institutional strengthening, resource, and S&T network.

Innovation system can not be separated from the innovative performance. Triyono (2014) revealed that the innovative performance of a country depends on the interaction that is how the actors relate to each other as elements of a collective system of knowledge creation and technology using. The actors are mainly private companies/industries, universities, and public research institutions and the people in it.

Triyono (2014) again reveals that there is no single definition of NIS is acceptable to all parties, but what is important in the definition of NIS is the existence of a network or system interaction as reflected in the definitions presented below (Niosi in Joseph, et al. , 2009), including:

“…that set of distinct institutions which jointly or individually contribute to the development and deployment of new technologies as well as providing a framework for governments to establish and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store, and transfer the knowledge, skills and artefacts which define new technologies "(Metcalf, 1995).

Another opinion expressed by Patel and Pavitt (1998) "... national institutions, the incentive structures and their competencies determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country”.

NIS, commonly known introduced by Kuhlmann (2001), the concept is shown in Figure 1. Figure 1 shows there are 4 types of actors in NIS include : 1) System acts as a producer of industrial products and services required by both customers as a final consumer or producers as well as consumers who need the products for further processing into final products, 2) education and research system serves as the center of creation and development of knowledge needed to strengthen and develop the industrial sector, 3) Institute intermediary role for bridging role of research institutions with industrial sector, and 4) the political system, including legislative act as a driver for NIS to working properly through infrastructure management and how to create conducive environmental framework.
Method

Content analysis is a general approach that's being used in the social sciences. Manning and Swan (2009) mentions that there are various kinds of analysis that can be used to describe and interpret the data. The degree of interest of documentary data can be reviewed one of them with content analysis. Content analysis is a technique which is actually oriented qualitative research, where the standard size applied to specific units, this technique is usually used to determine the character of the documents or comparation (Berelson, 1952; Kracauer, 1993).

Nawawi (2009) states that the analysis content of the policy includes a description of the specific policy and how it is evolving in terms of the relationship with the previous policy, or analysis can also be based on information provided by the framework of the theoretical value that tries to provide a critique of the policy. In addition, according to Putera (2012) that may reveal the contents of the policy network of institutional linkages in a policy document. It is important to reveal the role and interaction in policy implementation.

Based on a few understanding above, the method that can be used in this study is more focused on the analysis content of policy with the goal of revealing patterns, roles, and interaction of actors/institutions in S&T policy (Act No. 18 Year 2002).

Result and Analysis

Institutional aspects of S&T based on the documents Act No. 18 of 2002 contained in provision 6, 7, 8, 9, and 10 following verses in each chapter gives a description of the institutions of S&T.
Institutional of S&T as mentioned in provision 6 clause (1) consists of several elements: universities, R&D institutions, agencies and supporting institutions. The science and technology institutions serves to organize the formation of human resources, research, development, engineering, innovation, diffusion of technology, and also climate form and provide the necessary support for the implementation of the control, utilization, and promotion of S&T as include in clause (2).

In carrying out the functions of organizing, institutional of S&T is an umbrella looks a like for organization, where it is the place for planning, implementation, monitoring and supervision of the formation process of human resources, research, development, engineering, innovation, and technology diffusion. While the function of shaping the climate in clause (2) is the establishment of conditions that can accelerate the growth of the elements in implementing the formation of human resources, research, development, engineering, innovation, and technology diffusion, and also foster interactive relationship.

Climate formation that desired by clause (2) of Article 6 is a condition of bonding interaction existence which covered all elements in the overall whole that are complementary and reinforce each other and control to support the achievement of the mission or purpose of it system.

The existing system is a system that is open to life and behavior, orientation, and patterns of interactive relationships of its elements that can be changed dynamically depend on the inputs, constraints, and the condition derived from his environment. Elements of the system of research, development, and application of S&T is also an element of other systems, such as the education system, production system, and so on. All of these part from social and political systems that make up the identity of the state. Therefore, behavior, orientation, pattern of relationships between elements of

![Figure 2. Scope of S&T Institutional](image-url)
the life system and environment research, development, and application of S&T was also influenced by other systems.

The first element of S&T institutional in accordance with Provision 7 clause (1) and (2) is a university. University in the National System of Research, Development, and Application of S&T to carry out the primary mission of shaping human resources expertise, expertise, and competence in the field of S&T. University is also an institutional element in the education system so that it becomes a node element that links the National System of Research, Development, and Application of S&T with the education system. Linkage between universities in both systems is clearly seen from the type of activities that include the implementation of educational activities and teaching, research and development, and service community.

Research and Development (R&D) Institute as the second element of science and technology institutions, they mission in accordance with provision 8, clause (1), to cultivating the ability to perform updates in the advancement of science and technology. Through research and development, R&D institutions should always seek breakthroughs to gain new knowledge which can increase the treasures of S&T, look for the benefit of advanced S&T, as well as developing and preparing various aspects of the application.

R&D institutions in accordance with the explanation of the act, can be a stand-own institution, or a unit of organization of universities, enterprises, and the institutions are also supporting institutional elements of S&T. Thus, R&D institutions can be a node that links institutional elements of science and technology. R&D institutions also can be organizational units that are not related directly to the National System of Research, Development, and Application of S&T. Therefore, the agency also can be the node that links the National System of Research, Development, and Application of S&T with the other systems in Indonesia.

National System of Research, Development, and Application of S&T Enterprises also mandated to establish engineering capabilities and innovation to apply the benefits of science and technology into products and services that have economic value. This is in accordance with provision 9, clause (1). Institutional element and also diffusing technology, both produced themselves or others so that the resulting impact to people's lives become more widespread. Business entity is also an institutional element in the system of production and consumption of goods and services so that these elements into the node that links science system with the system.

Through its association in above two systems, the elements of institutional entities that utilize pull the market output simultaneously raises for research and development activities carried out by elements of R&D institutions and universities, so its benefits can be useful for the people.

In addition, Universities, Research Institutions and Enterprises, National System of Research, Development, and Application of S&T, and also supporting institute. Base on incorporate components of Provision 10 Clause (1) Supporting Institutions are institutions whose activities form the climatic or environmental conditions, support, and limitations that affect the development of higher education, R & D institutions and enterprises. Supporting organizations include the following organizations relevant
to policy makers in S&T such as Indonesian Academy of Sciences, National Research Council, and Regional Research Council; professional organizations; associated with standardization institutes like the National Standardization Agency standards and testing organizations; agency that handles IPR such as patent offices and centers of IPR; supervisory institutions in the field of S&T such as Nuclear Energy Regulatory Agency; agency consulting services in the field of S&T; institutions that represent the interests of consumers; institution that provides S&T information; financial institutions that funded S&T activities; other similar institutions.

Based on the model of the National Innovation System is raised by Kuhlmann and Arnold (2001) shows that the system of education and research as a center for the development of the knowledge needed penciptaan dan untuk memperkuat and develop the industrial sector, while the Law No. 18 Year 2002 education systems and research systems are separated and played by different institutions, which is carried by the Education System of Higher Education to perform the function as shapers of human resources with expertise, expertise, and competence in the field of science and technology, and System research conducted by research institutions to cultivate the ability to update the progress science and technology.

Another basic difference is in the Act No. 18 year 2002 does not mention institutional role in the Social and Political System. This is different from the concept of Kuhlmann and Arnold (2001), they said serves as a driving political system in order to NIS for work properly through the management of infrastructure and creation of a conducive environment framework, through the creation of a number of conditions with the Financial environment; taxation and incentives; propensity to innovation and entrepreneurship; and also mobility.

**Conclusion**

Based on a content analysis of Act No. 18 year 2002 on the National System of Research, Development, and Application of Science and Technology is known that institutional of science and technology become one of the main issues in provision 6-10. Description of these article mentions that the institutional elements of science and technology in Indonesia include universities, R&D institutions, agencies and supporting institutions. This is in contrast with the institutional model introduced by Kuhlmann and Arnold (2001) by entering the political system including the legislature as an integral part in shaping the policy framework of the system. Not only was the concept developed by Kuhlmann and Arnold (2001), elements of education and research becomes an inseparable unity, whereas Act No. 18 year 2002 both roles are run separately by universities and R&D institutions.

Based on these conditions this study has advised to put political system in the model of science and technology institutions in Indonesia, and does not separate the role of education and research.
References


Competence Development Measures
Employee Development in Times of Demographic Change

Gerrit Meyer, Leibniz University Hannover, Germany
Bianca Brünig, Leibniz University Hannover, Germany

Abstract
Demographic change forces companies to develop concepts for lifelong learning that focus on involving older and younger employees. Nevertheless, demographic change offers a great opportunity because older employees often have distinctive age-related competences. These are particularly relevant for failure management, where older employees, due to their knowledge gained through experience, positively influence the efficiency of work processes. One approach to use the competences of older as well as younger employees more effectively is an age-appropriate design of existing competence development measures.

In an online study, competence development measures used by companies to increase their employees’ professional, methodological, social, and self-competence were examined. In addition, a literature search was conducted. The measures used in practice were then analyzed according to specific criteria concerning their age-appropriate suitability. Furthermore, recommendations for the adjustment of competence development measures were derived.

As a result of this research, an enhanced age-appropriate design of competence development measures was determined. The results of the study show that e.g. 25% of the participating companies utilize mentoring to improve professional competence. But in the light of demographic change an increased use of mentoring is to be recommended. Older employees possess knowledge gained through experience as well as distinctive social competence. Therefore, they have a great potential to participate in mentoring.

Combining the competences of older and younger employees offers the opportunity for companies to improve their failure management by developing their employee’s competences. Thus, they can strengthen their competitive position.

Keywords: competence development, age-related competences, lifelong learning, demographic change
Introduction

Companies in Germany as well as in many other industrialized nations are facing the challenge of demographic change (Prezewowsky, 2007). The low birth rate of recent decades (Heinze & Naegele, 2008; Simon et al., 2012) and too little immigration (Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung, 2011) imply various consequences for companies: an increase in the average age of employees (Veen & Backes-Gellner, 2009), an increasing age heterogeneity (Ries et al., 2010) and a shortage of manpower, especially of skilled workers (McKinsey Germany, 2011). This trend will accelerate in the upcoming years.

The demographic development runs parallel to rising skill requirements (Lindh et al., 2010), which imply that the demand for professionals in the company increases while the demand for low-skilled workers decreases (Chiswick, 2011; Hardeye, 2008; Blanchard, 2005). Specialized professionals are urgently needed to tackle the central topics of the future such as dealing with complexity, innovation and flexibility (Spath et al., 2013). The increase in complexity refers to products on the one hand and on the other hand to the production process (Westkämper & Zahn, 2009). The increase in complexity implies inter alia a higher probability of the occurrence of failures (Meyer et al., 2014). To resolve failures sustainably and to implement preventive measures, qualified employees are needed (Meyer et al., 2013). Employees are thus long-term guarantee of success, especially in high-wage countries such as Germany (Hüsken & Hildebrand, 1991; Bullinger, 2012). In this context, employees’ competences and their development are increasingly focused upon (Jochmann & Gechter, 2007). The management of these employee competences thus gains in importance for companies (Krause et al., 2006) and the demographic change reinforces this trend.

Several competence development measures are available to enhance employee competences (Kauffeld, 2010). However, the demographic change forces companies to develop new competence development concepts which focus more and more on the simultaneous involvement of older and younger employees (Ilmarinen, 2005; Adenauer, 2014). Thereby, the demographic change presents a great opportunity as older workers often have age-specific competences (Ilmarinen, 2005). These are especially important for failure management whose efficiency is particularly influenced by the experiential knowledge that older workers often possess (Buck et al., 2002; Olesch, 2007). One approach to tackle these challenges is to re-design existing competence development measures to make them more age-appropriate. This way, competences of both older and younger workers can be used effectively.

For this purpose, a study within the research project "Sustainable failure management in manufacturing SMEs" investigated which employee competence development measures are used by companies to train their employees’ competences. The applied measures were then analyzed for their age-appropriateness. This paper describes the results of the study and concludes with recommendations for companies.
Importance of Competences in Times of the Demographic Change

Impact of the demographic change

The demographic development in Germany induces changes in various sectors of our society. This includes in particular the working environment (see Hamm et al, 2008; Weber, 2010). Scientists predict a rapid decline in population size for the upcoming decades. As part of this, the age structure of the German society will change. The Federal Statistical Office of Germany expects a decline in population size from approximately 82 million people in 2008 to nearly 65 million (lower limit of the "medium" population) in the year 2060. Mainly, this decline is caused by a sizable difference between the birth rate and the mortality, as the latter of which increases despite higher life expectancy (Statistisches Bundesamt, 2009). This in turn leads to a change in the labor force (see Fig. 1).

![Labor force development in Germany (in million)](image)

Figure 1: Labor force development in Germany (in millions) by age group (assumptions: net migration + 100,000 p.a., rising employment rates) for the years 2000-2050 (Fuchs et al, 2011.).

Figure 1 depicts the labor force development in Germany for the years 2000 to 2050. Especially striking is that the total number of workers will decrease continuously. While this figure stood at 44.03 million in 2000, it will fall to 32.73 million in 2050. This represents a decrease of over 25%. Furthermore, it becomes clear when looking at the age structure that the majority of the labor force today and in the future is between 30-49 years old. The second largest group will be the ones aged 50-64. In contrast, the group of 15-29 year olds will drop by 30% from 10.1 million in 2000 to 6.1 million in 2050 (see Fig. 1).

The consequence of the outlined development is a rise in the average age of workers in many manufacturing companies (Veen & Backes-Gellner, 2009). In addition, the age range between younger and older employees is increasing (Ries et al., 2010). Companies, such as BASF, BMW and Daimler, have recognized this development and created relevant programs that take into account the impact of the demographic
change and prepare the company for any resulting problems in the future (Econsense, 2006; Krause, 2007).

Competence development

The concept of ‘competence’ is discussed differently in different countries (e.g. Cheng et al., 2003; Heinen, 2011; Bohlinger & Münk, 2008). As the online study described here took place among German companies, a German competence definition is applied. This makes sense because manufacturing companies located on German ground are familiar with the German understanding of ‘competence’. According to Erpenbeck (2003, p. 365) competences are: “Dispositions for self-organization of human activities”. He considers competences to include creative thinking and, in contrast to other constructs such as skills, knowledge or abilities, to be expressible in form of self-organization capabilities of the specific individual. In consequence, competences are directly testable and can only be realized if dispositions are present. When assessing competences, Erpenbeck (2003) concludes that one has to look at the latest action and performance of an employee.

Generally, the four competence facets professional, methodological, social, and self-competence can be distinguished (Kauffeld, 2006; Meyer & Nyhuis, 2012; Heinen, 2011; Witzgall, 2009). Professional competence addresses the skills and knowledge that an employee needs to work in his or her occupation as well as the ability to identify potentials for improvement within the company and to develop relevant technical solutions (Kauffeld, 2006; Rauner et al., 2013; Heinen, 2011). Methodological competence is the cognitive ability of an employee to gain new expertise as well as to learn new working methods independently of others (Erpenbeck & Michel, 2006). Thereby, skills should be used across various settings and be applied in different situations (Heinen, 2011; Kauffeld, 2006). Social competence refers to the experience, knowledge, and skill to cope with diverse social encounters (Frey & Ruppert, 2013; Kauffeld, 2006). Finally, self-competence addresses the ability for self-assessment and for the independent shaping of conditions in which an employee as well as his or her values and attitudes towards the own work are developed (Frey & Ruppert, 2013; Kauffeld, 2006).

In the study “Continuing Vocational Training Survey” (CVTS) the importance of each competence facet was examined at the European level. The results show that professional competence is assessed by 77% of the companies as particularly relevant. Followed by social competence (30%), self-competence (20%) and methodological competence (13%). Prospectively, the importance of professional competence will decrease slightly (75%) and the other competence facets will gain in importance (social skills: 40%, self-competence: 26%, methodological competence: 19%) (Moraal et al., 2009).
Figure 2: Transparency and controllability of the four competence facets (based on Aigner & Bauer, 2008; Bernien, 1997).

Figure 2 illustrates the transparency and controllability of the four competence facets. According to Bernien (1997), professional competence is transparent, whereas self-competence is rather not transparent. Likewise, the latter is less controllable, while the former is most susceptible (Aigner & Bauer, 2008) and hence easiest to improve.

The consideration of the competence facets and individual competences takes place within the human resource planning. The operational competence management combines traditional education and training with learning, self-organization, competence application and marketing. According to North et al. (2013, p. 23) competence management fulfills four tasks:

- Acquisition of employee competences through competence assessment (including quantitative measurements, qualitative characterizations, observations) and creation of a structured overview (e.g. competence wheel) of existing competences. The basis for the acquisition of competences is a competence catalog, which lists the competencies to be acquired;
- Detection of existing competence gaps and opportunities by comparing actual with desired competences (gap analysis);
- Distribution and dissemination of competences in the company;
- Closure of the revealed competence gaps through targeted competence development measures.

These gaps are usually closed with help of competence development measures that take place within the working environment. Dehnbostel (2001) distinguishes three models of work-based learning:

- Work related learning (e.g. learning-on-the-job) takes place within the workplace. Learning and work are identical as the employee gains new skills while conducting his or her tasks.
- Work connected learning (e.g. learning factories) does not take place at the workplace, but is closely linked to it.
Work-based learning (e.g. business games) implies that learning and work are not only spatially separated. Work-based learning mostly takes place outside the company and the learning process is well organized and structured. However, the reality of everyday working life always guides this form of learning.

The majority of competence development measures originate in the field of education (Kauffeld, 2010). A transfer to the business environment asks for appropriate adjustments as the learning process of adults entails other characteristics. "Adults approach the learning experience with a rather problem-centered perspective" (Kauffeld, 2010, p. 69). From adults’ point of view, learning takes place through experience and should be as self-directed as possible. Generally, a trend towards individualization of competence development can be observed. Learning projects are increasingly achieved autonomously and self-organized (Kauffeld, 2010).

**Age-specific competences**

During the working career, performance requirements of a job vary only minimally. They can therefore be assumed to be almost constant. However, the psychological and physiological human performance is subject to changes during the working life. It rises at the beginning of working life, reaches a maximum in the midlife and falls in the high-age for some employees. Also, the inter-individual differences in performance, meaning the differences between different individuals, increase significantly with age (Buck, 2002; Langhoff, 2009; Adenauer & Stowasser, 2009; Landau et al., 2011). These developments imply that older people can no longer meet the performance requirements in some cases (see Fig. 3).

![Factors affecting performance capacity](image)

**Figure 3: Changes in performance requirements and capacity over time (Buck, 2002).**

Older workers are not less productive than younger employees, but abilities change once one gets older. While some particular physical abilities decline (e.g. physical
capacity), other competences (e.g. teamwork) remain constant and still others (e.g. experience) rise (Bullinger, 2002; Buck et al., 2002; Olesch, 2007).

Method

To develop age-appropriate competence development measures, an online survey investigated which measures are used in practice to enhance competences.

With the help of publicly available company databases, companies with an own production located in Germany were identified. As “own production” was the only selection criterion, the participating companies varied in terms of size and focus of production. All companies were first contacted by phone and asked about their willingness to participate in the study. Those companies, who expressed an interest in the study, received an e-mail with the link to the online survey, including detailed instructions regarding the study and the procedure. The whole study was conducted anonymously.

The final sample consisted of N = 51 experts, most of which are working within the production management or human resource department of manufacturing companies. Figure 4 shows the number of experts interviewed by company size.

![Figure 4: Respondents by company size.](image)

In the online survey, respondents were asked:

*Which of the following methods does your company use to enhance professional, methodological, social and self-competence?*

To this end, a pre-selection of competence development measures that are used in practice was carried out through a literature review. This pre-selection included the competence development measures business game, seminar, learning factory, mentoring and learning-on-the-job.

- "A business game is a tool to reproduce complex situations such that these can be experienced playfully and thereby be better understood and evaluated" (Schneider et al., 2012, p. 68).
• "A seminar is one of many training methods in which a lecturer presents the relevant learning content through language and audio-visual tools to a group of learners" (Kauffeld, 2010, p. 3).
• "A learning factory offers the possibility of a realistic representation of products, processes and resources in an experiential and participatory digital real learning environment" (Müller et al., 2012, p. 8). Compared to the business game, a learning factory takes place in the real production plant.
• Mentoring refers to the accompaniment of an employee by an experienced person for professional and personal development (Ryschka & Tietze, 2011).
• Learning-on-the-job designates workplace learning, for instance through diversification of tasks or sharing with colleagues (Duden, 2014).

Subsequent to the survey, an analysis of the age-specific fitness of the competence development measures was carried out. For this purpose, competences were initially selected that are pronounced differently across age groups. It was then assessed to what extent the use of a particular competence development measure makes sense in terms of minimizing deficits as well as for strengthening the potential of each age class.

Results of the Online Survey

The majority of companies surveyed use seminars and learning-on-the-job to develop their employees’ competences. Professional competence is the focus in this context. The results of the study are shown in Figure 5.

<table>
<thead>
<tr>
<th>Competence facet</th>
<th>Business game</th>
<th>Seminar</th>
<th>Learning factory</th>
<th>Mentoring</th>
<th>Learning-on-the-job</th>
<th>Respondents (total)</th>
<th>Frequency mention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional competence</td>
<td>4%</td>
<td>80%</td>
<td>2%</td>
<td>25%</td>
<td>78%</td>
<td>51</td>
<td>97</td>
</tr>
<tr>
<td>Methodological competence</td>
<td>10%</td>
<td>53%</td>
<td>4%</td>
<td>20%</td>
<td>78%</td>
<td>49</td>
<td>81</td>
</tr>
<tr>
<td>Social competence</td>
<td>0%</td>
<td>28%</td>
<td>0%</td>
<td>19%</td>
<td>83%</td>
<td>47</td>
<td>61</td>
</tr>
<tr>
<td>Self-competence</td>
<td>4%</td>
<td>37%</td>
<td>0%</td>
<td>20%</td>
<td>85%</td>
<td>46</td>
<td>67</td>
</tr>
</tbody>
</table>

Figure 5: Applied measures to increase professional, methodological, social and self-competence.

The results show that the respondents primarily utilize competence development measures to improve professional competence (97 mentions), whereby seminars and learning-on-the-job prevail. Of the 51 companies surveyed, N = 41 apply seminars (80%) and N = 40 learning-on-the-job (78%), whereas only N = 13 use mentoring (25%). The competence development measures business game (N = 2, 4%) and learning factory (N = 1, 2%) play no major role in improving professional competence.

The increase in methodological competence occupies the second rank with N = 81 nominations. Roughly 4 out of 5 companies (N = 38, 78%) use learning-on-the-job to extend this competence facet, almost every second company (N = 26) uses seminars and 20% (N = 10) mentoring. Business games are utilized by N = 5 companies (10%). Also, the results demonstrate that when business games are used, they are employed
to increase the methodological competence. The same applies to the competence development measure learning factory, which is only used by N = 2 companies (4%). Only three competence development measures are applied to increase social competence. Mainly, companies make use of learning-on-the-job (N = 39, 83%) as well as seminars (N = 13, 28%) and mentoring (N = 9, 19%). Business games and learning factories on the other hand do not matter.

To improve self-competence, 85% of companies (N = 39) use the competence development measure learning-on-the-job. 37% of companies use seminars (N = 17) and 20% of companies (N = 9) mentoring. Business games are utilized by N = 2 companies (4%) to enhance self-competence. Though, learning factories are neglected in this context.

In summary, one can notice the primary use of learning-on-the-job, followed by the competence development measures seminar and mentoring. However, learning factories and business games play a subordinate role in improving competences.

**Discussion**

The competence development measures from the survey were subsequently examined with regard to their age-specific suitability and instructions for the adjustment of these competence development measures were derived (see Fig. 6).

<table>
<thead>
<tr>
<th>Performance potential</th>
<th>Younger employees</th>
<th>Older employees</th>
<th>Competence development measure</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Business game</td>
<td>Seminar</td>
</tr>
<tr>
<td>Experience</td>
<td>-</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
</tr>
<tr>
<td>Creativity</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
<td>X</td>
</tr>
<tr>
<td>Willingness to learn</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
</tr>
<tr>
<td>Learning ability</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
<td>-</td>
</tr>
<tr>
<td>Work ethic/discipline</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
<td>(X)</td>
</tr>
<tr>
<td>Attitude toward quality</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
<td>(X)</td>
</tr>
<tr>
<td>Reliability</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
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</tr>
<tr>
<td>Loyalty</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Flexibility</td>
<td>-</td>
<td>(X)</td>
<td>-</td>
<td>(X)</td>
</tr>
<tr>
<td>Physical capacity</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Figure 6:** Age-specific suitability of competence development measures (cf. among others Bullinger, 2002; Buck et al, 2002; Olesch, 2007; Kauffeld, 2010; Müller et al., 2012; Ryschka & Tietze, 2011; Schneider et al., 2012).

- Advantages of this age group
- X = strong potential influence
- (X) = weak potential influence
- - = no influence
The results show that the competence development measure mentoring is particularly suited to respond to the demographic change. Furthermore, the use of learning factories offers advantages in the light of the demographic change. Seminars on the other hand serve this purpose only to a limited extent. The application of the measures learning-on-the-job and business games is not recommended in this context.

The results point to a current problem. Companies primarily use learning-on-the-job, although the utilization of this measure in the context of the demographic change is not advantageous. In view of the demographic development, it is advisable to increase the number of mentoring models and to use learning-on-the-job rather in combination with other measures. Seminars are currently used by many companies, but provide rudimentary means to minimize age-related deficits. The same applies to learning factories. As the survey results show, there is still much to be done, because this measure is currently hardly taken into account.

In summary, when selecting competence development measures companies must try to take more account of their potential to reduce age-related deficits and of their potential for the effective use of age-specific strengths. Above all a greater use of mentoring is recommended, followed by learning factories and seminars, while the last measure is already used frequently today.

Conclusion

Companies in Germany are confronted with challenges due to demographic change. The low birth rate and a low immigration lead to, among other things, a shortage of skilled workers. In this context, the development of employee competences becomes even more important. To this end, companies can choose among various competence development measures. However, these are often used without taking the age-specific suitability into account. It requires an age-friendly design of existing competence development measures to take advantage of the skills of older as well as younger workers.

For this purpose, we first investigated in an online study which competence development measures companies use to improve competences. The applied measures were then analyzed for their age-appropriate suitability to derive conclusions.

The results of the study show that in practice, primarily the competence development measure learning-on-the-job is used, followed by the measures seminars and mentoring. The business games and learning factories play a subordinate role for the development of employee competences.

However, a further analysis of the competence development measures shows that especially mentoring is suited to meet the challenges imposed by demographic change. Furthermore, the use of the measure learning factory is advantageous to deal with current demographic challenges. Seminars, serve this purpose only to a limited extent. The application of the measures learning-on-the-job and business games are not advantageous in this context.

In summary, companies must try to take more account of their ability to reduce age-related deficits and their potential for the effective use of age-specific strengths when
selecting competence development measures. First, a greater use of mentoring is recommended. Second, an enhanced application of learning factories and seminars is recommended.

The findings are used within the research project "Sustainable failure management in manufacturing SMEs" to identify measures for closing competence gaps and to account for the age-specific suitability of these measures.
Acknowledgment

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Biographical Details

Dipl.-Wirt.-Ing. Gerrit Meyer holds a Master’s Degree in Industrial Engineering. He studied at the Technical University of Dortmund, Germany. Currently, he is a research associate involved in the study of labour science while pursuing a PhD at the Institute of Production Systems and Logistics, Leibniz University Hannover.

Bianca Brünig has a Master’s Degree in Migration and Ethnic Relations. She studied at the University of Utrecht, The Netherlands. She is currently a research associate at the Institute of Sociology, Leibniz University Hannover, where she is focusing on the study of methods of social science while pursuing a PhD.
References


**Contact email:** Gerrit Meyer (meyer@ifa.uni-hannover.de), Bianca Brünig (b.bruenig@ish.uni-hannover.de)
The Leadership of the Principals in Space Management: Principle and Pattern

Tang Chih Min, National Chengchi University, Taiwan

The Asian Conference on Society, Education and Technology 2014
Official Conference Proceedings
Introduction

The theory of educational leadership has been developing rapidly for over 110 years since 1900. Leadership had already become a research goal widely in the early twentieth century and it was proved that the empirical studies had exceeded three thousand cases (Lunenburg & Ornstein, 2008). After 1980s, more and more new theories of educational leadership have been published: Chin (2010) new book about educational leadership discussed fifty-five theories of educational leadership. Yeh (2011) analyzed 150 ideas of educational leadership and built the ideal system structure. The leadership of space management was one of the newest theories of educational leadership.

A teacher’s attitude and behavior will be improved and influenced directly and indirectly by the space planning and facility quality of his/her school, in the same way a student’s attitude, behavior, achievement, learning patterns, physical and mental health, value, thoughts, personality development, and educational quality and accomplishments are directly and indirectly influenced by school space planning (Chih-Min Tang, 1991, 2006a; Wen-Ching Liao, 2011; Al-Enezi; 2002; Earthman, Cash & Van Berkum, 1995; Hines, 1996; Lanham, 1999; Maxwell, 1999; O’Neill, 2000; Smith, 2008; Tanner & Langford, 2003; Yarbrough, 2001). Therefore, for the United States, over 297 billion U.S. dollars were spent on the campus building of middle and elementary schools in the span of seventeen years (from 1995 to 2012) (Moore, Enderle, Reedy and Abramson, (Eds.), 2012). In the United Kingdom, 6.4 billion pounds were invested in 2007/08 and then the investment was increased to 8.2 billion pounds in 2010/11 to make sure the students’ learning environments meets the high standards of the twenty-first century (PricewaterhouseCoopers, 2008). Over the past twenty to thirty years, the Department of Education and the education bureaus of counties and cities in Taiwan have been investing at least 10 to 20 billion New Taiwan dollars each year on projects to improve and promote the school campuses and facilities of middle and elementary schools (Chih-Min Tang, 2010).

Due to these investments happening around the world, Chih-Min Tang (2008a, 2008b, 2008c, 2009a, 2009b, 2011a) initially brought the discussion of space leadership to the public to explain its meaning, methods for application, strategies, patterns, and structures. Both the research and practice of space leadership developed rapidly and they were emphasized and well-concerned day by day. To provide more input for the development of educational leadership, this paper focuses on the principles and patterns of principal space leadership.

The Principles of Space Leadership

The leadership of space management is a complex process. In order to meet the different needs of school faculty, students, parents and communities regarding school education, curriculum design, instruction methods, and school administration, it shall follow six principles: team cooperation, guiding by vision, overall planning, management of innovation, sustainable development, and participation in every stage.
Team Cooperation

The Principal space leadership shall be based on team cooperation, and cannot be done independently by a single person. School space planning and development involves curriculum and instruction design, administration and operating pattern, resource allocation and fund utilization, school image and community relation, and needs of faculty, students, parents and communities. It is necessary to form a leadership in space management team, select an architect, invite experts in school building architecture, representatives from school board, and representatives from community to integrate school vision, space conditions, user needs, funding and resources, school management strategy, so as to facilitate sustainable development of school education.

There is a stronger emphasis on team work in principal space leadership compared with other educational leadership styles. Three categories of principal space leadership exist: (a) team work with the principal taking the leading role, (b) team work with the principal taking a supporting role, (c) team work without participation from the principal. Team work also involves team learning. It is necessary for the team to visit newly established schools, excellent schools, benchmark schools, and featured schools frequently, to accumulate more common experience so as to focus team’s consensus building, raise effectiveness of team cooperation, and promote agreeable or likable campus and democratic campus participation in space leadership.

Guiding by Vision

The leadership of Principal in space management shall be guided by vision. Vision is the grand objective and direction of school management. Vision is also the ideal future image of the school. School space is part of the overall soft and hard resources and environment of the school as well as the most important environmental infrastructure of school education. There are several ways or means of education: educating by (personal) example, educating by verbal instructions, educating by surrounding, and educating by system rules. Educating by surrounding as a means of education cannot be ignored, and shall be well utilized and guided by the vision of the school. This can promote education mood, curriculum, teaching instruction, student learning, school administration, and public relation with the community. This can guide a school in establishing its space features, and advance its education development.

There is a stronger emphasis on the direction of principal space leadership compared with other educational leadership styles. Two categories exist: (a) space vision that is dominated the guiding vision of the school (b) space vision that is not dominated the guiding vision of the school. The vision is based on the constant principle, and has the ability to visualize the future; the spatial environment of the school may change quickly, adapting to changes in resource conditions, education polices, environmental policies. Vision may be properly adjusted at the right place and at the right time.

Overall Planning

Overall planning must be taken into the consideration in the leadership of principal in space management. Compared with other types of educational leadership, principal
space leadership puts more emphasis on resource utilization integration and overall planning. Two overall planning categories exist: (a) Overall planning that integrates resources that are both inside and outside the school, (b) Overall planning that integrates only the resources that are inside the school. Overall planning is resource integration and deployment, taking into consideration of the fairness, efficiency, and effectiveness of resource integration, distribution, and utilization. It shall be noted that the whole is not the sum of the parts. The advancement and operational effectiveness of leadership in space management can only be maximized by exerting the effect of \(1+1>2\).

**The Management of Innovation**

The leadership of Principal in space management shall have an innovative spirit. The scope of innovative management of school includes the following areas: education environment, school administration, curriculum design, teaching methods, learning resources, and community relations. A school may use campus spatial planning, organization structure and its utilization to improve education mood, pull ahead curriculum design, lead education innovation, enrich learning resources, promote administration innovation, and expand community relations. This will create campus environmental features, enhance school image, and facilitate education development. There is a stronger emphasis on innovation management in the principal space leadership compared with other educational leadership styles. Two categories exist for innovation management: (a) innovation in administration orientation, (b) innovation in curriculum instructions. Innovation management is the energizer for raising the effectiveness of education. Innovation shall involve new mood and new image. It shall take advantage of school conditions and special characteristics of the school, and convert disadvantages. Innovation shall help form special features and unique characteristics for the school. Innovation shall put education vitality into campus buildings, and enable the space leadership to have more substantial influence.

**Sustainable Development**

The leadership of Principal in space management is not a fad. It puts emphasis on sustainable development. Education is a long term process and requires multi-decade long term commitment. There shall be a circulatory system which is designed based on a comprehensive and detailed plan that takes into consideration of education methods, curriculum instructions, funding budgeting, resource conditions, space infrastructure, and operational pattern. This system makes the campus space plan better integrated with school education ideals, and enables sustainable operation and development. There is a stronger emphasis on sustainable development in principal space leadership compared with other educational leadership styles. Two categories exist for sustainable development: (a) sustainable development with green building as its core, (b) sustainable development with operational planning as its core. The key to sustainable development is recirculation. The funding or budget for sustainable development cannot be too small or too big. Too small a budget causes difficulty in spending. Too big a budget results in debt to be paid by future generations. There shall be a system pattern such that campus construction has inputs, process, outputs, and feedback support. This pattern shall enable recirculation of funding resources,
promote sustainable development of campus operations, and enable perpetual advancement and influence of space leadership.

**Participation at Every Stage**

The leadership of space management involves tasks at different stages. Campus planning is a complex process that involves planning, design, construction, operation, and evaluation after completion. Every stage has its own different expectations, tasks, participants, campus environment, and education policies. These factors joining together at different stages create a unique participation mechanism for space leadership. Special attention must be paid to the consistency and continuity of leadership participation across multiple stages so as to enable the implementation. There are two categories of stage participation for principal space leadership: (a) full participation, (b) semi-participation. The key to stage participation is continuity and connection. It requires core leadership team members to fully participate at all stages in order to effectively enforce and implement decision of space leadership.

**The Methods of Space Leadership**

School space has a close relationship with curriculum, teaching, learning, administration, and community. School curriculum, teacher’s teaching, student’s learning, school administration, and community relations all require support from school space and school equipment (Tang, Chih-Min, 2008). Furthermore, school spatial planning and infrastructure operations may facilitate curriculum design, enhance education and administration effectiveness, and improve community relations. According to the research of Tang, Chih-Min (2008a, 2008b, 2008c, 2009a, 2009b, 2011a, 2012), the methods of space leadership consist of the following: using space planning to promote education mood, pull ahead curriculum development, lead teaching innovation, enrich learning resources, improve administrative innovation, and expand community relations.

**Using Space Management to Promote Education Mood**

School is an environment for education. A school’s education ideals, development vision, and organizational culture require the support from the school’s space and equipment to promote overall education mood. Relatively speaking, the architecture style of school building, space allocation, and equipment installation may vary from school to school due to the differences in education visions and development ideals. In general, schools with large space, new or innovative equipment, buildings with elegant architecture design may enhance staff and students characters, students learning motivation, mood, attitude, and accomplishment.

**Using Space Management to Pull ahead Curriculum Development**

School provides space for education. School equipment may change with curriculum or course. For example, the equipment standards for ordinary high schools of Taiwan, was modified and published in 2005, then was modified again in 2008 due to the implementation of the 2009 curriculum guideline. This shows the interdependency between class room (space) and curriculum/course. Consequently, one of the methods of space leadership is using space plan to pull ahead curriculum development.
Using Space Management to Lead Teaching Innovation

School provides a place for education. Education objectives, process implementation, the rise in education quality and education effectiveness are closely related to the newness/novelty, refinement, and diversity of educational space and equipment. In general, the size of the space and quantity of the equipment affects the headcount capacity. The shape of the space and the arrangement of the equipment affect the quality of instruction. Space preparation and equipment function affect efficacy of education. Consequently, using space to lead teaching innovation is one of the methods of space leadership.

Using Space Management to Enrich Learning Resources

School provides a location for education. The subjects of education are students. A school’s space and equipment plan must have its core consideration focused on the student population which provides most of the users. It shall satisfy the physiological and psychological needs of the students during studying and relaxation. The need for learning resources can affect school space planning. School space planning could also affect student living and rest, and classmate interaction. Abundance in learning resources facilitates diversity in student activities, and a colorful student life. On the other hand, excessively simple and crude learning resources could slow down student learning and interaction. Consequently, using space to enrich learning resources is one of the methods of space leadership.

Using Space Management to Promote Administrative Innovation

A close relationship exists between the administration, management and operation of a school and the space and facilities of a school campus. For example, the mutual communication within each office of a school and the daily affairs of the teachers and students can have their influence on the pattern of the campus space management and the application of the facilities, so as when and how the campuses are allowed to be opened could be related to the application of the space and facilities of a school. Efficient administration needs to be supported by the space with efficient function. The maximum administrative efficiency can be produced with the minimum expense, labor, and resource operation if the architecture space and facilities of a school are well planned, managed and operated. This means that the space management and the operation of the school facilities can influence the administrative performance of a school. Therefore, using space management to promote administrative innovation is one of the patterns of the space leadership.

Using Space Management to Expand Community Relations

To have schools reach out to their surrounding community and to have the community function like a school, an organized school can become an important cultural and educational center in its surrounding community. The concept of directing a school into its surrounding community enforces the close connection, importance and value of combining the school and the community into one body. It is a necessary trend to build, plan and develop a school that will work closely together with its belonging community. Well-planned space can bring positive interaction and development to both the school and the community. They shall be living in the state of benefiting...
each other and going into blossom and harvest together. Therefore, using space management to broaden the community is one of the patterns of space leadership.

Conclusion

Building the space into a learning environment can have substantial influence on the education of the surroundings. The ideal thinking and opinions related to education from a principal or leading personnel of a school can bring innovation and development to the school space and education by setting up a well-planned and well-designed learning environment. When applying to practice, space leadership should control the six principles which are team cooperation, guiding by vision, overall planning, innovation management, sustainable development, and participation at every stage. The six patterns of space leadership include using space management to promote education moods, pull ahead curriculum developments, lead teaching innovation, enrich learning resources, promote administrative innovation, and expand community relations.

To sum up, space leadership is one of the newly-developing theories of educational leadership. Related research of the theories and building of the structures are still needed to have more enthusiastic people to participate and make efforts to plant in this field so that high quality creative education, excellent leadership and learning environments can be seen in the near future while promoting school space innovation and school education development.
Application of Grey Wolf Optimizer for Time Series Forecasting

Zuriani Mustaffa, Universiti Malaysia Pahang, Malaysia
Yuhanis Yusof, Universiti Utara Malaysia, Malaysia
Siti Sakira Kamaruddin, Universiti Utara Malaysia, Malaysia

Abstract
Forecasting the price of non-renewable commodity such as crude oil is a critical task and requires careful attention. Due to the vital role of non-renewable commodity in the economics of an organization, forecasting its price has attracted both researchers and practitioners. In this paper, a relatively new Swarm Intelligence (SI) technique, namely Grey Wolf Optimizer (GWO) is utilized as a method for short term time series forecasting. Classified as a nature-inspired meta-heuristic algorithm, the GWO emerged from the observation of leadership hierarchy and hunting mechanism of grey wolves in the nature. It incorporates of four groups which each of them belong to different level of hierarchy. To date, GWO has been proven to be comparable to existing optimization algorithms, thus carries a great potential for the said time series data. Realized in crude oil price time series data, the efficiency of GWO is measured based on statistical metric viz. Mean Absolute Percentage Error (MAPE) and is compared against two Evolutionary Computation (EC) algorithms namely Artificial Bee Colony (ABC) and Differential Evolution (DE). Based on the obtained findings, it is noted that the GWO produces the lowest MAPE which is at 5.4779\% while the ABC obtained a similar reading at 5.4170\%. However, the performance of DE is not at the same par as it produces 11.9320\% error rate. Thus, it can be concluded that the GWO may become a competitor in the domain of time series forecasting.

Keywords: Grey Wolf Optimizer, optimization, parameter tuning, time series forecasting,
Introduction

Forecasting crude oil price is proven to be challenging and of great interest to practitioners, governments, enterprises and academia. Known as ‘black gold’ due to its prosperous characteristics, it is regarded as one of the most significant resources as it has the strength to influence world economic development (Zhang & Wei, 2010). A reliable forecasting tool for the said time series data is not only essential in avoiding unwanted risk, reducing loss and gaining high profit but also contributes to an appropriate future planning. Possible development to overcome expected issue can be taken into account. Nonetheless, due to high complexity and nonlinearity features which caused by various factors such as supply and demand inventory, political situation, inflation, Gross Domestic Product (GDP) and many others, the price is continued to be hard to forecast (A. Gabralla, Jammazi, & Abraham, 2013; Li & Ma, 2010).

Classified as non renewable natural resources commodity, crude oil is very limited in production and irreplaceable in human time frame (Kemp 2004). With the limitation in resources and continuously increasing demand, this situation leads to only one result; higher prices. As for investors, this means opportunity, however, for public people, this indicates inflation (Zhang, Wu, & Zhang, 2010). Due to that matter, the importance of price forecasting for such data has resulted to a large growing body of literature and research among the community is continuously carried out (Jammazi & Aloui, 2012).

In literature, there are avalanche of studies which present various forecasting techniques for the said time series data. In Jammazi in Aloui (2012), monthly crude oil price forecasting was presented using an improved Back Propagation Neural Network (BPNN). Realized in West Texas Intermediate (WTI) crude oil price, the presented model is compared against conventional BPNN. The findings of the study was in favour to the improved BPNN. Meanwhile, a hybridization of Genetic Algorithm and Feed Forward Neural Network (FFNN) with BP algorithm has been demonstrated for crude oil price forecasting (Tehrani & Khodayar, 2011). In the study, GA was employed to improve the learning algorithm and reduce the complexity in determining the control parameters of ANN. Later, the prediction process is continued by the FFNN. The experimental process involved two time series data of crude oil prices, viz. WTI and Iran crude oil prices and comparison was conducted against conventional Artificial Neural Network (ANN). Upon completing the experiment, it is indicated that the results produced by GA-FFNN are closer to actual data.

Progressing further, an ensemble machine learning technique was investigated to forecast crude oil price (A. Gabralla, Jammazi, & Abraham, 2013). In the study, three machine learning algorithms were chosen for comparison purposes which includes Support Vector Machine (SVM), Instant Based Learning (IBL) and K.Star. Empirical results suggested that the developed ensemble algorithm performed better than the identified forecasting algorithm.

In related work, the combination of Pattern Modelling and Recognition System (PMRS), Error Correction model (ECM ) and Neural Networks (NN) has been presented to forecast the monthly WTI crude oil price (Xu, Zhang, Cheng, Xu, & Zhang, 2014). The empirical results suggested that the presented model give good
forecasting performance relative to the Mean Absolute Percentage Error (MAPE) and Root Mean Square Percentage Error (RMSPE). These methods, to a certain extent, all improve the accuracy of crude oil price forecasting.

Nonetheless, despite the various presented techniques in crude oil price forecasting, finding an effective forecasting models for the said time series data is important. The gaps that exist in the existing works, particularly the Neural Network based model (Jammazi in Aloui, 2012; Tehrani & Khodayar, 2011, Xu, et al., 2014) which is favorably applied in crude oil price forecasting is unavoidable to face with the poor generalization (Cheng, Qian, & Guo, 2006; Xiang & Jiang, 2009) and the requirement of many control parameters to be tuned (Xiang & Jiang, 2009; Zhang, et al., 1998).

In this study, Grey Wolf Optimizer (GWO) (Mirjalili, Mirjalili, & Lewis, 2014) is employed for crude oil price forecasting. As a relatively new Swarm Intelligence (SI) algorithm, GWO is motivated from social behaviour of grey wolves or also known as Canis Lupus which is belongs to Canidae group. This algorithm consists of four main parts namely social hierarchy, encircling prey, hunting, attacking prey and search for prey. Similarly like any other meta heuristic algorithm, exploitation and exploration are also two important features in GWO which are known as attacking prey and search for prey respectively. This algorithm has been proven to be competitive and better than the other existing optimization algorithms such as Particle Swarm Optimization (PSO), Gravitational Search Algorithm (GSA) and many others (Mirjalili, et al., 2014). With such performance, the GWO posses a great potential for forecasting the said time series data. This time series data is chosen due to its significant role not only in human life survival but also affect the global economic activities. As to use the GWO in forecasting task, this is done estimating the parameter values, as the ones applied in the existing works (Hadavandi, Ghanbari, & Abbasian-Naghne, 2010; Mustaffa, Yusof, & Kamaruddin, 2013).

This paper is organized as follows: In Section 2, a brief review on GWO is described. In Section 3, the implemented methodology is presented, followed results and discussion is presented in Section 4. Finally, Section 5 presents the conclusion of the study.

Grey Wolf Optimization

A. Theory of GWO

GWO is considered as apex predators, which makes them placed as the top in food chain. In GWO, there are 4 hierarchies on grey wolf population, namely alpha, beta delta and omega. The alpha consists of male and female grey wolf and responsible for decision making such as about hunting, sleeping place and others. Due to its dominant role, they are placed at the top of the hierarchy. As the most dominant pack, it is measures in terms of the best in managing the pack, not the strongest.

The second level namely beta responsible to help alpha in decision making or any other activities of the pack. The beta can be male or female and would be the best candidate for replacement in alpha if one of the alpha passes away or become old. The beta act as an advisor for the alpha in undertaking discipline of the pack.
Meanwhile, the delta, have to submit the solution to alpha and beta but they dominate the omega. This group consist of scouts, sentinels, elders, hunters and caretakers. Lastly, the omega, which ranked last in the hierarchy, plays the role as scapegoat.

B. Mathematical Model and Algorithm

1. Social Hierarchy
   In GWO, the fittest solution is represented by alpha ($\alpha$), followed by the second and third best solutions namely beta ($\beta$) and delta ($\delta$) respectively. Meanwhile, the rest of the candidate solutions are considered as omega ($\omega$). The hunting (optimization) is guided by $\alpha$, $\beta$ and $\delta$ while the $\omega$ follows the three groups.

2. Encircling Prey
   During hunting, the wolves tend to encircle their prey. As to model the encircling prey, the following equation is used:

   \[
   \begin{align*}
   \bar{D} &= |\hat{C}.\bar{X}_p(t) - \bar{X}(t)| \\
   \bar{X}(t+1) &= \bar{X}_p(t) - \bar{A}.\bar{D}
   \end{align*}
   \]

   where $t =$current iteration, $\bar{A}$ and $\hat{C}$ = coefficient vectors, $\bar{X}_p$ = position vector of the prey and $\bar{X}$ = position vector of the grey wolves.

   For vectors $\bar{A}$ and $\hat{C}$, is calculated as follows:

   \[
   \begin{align*}
   \bar{A} &= 2\tilde{a}\tilde{r}_1 - \tilde{a} \\
   \hat{C} &= 2\tilde{r}_2
   \end{align*}
   \]

   where components of $\tilde{a}$ are linearly decreased from 2 to 0 over the curse of iterations. Meanwhile, $r_1$ and $r_2$ are random vectors in the range of [0,1].

3. Hunting
   Commonly, the hunting is guided by the alpha. However, both beta and delta might also involved in hunting occasionally. In GWO, the alpha, i.e. the fittest candidate solution, beta and delta are the experts about the potential location of prey. Thus, the first three best solutions obtained so far are saved while the other agents (including omegas) are induced to update their positions based on the position of the best search agents. This is defined by:

   \[
   \begin{align*}
   \bar{D}_\alpha &= |\hat{C}_1.\bar{X}_\alpha - \bar{X}|, \bar{D}_\beta &= |\hat{C}_2.\bar{X}_\beta - \bar{X}|, \bar{D}_\delta &= |\hat{C}_3.\bar{X}_\delta - \bar{X} \\
   \bar{X}_1 &= \bar{X}_\alpha - \bar{A}_\alpha.(\bar{D}_\alpha), \bar{X}_2 &= \bar{X}_\beta - \bar{A}_\beta.(\bar{D}_\beta), \bar{X}_3 &= \bar{X}_\delta - \bar{A}_\delta.(\bar{D}_\delta)
   \end{align*}
   \]
Initialize the grey wolf population
Initialize $a$, $A$ and $C$
Calculate the fitness of each agent
$X_{\alpha} =$ the best search agent
$X_{\beta} =$ the second best search agent
$X_{\delta} =$ the third best search agent
while ($t < \text{Max number of iterations}$)
    for each search agent
        Update the position of the current search agent by equation (3.7)
    end for
    update $a$, $A$ and $C$
    Calculate the fitness of all search agents
    Update $X_{\alpha}$, $X_{\beta}$ and $X_{\delta}$
    $t = t + 1$
end while
return $X_{\alpha}$

Figure 1: Pseudo Code of GWO

Methodology

This section elaborates steps taken in developing a GWO forecasting model. It starts with data collection and its pre-processing activities. Upon completion of the forecasting model, relevant performance metrics were employed to determine the effectiveness of the proposed model.

A. Research Data and Data Preparation
In this study, real data of West Texas Intermediate (WTI) crude oil prices are considered in the examination. This is due it is the most famous benchmark price (Xiong, Bao & Hu, 2013). The time series data covered is from December 1, 1997 to June 30, 1998 and are freely obtained from Barchart website ("Barchart," 2012). From the sample, 70% is allocated for training purposes while the rest 30% is set for testing.

B. Experiment Setup
The variables assigned to features involved are as tabulated in Table 1. The input arrangement utilized is as suggested in (Malliaris & Malliaris, 2008). The output was the daily spot price of CL one month ahead (21 trading days).

Table 1. Assigning Input and Output Variables

<table>
<thead>
<tr>
<th>Input</th>
<th>Variable</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily closing price of crude oil price</td>
<td>CL</td>
<td>Daily spot price of crude oil price from day 21 onwards (CL21)</td>
</tr>
<tr>
<td>Percent change in daily closing spot price from the previous day of crude oil price</td>
<td>%Chg</td>
<td></td>
</tr>
<tr>
<td>Standard deviation over the previous 5 days of trading days of crude oil price</td>
<td>Std5</td>
<td></td>
</tr>
<tr>
<td>Standard deviation over the previous 21 days of trading days of crude oil price</td>
<td>Std21</td>
<td></td>
</tr>
</tbody>
</table>
C. The Algorithm of GWO for Crude Oil Price Forecasting

In this study, the goal is to minimize the error between the forecast and actual price of the crude oil. For that purpose, the objective function is served by Mean Absolute Percentage Error (MAPE) (see section E). The equation of crude oil price forecasting is modified from (Hadavandi, Ghanbari, & Abbasian-Naghneh, 2010) and defined as follows:

\[
CL_{21} = (\alpha \times CL) + (\beta \times \%Chg) + (\gamma \times Std5) + (\delta \times Std21) + \epsilon
\]

(8)

where the \(\alpha\), \(\beta\), \(\gamma\) and \(\delta\) are the coefficients for CL, \%Chg, Std5 and Std21 respectively (see Table 1) while the \(\epsilon\) is the intercept coefficient.

D. Benchmarking Techniques

In this study, the results from the GWO are compared with the results produced by the following techniques:

i) Artificial Bee Colony Algorithm (ABC)

The ABC algorithm which has been introduced by Dervis Karaboga (Karaboga, 2005) is enlightened from the intelligent foraging behaviour of honey bees swarm. In the algorithm, it is consists of three groups of bees viz. employed bee, onlooker bees and scout bees.

ii) Differential Algorithm (DE)

Introduced by Storn and Price (1997), DE is inspired by the mechanism of natural selection which considered as extension of GA. The difference between DE and GA is, in DE, all possible solutions have an equal chance in evaluation task, while in GA, the chance of updating the solution is depends on fitness value.

E. Performance Evaluation Metric

The performance of the forecasting algorithm is evaluated via statistical evaluation indices namely Mean Absolute Percentage Error (MAPE) (Hyndman & Koehler, 2006) and prediction accuracy (PA). The definitions of these evaluation metrics are shown as follows:

\[
MAPE = \frac{1}{N} \left[ \sum_{n=1}^{N} \left| \frac{y_n - y(x_n)}{y_n} \right| \right]
\]

(17)

\[
PA = 100\% - (MAPE \times 100)
\]

(18)

Where \(n = 1, 2, ..., x\)

\(- y_n = \) actual values

\(- y(x_n) = \) predicted values/approximate values by predictor models

\(- N = \) Number of test data
Empirical Results and Discussion

For comparison purposes, the forecasting performance of GWO is compared against the results produced by ABC (Mustaffa, Yusof, & Kamaruddin, 2013) and DE. According to the obtained results in Table 2, the values of $\alpha$, $\beta$, $\gamma$, $\delta$ and $\varepsilon$ produced by GWO are 0.8346, 0.1128, 0.1521, 1 and 1 respectively. The combination of this parameters yield 5.4779% of MAPE in testing. Meanwhile, the ABC capable to produced slightly lower MAPE which is 5.4170%. However, based on paired sample T-test, it shows that the statistical level of the difference of the means between GWO and ABC is not significant at 0.05% significance level (see Table 3). By producing high correlation, which is 0.9902, it indicates that the prediction values produced by both techniques move very much in the same patterns. Hence the insignificant difference. On the other hand, the DE is left far behind when the produced MAPE is more than 10%, which is 11.9320%.

Table 2: Comparison of Prediction Techniques for CL Price Forecasting

<table>
<thead>
<tr>
<th></th>
<th>GWO</th>
<th>ABC</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.8346</td>
<td>0.8454</td>
<td>0.8454</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.1128</td>
<td>0.1081</td>
<td>0.1081</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.1521</td>
<td>0.4255</td>
<td>0.4255</td>
</tr>
<tr>
<td>$\delta$</td>
<td>1.0000</td>
<td>0.8673</td>
<td>0.8673</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>1.0000</td>
<td>0.9119</td>
<td>0.9119</td>
</tr>
<tr>
<td>MAPE (Testing(%))</td>
<td>5.4779</td>
<td>5.4170</td>
<td>11.9320</td>
</tr>
<tr>
<td>PA(%)</td>
<td>94.5221</td>
<td>94.5830</td>
<td>88.0680</td>
</tr>
</tbody>
</table>

Table 3: Significant Test for CL Price Forecasting

<table>
<thead>
<tr>
<th></th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWO - ABC</td>
<td>0.9902</td>
<td>0.6111</td>
</tr>
<tr>
<td>GWO - DE</td>
<td>0.3049</td>
<td>0.0003</td>
</tr>
<tr>
<td>ABC - DE</td>
<td>0.2913</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

The visual performances of results are shown in Figure 1, which plot the actual and forecast value of GWO and the identified competitors from day 103 to day 146 (testing phase). The dashed line represents the actual price, the solid line show the GWO forecast price, while the diamond mark and crossmark represent the forecast value obtained using ABC and DE respectively.
Meanwhile, the actual and forecast values of GWO and the two identified techniques from day 121 to 130 (testing phase) are tabulated in Table 4. The highlighted figures indicated that the respective approach has closer prediction value as compared to the rest in certain days.

Table 4: Actual vs. Forecast Values by GWO, ABC and DE

<table>
<thead>
<tr>
<th>Day</th>
<th>Actual Price</th>
<th>GWO</th>
<th>ABC</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>13.85</td>
<td><strong>13.9968</strong></td>
<td>14.1125</td>
<td>12.989</td>
</tr>
<tr>
<td>122</td>
<td>14.59</td>
<td>14.0176</td>
<td><strong>14.1344</strong></td>
<td>13.0102</td>
</tr>
<tr>
<td>123</td>
<td>14.02</td>
<td><strong>14.0262</strong></td>
<td>14.0827</td>
<td>13.1001</td>
</tr>
<tr>
<td>125</td>
<td>14.1</td>
<td><strong>14.1466</strong></td>
<td>14.1582</td>
<td>12.9915</td>
</tr>
<tr>
<td>126</td>
<td>14.15</td>
<td><strong>14.5134</strong></td>
<td>14.537</td>
<td>15.2244</td>
</tr>
<tr>
<td>127</td>
<td>14.19</td>
<td>13.8318</td>
<td><strong>13.8749</strong></td>
<td>13.422</td>
</tr>
<tr>
<td>130</td>
<td>13.77</td>
<td>13.6482</td>
<td><strong>13.7291</strong></td>
<td>13.0227</td>
</tr>
</tbody>
</table>

Conclusion

In this study, a new SI algorithm namely GWO is employed for short term crude oil price forecasting. The efficiency of the proposed technique is measured based on MAPE and PA and is compared against the ones produced by ABC and DE algorithm. Findings of the study reveal competitive results where it is learned that GWO is comparable to ABC algorithm. Thus, it indicates a positive opportunity for future works.
References


Grey Wolf Optimizer Technique to Solve Combined Economic Emission Dispatch (CEED) Problem

Hong Mee Song, Universiti Malaysia Pahang, Malaysia
Mohd Herwan Sulaiman, Universiti Malaysia Pahang, Malaysia
Mohd Rusllim Mohamed, Universiti Malaysia Pahang, Malaysia

Abstract
Grey Wolf Optimizer (GWO) is a newly proposed algorithm that developed based on inspiration of grey wolves (Canis Lupus). This GWO algorithm mimics the nature of grey wolves in leadership hierarchy and hunting mechanism. This paper is in the purpose of introducing GWO to solve combined economic emission dispatch problem (CEED) in power system. CEED actually is a bi-objective problem where the objective of economic dispatch (ED) and emission dispatch (EMD) are combined into a single function by using price penalty factor. Hence, CEED is used to minimize total generation cost by minimized fuel cost and emission at the same time determines the optimum power generation. The proposed algorithm will be implemented in two different systems which are 6 and 11-generating unit test system with different constraints on various power load demands. The result was compared with the optimization techniques reported in recent literature in order to observe the effectiveness.

Keywords: Combined Economic Emission Dispatch, Grey Wolf Optimizer
Introduction

Economic Dispatch (ED) in power system is for schedule the generators to minimize the total operating cost at the same time to meet load demand of the power system over some appropriate period while satisfying various equality and inequality constraint. The ED basically considers the load balance constraint beside the generating capacity limits. (Harinder Pal Singh 2013)

Recently, contribution of power engineering to the environment always questioned since the setup of thermal power plant that generate power from combustion of fossil fuel increasing. Usually power plant which based on lowest fuel cost did not consider the environmental pollution. (Güvenç 2010) Hence, emission dispatch assigned in economic dispatch for the purpose of determine the optimal amount of generated power for the generating units by minimizing the fuel cost and emission level simultaneously subject to various system constraints. In CEED, the emission function is the second objective function to be minimized. The two main emissions of power plant are sulphur dioxide \((SO_2)\) and nitrogen oxide \((NO_x)\). (S.Subramaniam 2010)

Quite high numbers of methods have been presented in literature to solve combined economic emission dispatch (CEED) problem. Some also tried to develop these methods in order to improve the results obtained. The most simplest method used in this field is Lagrange Multiplier method which only solves equality constraint and later it was extended by implementing Kuhn Tucker method which solves inequality constraint. (Hassan 2010) To date, nature inspired meta-heuristic optimization technique widely used to solve CEED problems where the effectiveness can be observed vividly compare with conventional method. For example, Abido (Abido 2009) developed a multiobjective evolutionary algorithm that use the strength pareto evolutionary algorithm. Bhuvnesh Khokhar & Singh Parmar (Bhuvnesh Khokhar 2012) introduced novel weight-improved particle swarm optimization by improving function of weight parameter in order to find optimal soltion for CEED. A simplified recursive approach of Dynamic Programming (DP) presented by Balamurugan & Subramaniam in (R.Balamurugan 2008) to solve CEED problem by generalized the equation so that it is easier to implemented in larger system. Similarly, Güvenç (Güvenç 2010) presented genetic algorithm based on similarity crossover to solve CEED which implemented the inspiration of children created by using similarity measurement between parents chromosome.

Grey Wolf Optimizer (GWO) is a newly proposed technique by S.Mirjalili, S.M.Mirjalili and A.Lewis (Mirjalili, Mirjalili et al. 2014) in year 2013. The technique is inspired by leadership hierarchy and hunting mechanism of grey wolf (Canis Lupus) which belongs to Canidae family. In this paper, the proposed optimization technique used to solve CEED problem. The study result show that the proposed approach is more efficient in minimizing fuel cost and emission compare with reviewed paper.

Problem Formulation
The objective of Combined Economic Emission Dispatch is to minimize the fuel cost and emission while satisfying several equality and inequality constraints. Hence, the problem can be formulated as

A. Problem formulation

Consider a power system having N generating units, the objective function is formulated as

\[ F_T = \text{Min} \, f(FC, EC) \]  

(B) Minimization of Fuel Cost

The generator cost curves are represented by quadratic functions and the total fuel cost FC in ($/h) can be expressed as

\[ FC = \sum_{i=1}^{N} \left( a_i P_i^2 + b_i P_i + c_i \right) \]  

where N is the number of generators; \( a_i, b_i, c_i \) are the cost coefficients of the \( i^{th} \) generator and \( P \) is the vector of real power outputs of generators and defined as

\[ P = [P_1, P_2, \ldots, P_N] \]

(C) Minimization of Emission

The total emission EC in (Kg/h) can be expressed as

\[ EC = \sum_{i=1}^{N} \left( \alpha_i P_i^2 + \beta_i P_i + \gamma_i \right) \]  

where N is the number of generators; \( \alpha_i, \beta_i, \gamma_i \) are the emission coefficients of the \( i^{th} \) generator.

D. Constraints

1.) Power Balance/Equality Constraint

The total generated power must cover the total load power which can be defined as

\[ P_{\text{load}} - \sum_{i=1}^{N} P_i = 0 \]  

2.) Generation Capacity/Inequality Constraint

For stable operation, the real power output of each generator is restricted by lower and upper limits as follows:

\[ P_i^{\text{min}} \leq P_i \leq P_i^{\text{max}} \quad i = 1, 2 \ldots N \]

E. Price Penalty Factor

The bi-objective of combined economic emission dispatch actually can be converted into single objective function by implementing price penalty factor \( h_i \). (Venkatesh, Gnanadass et al. 2003) The price penalty factor of each generator is the ratio between the fuel cost and emission at its maximum power output.
\[ h_i = \frac{a_i P_{i,\text{max}}^2 + b_i P_{i,\text{max}} + c_i}{\alpha_i P_{i,\text{max}}^2 + \beta_i P_{i,\text{max}} + \gamma_i} \] (7)

F. Total Cost of Generation
The total generating cost actually is sum of minimized fuel cost and minimized emission where the emission (Kg/h) is converted into emission cost ($/h).

\[ \text{Min } F_i = \sum_{i=1}^{N} \left( a_i P_i^2 + b_i P_i + c_i \right) + h_i \left( \alpha_i P_i^2 + \beta_i P_i + \gamma_i \right) \] (8)

The transmission losses of the system have been ignored in this paper due to mathematical simplicity and comparison with reviewed paper.

**Grey Wolf Optimizer Algorithm**

GWO actually inspired by grey wolf which are the apex predators where they are stands at the top of the food chain. They mostly live in group which consist 5-12 members. Their leadership hierarchy is as shown in Figure 1. The alpha in the figure shown can be represented as leader where it is decision maker and dictator of the group.

The beta wolf in the hierarchy plays the role as consultant to the alpha wolf where help alpha wolf to make decision. It will be appointed as alpha in case the former alpha is passed away or too weak. The lowest ranking in the hierarchy is omega wolves where it plays the role as scapegoat. The losing of omega wolf will cause the entire group facing internal fighting. Omega wolves also can be described as babysitters of the group.

Delta wolves in the hierarchy also described as subordinate. It has to submit to alpha and beta but dominate the omega. There are few roles in this category which consists of scouts, sentinels, elders, hunters, and caretakers. The most common social behaviour of grey wolves is group hunting. Hunting of grey wolf can be divided into phases as follows (Mirjalili, Mirjalili et al. 2014), (C. Muro 2011):

- Tracking, chasing, and approaching prey.
- Pursuing, encircling, and harassing the prey until it stops moving.
- Attack towards the prey.

In the mean of design GWO, the hunting techniques and the leadership hierarchy of the grey wolves are mathematically modelled.

![Hierarchy of grey wolf](image)
To model the mathematical computation, the first stage is social hierarchy where the fittest solution is $\alpha$ followed by $\beta$ and $\delta$. The rest of the candidate solution is assumed as $\omega$.

In the stage of encircling prey, the proposed equations are

$$
\tilde{D} = \left| \tilde{C}.\tilde{X}_p(t) - \tilde{X}(t) \right| \tag{9}
$$

$$
\tilde{X}(t+1) = \tilde{X}_p(t) - \tilde{A}\tilde{D} \tag{10}
$$

$$
\tilde{A} = 2\tilde{a}\tilde{r}_1 - \tilde{a} \tag{11}
$$

$$
\tilde{C} = 2\tilde{r}_2 \tag{12}
$$

Where $t$ indicates the current iteration, $\tilde{A}$ and $\tilde{C}$ are coefficient vectors, $\tilde{X}_p$ is the position vector of the prey, and $\tilde{X}$ indicates the position vector of a grey wolf. $\tilde{A}$ and $\tilde{C}$ actually can be calculated as shown in equation (11) and (12) where $\tilde{a}$ linearly decreased from 2 to 0 over the course of iterations and $r_1, r_2$ are random vectors. The position of grey wolf ($X, Y$) can be updated according to the position of prey ($X^*, Y^*$).

The mathematical formulation during the stage of hunting is as follow

$$
\tilde{D}_\alpha = \left| \tilde{C}_1.\tilde{X}_\alpha - \tilde{X} \right|, \tilde{D}_\beta = \left| \tilde{C}_2.\tilde{X}_\beta - \tilde{X} \right|, \tilde{D}_\delta = \left| \tilde{C}_3.\tilde{X}_\delta - \tilde{X} \right| \tag{13}
$$

$$
\tilde{X}_1 = \tilde{X}_\alpha - \tilde{A}_1.(\tilde{D}_\alpha), \tilde{X}_2 = \tilde{X}_\beta - \tilde{A}_2.(\tilde{D}_\beta), \tilde{X}_3 = \tilde{X}_\delta - \tilde{A}_3.(\tilde{D}_\delta) \tag{14}
$$

$$
\tilde{X}(t+1) = \frac{\tilde{X}_1 + \tilde{X}_2 + \tilde{X}_3}{3} \tag{15}
$$
Figure 2: Pseudo code of the GWO algorithm

GWO for Combined Economic Emission Dispatch Problem

The parameter that needs to be set in GWO is search agents and number of iteration. The solution of GWO for CEED is initialized based a set of candidate, $X_{sa,ng}$. This comprises of the number of generations of the system that will be optimized which resulted minimum total cost, fuel cost and emission by fulfilling all the constraints. The search agent variables of the CEED can be expressed as follows:

$$X_{i,j} = \begin{bmatrix} x_1^i & \cdots & x_{ng}^i \\ \vdots & \ddots & \vdots \\ x_{sa}^i & \cdots & x_{ng}^i \end{bmatrix}$$

(16)

where $sa$ is the number of search agents and $ng$ is the number of generator plant in the system. To achieve the targeted objective which is to solve CEED, Eq. (17) was applied in the performance of evaluation. GWO algorithm chooses the boundaries values when the solution obtained exits the boundaries in any iteration for equality constraint. At the same time for equality constraint, the penalty factor PF implemented in objective functions when it is violated. The implementation of PF is as follows

$$F = (FC) + PF \times \text{abs}[P_D - (\sum_{i=1}^{N} P_i)]$$

(17)

$$E = (EC) + PF \times \text{abs}[P_D - (\sum_{i=1}^{N} P_i)]$$

(18)

The algorithm will continue until the maximum iteration is met and the optimum result is obtained (M.H. Sulaiman 2014).

Results & Discussion
The proposed method is tested on six-generator test system taken from (Güvenç 2010) for solving CEED problem while ignoring power losses. The fuel cost coefficient, emission coefficient and generator capacity limit are given in Table 1 and 2.

Table 1: Fuel cost coefficients and generation limits of six-generator system

<table>
<thead>
<tr>
<th>Generator</th>
<th>$a_i$ ($$/MW^2h$$)</th>
<th>$b_i$ ($$/MWh$$)</th>
<th>$c_i$ ($$/h$$)</th>
<th>$P_{i_{min}}$ (MW)</th>
<th>$P_{i_{max}}$ (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1525</td>
<td>38.540</td>
<td>756.800</td>
<td>10</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>0.1060</td>
<td>46.160</td>
<td>451.325</td>
<td>15</td>
<td>225</td>
</tr>
<tr>
<td>3</td>
<td>0.0280</td>
<td>40.400</td>
<td>1050.000</td>
<td>35</td>
<td>210</td>
</tr>
<tr>
<td>4</td>
<td>0.0355</td>
<td>38.310</td>
<td>1243.530</td>
<td>35</td>
<td>210</td>
</tr>
<tr>
<td>5</td>
<td>0.0211</td>
<td>36.328</td>
<td>1658.570</td>
<td>130</td>
<td>325</td>
</tr>
<tr>
<td>6</td>
<td>0.0180</td>
<td>38.270</td>
<td>1356.660</td>
<td>125</td>
<td>315</td>
</tr>
</tbody>
</table>

Table 2: Emission coefficients of six-generator system

<table>
<thead>
<tr>
<th>Generator</th>
<th>$\alpha_i$ (Kg/MW²h)</th>
<th>$\beta_i$ (Kg/MWh)</th>
<th>$\gamma_i$ (Kg/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0042</td>
<td>0.3300</td>
<td>13.860</td>
</tr>
<tr>
<td>2</td>
<td>0.0042</td>
<td>0.3300</td>
<td>13.860</td>
</tr>
<tr>
<td>3</td>
<td>0.0068</td>
<td>-0.5455</td>
<td>40.267</td>
</tr>
<tr>
<td>4</td>
<td>0.0068</td>
<td>-0.5455</td>
<td>40.267</td>
</tr>
<tr>
<td>5</td>
<td>0.0046</td>
<td>-0.5112</td>
<td>42.900</td>
</tr>
<tr>
<td>6</td>
<td>0.0046</td>
<td>-0.5112</td>
<td>42.900</td>
</tr>
</tbody>
</table>

Table 3 presents the best optimal power output with minimum total cost, fuel cost and emission using GWO algorithm with the power demand varies from 500-1100 MW for six generator system. While Table 4 gives the comparative result of GWO with other optimization techniques for six-generator test system with power demand of 500-1100 MW.

Table 3: CEED solution for six-generator system

<table>
<thead>
<tr>
<th>Load (MW)</th>
<th>500</th>
<th>600</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1000</th>
<th>1100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.879</td>
<td>46.008</td>
<td>60.217</td>
<td>74.278</td>
<td>88.518</td>
<td>102.70</td>
<td>116.903</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>83</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Unit 2 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.404</td>
<td>40.524</td>
<td>56.885</td>
<td>73.164</td>
<td>89.375</td>
<td>105.80</td>
<td>122.045</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>75</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Unit 3 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88.060</td>
<td>102.17</td>
<td>116.19</td>
<td>130.32</td>
<td>144.34</td>
<td>158.40</td>
<td>172.536</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>37</td>
<td>17</td>
<td>91</td>
<td>43</td>
<td>78</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Unit 4 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>89.058</td>
<td>102.91</td>
<td>116.66</td>
<td>130.54</td>
<td>144.28</td>
<td>157.97</td>
<td>171.707</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>78</td>
<td>27</td>
<td>62</td>
<td>55</td>
<td>17</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Unit 5 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>134.38</td>
<td>155.23</td>
<td>175.95</td>
<td>196.53</td>
<td>217.22</td>
<td>238.11</td>
<td>258.731</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>92</td>
<td>22</td>
<td>94</td>
<td>05</td>
<td>82</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Unit 6 (MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>132.21</td>
<td>153.13</td>
<td>174.09</td>
<td>195.14</td>
<td>216.25</td>
<td>236.98</td>
<td>258.076</td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>61</td>
<td>11</td>
<td>27</td>
<td>57</td>
<td>65</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Comparison of fuel cost, emission and total cost for six-generator system

<table>
<thead>
<tr>
<th>Fuel Cost ($/h)</th>
<th>Method</th>
<th>Load (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>27195.</td>
<td>Y-Iteration (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>27092.</td>
</tr>
<tr>
<td>7055</td>
<td>Recursive (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>27092.</td>
</tr>
<tr>
<td>7593</td>
<td>PSO (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>27097.</td>
</tr>
<tr>
<td>257.11</td>
<td>DE (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>27098.</td>
</tr>
<tr>
<td>16</td>
<td>Simplified recursive (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>27092.</td>
</tr>
<tr>
<td>82</td>
<td>Similarity crossover of GA (Güvenç 2010)</td>
<td>27089.</td>
</tr>
<tr>
<td>176</td>
<td>Proposed GWO</td>
<td>27195.</td>
</tr>
<tr>
<td>225</td>
<td>Emission Output (Kg/h)</td>
<td>261.63</td>
</tr>
<tr>
<td>324</td>
<td>Y-Iteration (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>261.63</td>
</tr>
<tr>
<td>373</td>
<td>Recursive (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>261.63</td>
</tr>
<tr>
<td>422</td>
<td>PSO (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>262.22</td>
</tr>
<tr>
<td>471</td>
<td>DE (Güvenç 2010), (R. Balamurugan 2008)</td>
<td>261.85</td>
</tr>
</tbody>
</table>
In Table 3, proposed GWO obtained minimum total cost by minimizes fuel cost and emission. When the load varied from 500-1100 MW, the algorithm demonstrated its efficiency well by choosing optimal power of generating unit with minimum cost of operation. The comparison with other techniques showed that GWO have the most minimum total cost of generation for six-generator system when the same price penalty factor applied to the value of other techniques. The optimum minimization in emission successfully minimized the total operating cost of the system.

**Conclusion**

In this paper, the recent natures-inspired Grey Wolf Optimizer (GWO) technique discussed to solve CEED problems with loss less. It has been tested with six-generator system to observe its effectiveness and robustness. From the simulation, it can be concluded that the proposed GWO algorithm performed better than other optimization compared by minimizes the total generating cost. The technique chooses to minimize the emission more rather than fuel cost in terms to minimize the total operating cost with generated price penalty factor.

**Acknowledgement**

The authors would like to acknowledge Universiti Malaysia Pahang (UMP) and Ministry of Higher Education Malaysia (MOHE) for the financial supports and facilities provided to conduct this research. Grant #RDU130104.
References


Beyond the Bars, Breaking Barriers Towards Digital Inclusion: Family Visits Through ICT-based “e-Dalaw” as Innovation in the Reformation Program of the Maximum Security Inmates of the New Bilibid Prisons, Philippines

Marjorie Don Resuello, University of the Philippines Los Baños, Philippines
Rosario V. Tatlonghari, University of the Philippines Los Baños, Philippines

Abstract
Information Communication Technologies (ICT) have become pervasive in many cultures. The Internet is now being called “Relationship Technology” for making connections possible, breaking barriers of time and distance and foster social and digital inclusion. The Philippines’ Correctional System through the Bureau of Corrections has piloted a project called “e-Dalaw” in line with modern reformation concepts on the visiting system. It is an ICT-based program for the inmates which has a goal of enabling them to connect to their families locally or abroad.

The study, with the Unified Theory of Acceptance and Use of Technology (UTAUT) Theory as framework, determined the knowledge, attitudes, and practices of selected inmates of the Maximum Security Compound in the New Bilibid Prison and their problems with e-Dalaw. Data were collected through a survey of 330 inmates and key informant interviews.

The respondents had average level of knowledge on e-Dalaw, mainly through social influence in UTAUT. The most perceived usefulness or outcome expectations of the respondents on e-Dalaw were happiness. Its perceived ease of use or effort expectancy was complicated and assistance was needed. The facilitating conditions that need improvement were availability of more material resources.

Using Behavior Change Communication, the results of the study revealed that the inmates who were satisfied with e-Dalaw promoted the behavior to their social network. Chi-Square Test of Independence indicated that knowledge had significant relationship with attitude, and between knowledge and practices of e-Dalaw. The socio-demographic characteristic “last visitation received” was the most significant factor affecting knowledge on e-Dalaw.

Keywords: inmates; prison reformation; e-Dalaw; visitation; social inclusion; digital inclusion
Introduction

New media revolutionized people’s mode of acquiring knowledge and ways of living (Flichy, 1999). Kramarae (1999) declared that as people use new media in new ways, new terminologies develop; for example, for making connections possible across time and space, the internet is referred to as the new “Relationship Technology” instead of Information Technology (IT). Such relationships and deprivation thereof led to the concept of social inclusion and social exclusion being equated with Information Communication Technologies (ICT) or ICTs. Haddon (2000) expounded on the relationship of ICTs and social inclusion, with ICTs enabling people to participate, be part of the wider society, and avoiding social isolation, which is the essence of social inclusion. Sy (2001) highlighted ICT’s role in the Philippine context with social interactions increasingly becoming mediated. This might explain why the Philippines has recently been declared as Social Networking Capital of the World (Manila Standard, 2013).

With social inclusion being prominent in European policy spheres, it is no wonder that e-inclusion is being vigorously promoted in the continent. E-Inclusion aims at achieving that “no one is left behind” in enjoying the benefits of ICT (e-inclusion, Be Part of It, 2012). Focusing on participation of all individuals and communities in all aspects of the information society, e-Inclusion means both inclusive ICT and the use of ICT to achieve wider inclusion objectives. In relation to how people appropriate and use ICTs, understanding the concept of digital inclusion helps to understand the routes to social inclusion. Thomas and Wyatt (2000) as cited by Bure (2005) claimed that digital inclusion involves not just access to ICTs, but also “ICT capability.”

The United Nations considers ICT access as among the basic human rights. Democratized reach and access target the marginalized groups, and inmates have benefitted from these initiatives. The United Kingdom government launched the action plan Delivering Digital Inclusion which has a strategy to ensure that the benefits of digital technology were spread equally to all groups and communities (Prison Reform Trust, 2009). It reported that there are considerable opportunities to extend IT services in prison, which can assist in reducing reoffending. Prison programs have the primary purpose to assist the inmates in preparing them for their return to the society (Howsera, Grossmanb, & Macdonald, 2008).

In the Philippines, the Bureau of Corrections initiated the e-Dalaw, which means electronic visitation (of inmates’ families) in English. This is within the principle of providing humane treatment by affording the inmates human basic needs in the prison environment, prohibiting cruel methods and providing a variety of rehabilitation program. The Minnesota Department of Corrections (DOC) had a study about the effects of prison visitation on recidivism among 16,420 offenders. The results suggested that prison visitation can significantly improve the transition inmates make from the institution to the community. Also, the results suggested that both the presence and frequency of prison visits during the last year of confinement were associated with reduced recidivism. Thus, an inmate’s capability to cope with the substantial emotional, economic, legal, and other challenges they face during incarceration is determined through the extent to which they are able to maintain contacts with individuals on the outside in which visitation is the primary link (Sitren, 2009).
With family relationships being sustained, the use of ICTs through e-dalaw in prison reform takes the social inclusion/digital inclusion dimension. Interest has been actually increasing in the area of new technologies being implemented in prisons and jails, specifically in the area of visitation and the need for avenues through which the family support system and the reintegration of inmates back into the community could be improved during incarceration (Johnson & Hesse, 2005).

This innovation thus merits a study on the perception of inmates of such technology. While the concept is socially relevant in terms of fostering family ties amid imprisonment of a family member, it necessitates research investigation on the use of technology and its acceptance in the prison setting.

e-Dalaw is a new facility in line with modern reformation concepts on the visiting system. It is an ICT-based program for the inmates which has a goal of enabling them to connect to their families locally or abroad without leaving the jail through supervised Internet video calls. Bureau of Jail Management and Penology (BJMP) launched the e-Dalaw project last October 2011 in the Quezon City Jail, the pilot jail of this project, and was also introduced in the New Bilibid Prison (Aurelio, 2011). It is one of the Bureau of Corrections’ (BuCor) efforts to fulfill its mandate to reform the inmates. BuCor is a government agency under the Corrections pillar of the Philippine Criminal Justice System, which is supervised by the Department of Justice. As stated in its Road Map “Strategic Plan: BuCor 2022,” reformation is designed to “help ensure that as inmates are released, they will be productive, healthy, and less likely to be in conflict with the law again.”

As stated in the United Nations Standard Minimum Rules for the Treatment of Prisoners (n.d.), “Prisoners shall be allowed under necessary supervision to communicate with their family and reputable friends at regular intervals, both by correspondence and by receiving visits.” As one of the stakeholders of prison reform, the inmates’ families can help in the rehabilitation process of the inmates. Visitation has rehabilitative benefits for the inmates and it can reduce strains on the inmates’ relations with their families and can help in the inmates' post-release success (Gordon & McConnell, 1999).

This study can provide a baseline assessment of e-Dalaw in the Philippines and address the dearth of literature on technology assessment and acceptance in prisons, particularly those under Maximum Security. Determining the knowledge, attitudes, and practices of this sector and their recommendations would hopefully help bring about areas for further improvement in order to maximize the full potentials of this ICT-based reformation program for inmates.

Objectives

This study aimed to determine the level of knowledge, attitudes, and practices of the selected inmates of the Maximum Security Compound in the New Bilibid Prison regarding e-Dalaw. The relationship of the residents’ socio-demographic characteristics to their knowledge, attitudes, and practices were also established. It also assessed the problems the inmates encountered in using e-Dalaw; and elicited the inmates’ recommendations for the improvement of e-Dalaw.
Theoretical Framework

Silva (2006 as cited by Silva and Dais 2007) highlighted the importance of not having only a technical view, but to understand the behavior of who will use information systems. Predicting and analyzing user acceptance of computer technology are important to address success and failure of technological products. Information systems (IS) adoption is just the first step towards overall IS success. It can be truly considered a success when significant number of users has moved beyond initial adoption and used IS on a continued basis (Bhattacherjee (2001), Davis and Venkatesh (2004) and Limayem and Hirt (2003) as cited by Cheung and Limayem, (n.d.)).

To understand the IT acceptance of the inmates in the Maximum Security Compound in the New Bilibid Prison, the theoretical framework of the study utilized the Unified Theory of Acceptance and Use of Technology (UTAUT) Theory. UTAUT suggested three constructs – performance expectancy, effort expectancy, and social influence – as main determinants of intention to use an IT which comprise the most influential constructs of the eight theories and models (Venkatesh, et. al., 2003 as cited by Li, n.d.).

Performance expectancy refers to the “degree to which the user expects that using the system will help him or her attain gains in job performance” (Venkatesh, et. al., 2003 as cited by Li, n.d.). Under this construct are five root constructs which are perceived usefulness, extrinsic motivation, relative advantage, and outcome expectations. According to Davis (1989) as cited by Li (n.d.), the strongest predictor of an individual’s attention to use an IT is perceived usefulness.

The second construct of UTAUT is effort expectancy, which refers to “the degree of ease associated with the use of the system,” (Venkatesh, et. al., 2003 as cited by Li, n.d.). It was used in UTAUT to capture the concepts of perceived ease of use, complexity, and ease of use. Technology acceptance models found out that perceived usefulness, behavior attitude, intention, and actual use was significantly influenced by perceived ease of use (Davis, 1989, as cited by Li, n. d.).

Lastly, social influence refers to the “degree to which an individual perceives that important others believe that he or she should use the new system” (Venkatesh, et. al., 2003 as cited by Li, n.d.). The study by Lu et al. (2005) as cited by Li (n.d.) suggested that individual’s perceptions of usefulness and ease of use were influenced by social influences from social networks and the sense of image. Venkatesh, et al. (2003) as cited by Li (n.d.) suggested that social influences are “more likely to be salient to older workers, particularly women, and even then during early stages of experience/adoption.”

User behavior is reflected by the behavior intention of a person. Performance expectancy, effort expectancy, and social influence affect behavior through behavioral intention whereas; facilitating conditions affect behavior either directly or through behavioral intention (Thompson, et. al., 1991 as cited by Li, n.d). Facilitating conditions was defined by Venkatesh, et. al. (2003) as cited by Li (n.d.) as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.” Moreover, it was suggested that age and experience of the individual affects the influence of facilitating conditions on usage.
In achieving behavior change, knowledge, approval, intention, practice, and then advocacy are the ideal steps.

In knowledge, one must first learn about a new behavior. Approval refers to responding favorably to the new behavior. If one believes that the behavior is beneficial to them, one intends to adopt it. The attempts to try the new behavior and continues doing it is the practice. Lastly, with the experiences and acknowledgement of personal benefits of adopting the new behavior, advocacy is promoting the new behavior through social or professional networks.

**Conceptual Framework**

This study adopted the concepts of the UTAUT Theory to understand the IT acceptance and behavior of the inmates in the Maximum Security Compound in the New Bilibid Prison.

The knowledge of the inmates on e-Dalaw was viewed as the first step in the Behavior Change Communication continuum. The attitudes of the inmates towards e-Dalaw were reflected on the constructs of UTAUT which are the performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), and social influence (information sources), and also facilitating conditions (policies and material/human resources). These are also viewed as the approval stage in the Behavior Change Communication continuum. Attitudes/approval constitute the behavioral intention factors.
Methods

The study was conducted from June 2012 to April 2013 in the Maximum Security Compound, where the e-Dalaw system was piloted in October 2011 in the New Bilibid Prison. Survey research design was used in which self-administered questionnaires were given to 330 inmates, out of 3,140 inmates in the Maximum Security Compound who used e-Dalaw. Qualitative data were gathered from key informant interviews of three prison officials. Secondary data were collected in the form of the statistical reports on socio-demographics of the inmates.

Data were analyzed through descriptive statistics (percentages, means, and frequency counts) and Chi-square Test of Independence to determine the relationship of knowledge, attitudes, and practices to socio-demographic characteristics of the respondents.

Moreover, UTAUT Theory was used to understand the behavior and acceptance of the respondents towards the technological innovation. The practice or usage of e-Dalaw (user behavior) was also analyzed through the Behavior Change Continuum, particularly the progress from knowledge to approval to intention to practice to advocacy.

Results and Discussion

Respondents’ Socio-demographic Characteristics. Based on the prison record as of February 23, 2013 of the Office of the Overseer, Maximum Security Compound, New Bilibid Prison, a total of 13,229 inmates were male whose sentences were more than 20 years of imprisonment. The largest portion of the respondents had spent not more than five years of their sentence, were from Luzon, particularly in the National Capital Region, in their thirties, and high school graduates. Most of them were
married and had personal visitations in which most of their visitors were their children followed by their wives.

The results of the study conducted by US Department of Health and Human Services in 2009 suggested that when individuals were already in the midst of potentially aging out of crime, living in a married or married-like relationship can be an important source of support upon release from prison. Furthermore, BuCor Director General Gaudencio Pangilinan (personal communication, February 1, 2013) said that inmates who had no visits were likely to be scumbag after release from prison. This implied the importance of family support and relationship in the reformation program of the inmates and in overcoming the problems and challenges the inmates face during their incarceration.

The Minnesota Department of Corrections reported in 2011 that prison visitation can improve recidivism outcomes by helping the inmates to not only maintain social ties with their families while incarcerated, but also by developing networks of social support which was important in lowering recidivism. Findings of Minnesota Department of Correction in 2011 showed that the more frequent the inmates received visitation, the less likely they recidivate.

Respondents’ Knowledge on e-Dalaw. Inmates may use e-Dalaw every day except on Mondays and holidays for up to 20 minutes. According to BuCor Dir. Gen. Pangilinan (personal communication, February 1, 2013), an inmate can extend his time talking to his families and friends as long as there were only few e-Dalaw users for that particular day.

More than half of the respondents (67.30%) had an average score (2-3 points) on the knowledge test composed of questions about the rules on what days and time and how frequent and long they could access e-Dalaw. The results could imply confusion of the inmates, which could be attributed to changes in the rules and regulation to e-Dalaw access, availability of e-Dalaw personnel, and availability, and efficiency of computer units.

Results showed that 82.12% of the respondents became aware of e-Dalaw through recommendations from the prison guards and officials, which represented the social influence in UTAUT. Social influences are within the subjective norm, which “has a direct effect on intention through the mechanism of compliance.” The result implied superior influence and mechanisms of compliance.

Respondents’ Attitude towards e-Dalaw. The most perceived usefulness in using e-Dalaw was the happiness it brought about either to themselves or their families. According to BuCor Dir. Gen. Pangilinan (personal communication, February 1, 2013), e-Dalaw was introduced in the New Bilibid Prison to help the inmates communicate with their loved ones outside and as a reformation program for the inmates which prepares them in all aspect as they will eventually go back to the society. He further said that e-Dalaw is effective in meeting its purpose if its usage was appreciated by the inmates, that is, giving them happiness and making them feel human.
At 46.97% of the respondents, results showed that a large portion of the respondents aw
the importance of e-Dalaw in their eventual release (outcome expectation). Outcome
expectation is one of the constructs in performance expectancy (Venkatesh, et. al.,
2003 as cited by Li, n.d.), which include matters pertaining to the inmates’ higher
self-esteem, sense of accomplishment, and feelings of job. Performance expectancy
(perceived usefulness and outcome expectation) influences individual behavior
intention to use e-Dalaw and actual usage.

In terms of perceived ease of use or effort expectancy of e-Dalaw, 84.55% of the
respondents found use of e-Dalaw complicated and needed assistance to access e-
Dalaw. Effort expectancy, one of the three constructs in UTAUT, is the degree of
ease associated with the use of system (Venkatesh, et. al., 2003, as cited by Li, n.d.).
Lack of IT knowledge can inhibit computer use (Bure, 2005). However, “it has also
been suggested that perceived ease of use is significant in early phases of usage but it
slowly becomes less important over time” (Hakkarainen, 2013).

Moreover, although results showed that inmates experience difficulty in using e-
Dalaw, “usefulness is more strongly linked to usage behavior than ease of use.
Although difficulty of use can discourage adoption, no amount of ease of use can
compensate for a system that does not perform a useful function” (Hakkarainen,
2013).

The result showed that respondents wanted to increase the number of days and time
usage of e-Dalaw, number of computer units, and facilitators who will guide the e-
Dalaw users. Other needs of the respondents were information, enforcement of the
rules and regulations on the use of e-Dalaw, and improvement in e-Dalaw system.
Outside of the choices given, the inmates suggested increasing the space for e-Dalaw
and improving the ventilation of the e-Dalaw room. These are the facilitating
conditions in UTAUT, which are in the environment that can remove barriers of
technology acceptance and usage. Facilitating conditions that needed to be improved
were material resources like computer units, physical space, Internet access and
equipment, and well-ventilated facilities and human resources like facilitators who
were knowledgeable of using e-Dalaw.

Respondents’ Practices on e-Dalaw. It was found out that 52.73% of the respondents
never used e-Dalaw without guidance. According to e-Dalaw Supervisor PG1
Morales (personal communication, March 14, 2013), the volunteer inmates assisted
the inmates whenever they used e-Dalaw for their convenience.

With the weighted mean of 1.55 (sometimes), this shows that the respondents using e-
Dalaw without guidance can eventually lead to their learning of using e-Dalaw on
their own. Using the Behavior Change Communication, the results reflected the
inmates’ learning or knowledge on how to use e-Dalaw.

Majority of the respondents (72.73%) were following the prescribed days in using e-
Dalaw. With the weighted mean of 2.69 (always), this means that the respondents
followed rules on what days they could use e-Dalaw, which was every week except
on Mondays. With the weighted mean of 2.81 (always), majority of the respondents
(72.73%) always followed the prescribed time on using e-Dalaw. Adopting the
concepts of the Behavior Change Communication, the result showed that by
following prescribed days and time on use of e-Dalaw, majority of the respondents responded favorably, intended to adopt it, and continued doing it.

Table 1. Respondents’ practices on e-Dalaw

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>NEVER F n=330</th>
<th>SOMETIMES P (%)</th>
<th>ALWAYS F n=330</th>
<th>WEIGHTED MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use without guidance</td>
<td>174 52.75</td>
<td>115 34.85</td>
<td>31 9.39</td>
<td>1.55</td>
</tr>
<tr>
<td>2. Follow prescribed days</td>
<td>18 5.45</td>
<td>63 19.09</td>
<td>240 72.73</td>
<td>2.69</td>
</tr>
<tr>
<td>3. Follow prescribed time</td>
<td>7 2.12</td>
<td>46 13.94</td>
<td>268 81.21</td>
<td>2.81</td>
</tr>
<tr>
<td>4. Cut use of e-Dalaw</td>
<td>33 10.00</td>
<td>122 36.97</td>
<td>164 49.70</td>
<td>2.41</td>
</tr>
<tr>
<td>5. Can use equipment well</td>
<td>10 3.03</td>
<td>60 18.18</td>
<td>250 75.76</td>
<td>2.75</td>
</tr>
<tr>
<td>6. Good internet connection</td>
<td>15 4.55</td>
<td>122 36.97</td>
<td>181 54.85</td>
<td>2.52</td>
</tr>
<tr>
<td>7. Share knowledge on e-Dalaw</td>
<td>40 12.12</td>
<td>121 36.67</td>
<td>152 46.06</td>
<td>2.36</td>
</tr>
<tr>
<td>8. Recommend to relatives</td>
<td>22 6.67</td>
<td>94 28.48</td>
<td>203 61.52</td>
<td>2.57</td>
</tr>
<tr>
<td>9. Recommend to inmates</td>
<td>29 8.79</td>
<td>118 35.76</td>
<td>171 51.82</td>
<td>2.45</td>
</tr>
<tr>
<td>OVERALL</td>
<td>11.72 24.96</td>
<td>55.89 2.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Almost half (49.70%) always cut their use of e-Dalaw which means that they followed the rules on the allotted time for every use of e-Dalaw and respected their fellow inmates. With weighted mean of 2.41 (sometimes), the results showed that the respondents were able to sometimes cut their use of e-Dalaw when they exceeded the time limit to give way to other inmates who would also use it. Based on the Behavior Change Communication, the favorable response of the inmates showed their approval, intention to adopt, and attempt to try the behavior.

Most of the inmates (75.76%) could always use the equipment in good condition (2.75). Majority of the respondents (54.85%) could use e-Dalaw with good Internet connection, and this happened always as indicated by the weighted mean average of 2.52. Good Internet connection must come hand in hand with availability of equipment in order for the inmates to have positive experience in e-Dalaw use. This becomes significant because slow Internet connection could shorten the limited time allotted for each inmate.

Using the Behavior Change Communication, the respondents’ good experience in use of equipment and Internet connection might promote the use of e-Dalaw, which corresponded to the nearly half of the respondents (46.06%) who always shared their knowledge on using e-Dalaw.

Most of the respondents always recommended the use e-Dalaw to their relatives (61.52%) and fellow inmates (51.82%). Adopting the Behavior Change
Communication, inmates who were satisfied and acknowledged personal benefits of adopting behavior tended to promote it to their social network, which is the advocacy.

Problems Encountered and Recommendations on e-Dalaw. Limited time to use e-Dalaw may be attributed to the only seven computers being used which were not proportionate to the number of inmates who want to use e-Dalaw. Trainings and supervision must be given to those who did not know how to use e-Dalaw. Furthermore, they must be encouraged more to acknowledge the personal benefits of adopting the use of e-Dalaw. The respondents suggested to ask request and further assistance from the BuCor administration, thus to higher budget for e-Dalaw to have additional computer units, increased time usage of e-Dalaw, and good room ventilation, and also to implement strictly the rules and regulation on use of e-Dalaw.

The BuCor official (personal communication, February 1, 2013) said that one of the challenges in use of e-Dalaw was the number of inmates who did not know how to use computer. To address this problem, aside from encouraging every inmate to use e-Dalaw, they extended their assistance through work assignment. This was where the role of volunteer inmates came in. These volunteer inmates would look for those who were not visited and would share their knowledge on using computer and the Internet. In return, these volunteer inmates who have work assignment would receive a five-day deduction every month in his sentence, for instance from 35 days of his sentence, it would become 30 days.

Relationship of Knowledge, Attitudes and Practices of the Respondents. Using Chi-square Test of Independence, there was considered a relationship between two variables if p-value was less than 0.05 level of significance.

Chi-square results showed that there was a relationship between the respondents’ knowledge and attitude (Table 2).

Table 2. Relationship of respondents’ knowledge and attitude towards e-Dalaw

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CHI-SQUARE VALUE</th>
<th>P-VALUE</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>acceptance and knowledge</td>
<td>100.5</td>
<td>0.000 **</td>
<td>Significant</td>
</tr>
<tr>
<td>confidence and knowledge</td>
<td>82.108</td>
<td>0.000 **</td>
<td>Significant</td>
</tr>
<tr>
<td>motivation and knowledge</td>
<td>44.788</td>
<td>0.001 **</td>
<td>Significant</td>
</tr>
<tr>
<td>trust and knowledge</td>
<td>82.210</td>
<td>0.000 **</td>
<td>Significant</td>
</tr>
<tr>
<td>sentiments and knowledge</td>
<td>87.495</td>
<td>0.000 **</td>
<td>Significant</td>
</tr>
</tbody>
</table>

**significant at 5%

Specifically, there was a relationship between the respondents’ knowledge and a) acceptance of the importance of e-Dalaw; b) confidence in using e-Dalaw without guidance; c) motivation from others to use e-Dalaw; d) trust on the benefits of using e-Dalaw; and e) sentiments on how to improve the e-Dalaw service. Using the Behavior Change Communication, this referred to the approval or the favorable response to the use of e-Dalaw. This could lead to the intention, practice, and advocacy on the use of e-Dalaw.
There was a significant relationship between the inmates’ knowledge and practices towards e-Dalaw (Table 3). The results indicated the realization of the knowledge-attitudes-practices continuum, thereby establishing that behavior change was reached in terms of knowledge on e-Dalaw, approval (technology acceptance), intention (favorable attitude), practice (usage), and then may lead to advocacy (recommending to others).

**Table 3. Relationship of respondents’ knowledge and practices of e-Dalaw**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CHI-SQUARE VALUE</th>
<th>P-VALUE</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practices and knowledge</td>
<td>13.199</td>
<td>0.355 **</td>
<td>Significant</td>
</tr>
</tbody>
</table>

**significant at 5%**

Relationship between Socio-demographic Characteristics and Knowledge, Attitudes, and Knowledge of the Respondents. There was only one socio-demographic characteristic, inmates’ last visitation received, that had significant relationship with knowledge on using e-Dalaw (Table 4).

Results showed that last visitation was the most significant factor affecting knowledge on e-Dalaw, indicating that social influence particularly peer influence would be instrumental in achieving the first step in Behavior Change. Although information about e-Dalaw might have primarily came from prison guards and officials (social influence in UTAUT), the knowledge component – details about e-Dalaw or processed information – had been established to be more related with peer influence. Here, the value of last visitation was highlighted in so far as bringing knowledge was concerned.

**Table 4. Relationship of respondents’ socio-demographic characteristics and knowledge on e-Dalaw**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CHI-SQUARE VALUE</th>
<th>P-VALUE</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place vs knowledge</td>
<td>105.4</td>
<td>0.859 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Age vs knowledge</td>
<td>319.1</td>
<td>0.985 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Civil status vs knowledge</td>
<td>63.299</td>
<td>0.234 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Education vs knowledge</td>
<td>105.5</td>
<td>0.098 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Years in maximum vs knowledge</td>
<td>55.403</td>
<td>0.213 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Has visitation vs knowledge</td>
<td>35.768</td>
<td>0.058 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Last visit vs knowledge</td>
<td>113.1</td>
<td>0.037 **</td>
<td>Significant</td>
</tr>
<tr>
<td>Visitors vs knowledge</td>
<td>301.4</td>
<td>0.492 ns</td>
<td>Not significant</td>
</tr>
<tr>
<td>Relative’s address vs knowledge</td>
<td>987.8</td>
<td>0.995 ns</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

**significant at 5%**

**Conclusion.** Truly, the potential of e-Dalaw to make possible constant visitation would highlight the role of communication and ICTs in building stronger families and knowledge toward reformation of inmates. As BuCor Director Gen. Pangilinan (personal communication, February 1, 2013) said “Communication is the key to
reformation.” Knowledge according to the Criminal Justice Initiative (2013) is “capable of igniting recovery and redemption, and promoting liberation.” ICTs have important roles not only in the reformation of inmates but have vast potentials to bring about wider social inclusion.

Recommendations. As a benchmark study, collection of qualitative data such as conducting focus group discussions among respondents can be explored. Furthermore, inclusion of inmates in the Minimum and Medium Security Compound as respondents of the study and inclusion of the Correctional Institution for Women for a study on a gendered use of ICT in prison facilities can be explored.
References


MST Lifestyle (May 21, 2013). PH is social networking capital of the world. Manila Standard online


Contact e-mail: resuello.marjorie@gmail.com and rvtatlonghari@devcom.edu.ph
Technology Acceptance by In-Service Teachers in Hong Kong - Preliminary Results

Gary Ka-Wai Wong & Ho-Yin Cheung
Hong Kong Institute of Education, Hong Kong, China
Graduate School of Education, University of Bristol, United Kingdom

Abstract
Educational technology is appealing to some educators due to its potential in supporting a larger variety of pedagogy. Since 1998, the government in Hong Kong has been making continuous investment into the ICT infrastructure and staff training in local public schools to support the use of ICT for teaching and learning enhancement. It is nevertheless our observation that teachers have their own considerations when it comes to using technology in their own teaching and they are not always supportive. This paper presents part of our quantitative study of technology acceptance of a group of in-service primary school teachers in Hong Kong. The key factors leading to the teachers’ behavioral intention of use of these technologies are found using multiple-regression as a preliminary analysis. The results show that (1) in-service teachers in Hong Kong rely heavily on attitude and facilitating conditions when they decide on the adoption or non-adoption of technology in their teaching, while the perceived usefulness and perceived ease of use are considered less important; and (2) they have relatively low rating on perceived usefulness and perceived ease of use of the technology, and most noticeably on the facilitating conditions available to their school despite the government’s long-term investment. The implications of these results are discussed.
Introduction

Educational technology is compelling to educators all over the world for its potential revolutionary impact on teaching and learning. In Hong Kong, the government has been making continuous investment via three stages of Strategies on Information Technology in Education (Education Bureau, n.d.) since 1998 to develop the ICT infrastructure to facilitate the use of educational technologies in local public schools. A recent report by the Educational Bureau of Hong Kong shows that primary teachers are generally confident and experienced with ICT in education (Education Bureau, 2012). The same report also indicates that local schools are equipped with the necessary ICT infrastructure for this development.

Nevertheless, it is our observation that not all teachers are putting ICTs to full use. Instead, many seem to be reluctant to incorporate ICT into their teaching unless they feel they are well supported by their corresponding school. Time constraint also seems to be another issue. This echoes with some existing research, which suggests that in case of voluntary use, teachers are selective in ICT adoption based on pragmatic considerations such as time and resources. Besides, they often consider ICT to be unnecessary, time-consuming, inflexible, and difficult to use, thus they prefer to use it only selectively (West, Waddoups, & Graham, 2006).

To confirm this observation and gain a deeper understanding of the phenomenon, a research project is being conducted to collect and analyze data from local primary school teachers to investigate the factors contributing to the technology acceptance of these teachers. The study uses structural equation modeling to find the relation between these factors, while the present paper reports the results of the preliminary step to use multiple-regression to identify the important factors, which serves to inspire model building in the next stage.

A Brief Description of Related Works

Existing research on technology acceptance is mostly quantitative. Theoretical models are built to propose the relations among various possible factors. These models are then empirically verified using statistical data collected via questionnaire. One of the most popular models is the Technology Acceptance Model (TAM) originally developed by Davis (1985). This model is based on two other theories in psychology: the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977) and the Theory of Planned Behavior (TPB) (Netemeyer, Ryn, & Ajzen, 1991). To put it simple, the TAM adapts TRA and TPB in the context of ICT adoption in education. It assumes that the intention of a person to adopt ICT in education depends on his/her attitude towards the behavior. This attitude in turn relies on the perceived usefulness and perceived ease of use of the technology. These two factors are further influenced by a number of external variables, including computer self-efficacy, facilitating conditions, and subjective norm. Here computer self-efficacy refers to the confidence of the person that he/she can tackle the difficulties in using the technology. Facilitating conditions relates to time, resources, and knowledge that facilitate the use of the technology. Finally, subjective norm refers to how the person thinks their peers or the society think they should behave. The TAM is illustrated in Figure 1.
The TAM is not the only model used in this field of research. In fact, most researchers apply customizations to the model by introducing new variables or altering the structure of the model to fit their particular needs. See, e.g. Legris, Ingham, & Collerette (2003) for a comprehensive review of studies using TAM and its variants to approach the problem.

Later, Venkatesh et al. (2003) combined eight of the more prominent models, including TAM, to form a new, unified model named Unified Theory of Acceptance and Use of Technology (UTAUT). This theory postulates that performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), social influence (subjective norm) and facilitating conditions are the key factors of behavioral intention. These factors are also moderated by gender, age, experience, and voluntariness of use. A review on studies using UTAUT can be found in Taiwo & Downe (2013).

Because of the freedom to customize the model according to the needs of the individual authors, two studies seldom use completely identical models. Empirically, they also produce diverse results. To cite some examples, Yuen & Ma (2008) surveyed 152 teachers in Hong Kong taking part-time postgraduate diploma in education and showed that perceived ease of use was the key factor to behavioral intention, while perceived usefulness had no significant effect. As for external variables, they showed that subjective norm and computer self-efficacy acted on perceived ease of use to affect behavioral intention. Another study by Wang & Wang (2009) using 268 university instructors in Taiwan somewhat produced inconsistent results. They found that perceived ease of use only had a weak influence, while subjective norm and perceived usefulness were the dominating factors of behavioral intention. Another study by Chen & Tseng (2012), also conducted in Taiwan but on 402 junior high school teachers, showed that perceived usefulness and perceived ease of use possess the strongest effect on behavioral intention.

The diverse results are not only due to different model used but also due to the different contexts. Cross-cultural studies show that both national and professional culture can have significant influence on technology acceptance (Nistor, Lerche, Weinberger, Ceobanu, & Heymann, 2012; Sánchez-Franco, Martínez-López, & Martín-Velicia, 2009). For this reason, it is often difficult to generalize the findings of one study to other situations in the field of technology acceptance. The present project therefore serves to investigate technology acceptance in the context of primary education in Hong Kong, which has not been covered in existing literature.
Methodology

Model and Instrument

This study uses a multi-regression model for preliminary analysis of the data. The questionnaire instrument has been adapted from Venkatesh et al. (2003) with minimal adjustments to the wordings to fit into our present context. The core section of the questionnaire contains 31 items classified under eight variables as shown in Table 1. The information section of the questionnaire then asks the participants about their sex, year of birth, major subject taught, experience using educational technology in workplace, and their voluntariness of use.

Table 1: Constructs and Items used in this Study

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Codes</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness (PU)</td>
<td>PU1</td>
<td>I find educational technology useful in my teaching.</td>
</tr>
<tr>
<td>(Performance expectancy in</td>
<td>PU2</td>
<td>Using educational technology enables me to accomplish teaching tasks</td>
</tr>
<tr>
<td>UTAUT)</td>
<td></td>
<td>more quickly.</td>
</tr>
<tr>
<td>Perceived ease of use (PEU)</td>
<td>PEU1</td>
<td>My interaction with educational technology is clear and understandable.</td>
</tr>
<tr>
<td>(Effort expectancy in UTAUT)</td>
<td>PEU2</td>
<td>It is easy for me to become skillful at using educational technology.</td>
</tr>
<tr>
<td>Attitude (ATT)</td>
<td>ATT1</td>
<td>Using educational technology is a good idea.</td>
</tr>
<tr>
<td></td>
<td>ATT2</td>
<td>Educational technology makes my work more interesting.</td>
</tr>
<tr>
<td></td>
<td>ATT3</td>
<td>Educational technology is fun.</td>
</tr>
<tr>
<td></td>
<td>ATT4</td>
<td>I like using educational technology in teaching.</td>
</tr>
<tr>
<td>Subjective norm (SN) (Social</td>
<td>SN1</td>
<td>People who influence my behavior think that I should use educational</td>
</tr>
<tr>
<td>influence in UTAUT)</td>
<td>SN2</td>
<td>technology.</td>
</tr>
<tr>
<td></td>
<td>SN3</td>
<td>The senior management of my school has been helpful in the use of</td>
</tr>
<tr>
<td></td>
<td>SN4</td>
<td>educational technology.</td>
</tr>
<tr>
<td>Facilitating conditions (FC)</td>
<td>FC1</td>
<td>I have the resources necessary to use educational technology.</td>
</tr>
<tr>
<td></td>
<td>FC2</td>
<td>I have the knowledge necessary to use educational technology.</td>
</tr>
<tr>
<td></td>
<td>FC3</td>
<td>Educational technology fits well into my workflow.</td>
</tr>
<tr>
<td></td>
<td>FC4</td>
<td>A specific person or group (e.g. technical support team) is available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for assistance with difficulties using educational technology.</td>
</tr>
<tr>
<td>Computer self-efficacy (EFF)</td>
<td></td>
<td>I could complete a job or task using educational technology…</td>
</tr>
</tbody>
</table>
EFF1 … even if there was no one around to tell me what to do as I go.
EFF2 … if I could call someone for help if I got stuck.
EFF3 … if I had enough time.
EFF4 … if I had access to the instruction manuals for the technology.

<table>
<thead>
<tr>
<th>Anxiety (ANX)</th>
<th>ANX1</th>
<th>I fear about using educational technology.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANX2</td>
<td>It scares me to think that I could ruin my teaching using educational technology by making a small mistake.</td>
</tr>
<tr>
<td></td>
<td>ANX3</td>
<td>I hesitate to use educational technology for fear of making mistakes I cannot correct.</td>
</tr>
<tr>
<td></td>
<td>ANX4</td>
<td>Educational technology is somewhat frightening to me.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavioral Intention of use (BI)</th>
<th>BI1</th>
<th>I intend to use educational technology in this and the coming semester.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BI2</td>
<td>I predict I would use educational technology in this and the coming semester.</td>
</tr>
<tr>
<td></td>
<td>BI3</td>
<td>I have actual plan to use educational technology in this and the coming semester</td>
</tr>
</tbody>
</table>

**Data Collection**

Data were collected mainly from the 21 primary schools subsidized under the “Direct Subsidy Scheme” (DSS) in Hong Kong, while a few non-DSS schools were also invited. The questionnaires together with other supplementary documents were mailed to the principals of these schools in paper form. Participation was voluntary.

In the end, six schools responded to the invitation and returned 206 questionnaires. After data pre-processing, 21 questionnaires were discarded for missing or invalid data. The total number of valid samples used for further analysis was 185.

**Data Analysis**

The data were analyzed using stepwise multiple-regression (Hocking, 1976) with behavioral intention as dependent variable and all the other seven constructs as independent variables. The regression is stepwise in a sense that initially all the seven independent variables are included in the regression, then the algorithm performs variable selection by iteratively eliminating or adding back variables to minimize the AIC (Akaike, 1974) of the model. This approach helps to determine numerically what variables are necessary to fit the data while eliminating the unnecessary ones. This insight, together with other theoretical considerations, are useful to inspire the building of more complicated models to be analyzed in a later stage using the more sophisticated methods such as structural equation modeling.

**Results**

**Demographic and Descriptive Statistics**

Table 2 shows the demographic statistics of the data. It can be seen that the participants vary in terms of age group, subjects taught, experience using educational
technology, and voluntariness of use. The mean, standard deviation, skewness, and kurtosis are shown in Table 3.

Table 2: Demographic Statistics

<table>
<thead>
<tr>
<th>Items</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>135</td>
<td>73%</td>
</tr>
<tr>
<td>Male</td>
<td>45</td>
<td>24%</td>
</tr>
<tr>
<td>Invalid answers</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>100%</td>
</tr>
<tr>
<td>Year of Birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960 or before</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>1961-1970</td>
<td>71</td>
<td>38%</td>
</tr>
<tr>
<td>1971-1980</td>
<td>74</td>
<td>40%</td>
</tr>
<tr>
<td>1981-1990</td>
<td>23</td>
<td>12%</td>
</tr>
<tr>
<td>After 1990</td>
<td>11</td>
<td>6%</td>
</tr>
<tr>
<td>Invalid answers</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>100%</td>
</tr>
<tr>
<td>Main subject taught</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>General education</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Language</td>
<td>104</td>
<td>56%</td>
</tr>
<tr>
<td>Science and mathematics</td>
<td>47</td>
<td>25%</td>
</tr>
<tr>
<td>Arts, PE, and others</td>
<td>15</td>
<td>8%</td>
</tr>
<tr>
<td>Multiple selected</td>
<td>9</td>
<td>5%</td>
</tr>
<tr>
<td>Invalid answers</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>100%</td>
</tr>
<tr>
<td>Experience with educational technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never learned about it formally</td>
<td>15</td>
<td>8%</td>
</tr>
<tr>
<td>Learned, but not used</td>
<td>19</td>
<td>10%</td>
</tr>
<tr>
<td>Learned, and used for at least one semester</td>
<td>144</td>
<td>78%</td>
</tr>
<tr>
<td>Invalid answers</td>
<td>7</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>100%</td>
</tr>
<tr>
<td>Voluntariness of use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completely free to decide</td>
<td>14</td>
<td>8%</td>
</tr>
<tr>
<td>Some mandate but otherwise free to decide</td>
<td>61</td>
<td>33%</td>
</tr>
<tr>
<td>Mandate in most aspects of teaching</td>
<td>108</td>
<td>58%</td>
</tr>
<tr>
<td>Invalid answers</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3: Descriptive Statistics of the Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness (PU)</td>
<td>2.96</td>
<td>0.57</td>
<td>-0.32</td>
<td>0.17</td>
</tr>
<tr>
<td>Perceived ease of use (PEU)</td>
<td>2.64</td>
<td>0.62</td>
<td>0.03</td>
<td>-0.09</td>
</tr>
<tr>
<td>Subjective norm (SN)</td>
<td>3.42</td>
<td>0.54</td>
<td>-0.46</td>
<td>0.58</td>
</tr>
<tr>
<td>Attitude (ATT)</td>
<td>3.12</td>
<td>0.50</td>
<td>-0.07</td>
<td>0.49</td>
</tr>
</tbody>
</table>
Facilitating conditions (FC) 2.72 0.52 -0.22 0.38
Computer self-efficacy (EFF) 3.44 0.52 -0.25 1.01
Anxiety (ANX) 2.43 0.84 0.29 -0.48
Behavioral intention of use (BI) 3.23 0.66 -0.13 -0.38

**Behavioral Intention by Group**

One particular type of descriptive statistics that may be of particular interest is the average scores of behavioral intention by age group and major subject taught respectively. In Table 4 below, the age groups and major subjects with group size of at least 10 are selected for comparison. One-way ANOVA across different age groups shows that there is no difference between the behavioral intention of participants of different ages to use educational technologies in teaching. One-way ANOVA across different subjects taught show a similar result among participants teaching different subjects. In other words, there is no statistical evidence that participants at different age groups or teaching different subjects have higher or lower behavioral intention than the other groups to use educational technology in their teaching.

**Table 4: Comparing Behavioral Intention of Use by Group**

<table>
<thead>
<tr>
<th>Items</th>
<th>Frequency</th>
<th>Mean of BI</th>
<th>Standard Deviation of BI</th>
<th>F-test p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of Birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960 or before</td>
<td>3</td>
<td>3.00</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>1961-1970</td>
<td>71</td>
<td>3.34</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>1971-1980</td>
<td>74</td>
<td>3.22</td>
<td>0.69</td>
<td>0.166</td>
</tr>
<tr>
<td>1981-1990</td>
<td>23</td>
<td>3.01</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>After 1990</td>
<td>11</td>
<td>3.09</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>Invalid answers</td>
<td>3</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main subject taught</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>2</td>
<td>3.67</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>General education</td>
<td>3</td>
<td>3.33</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>104</td>
<td>3.20</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Science and mathematics</td>
<td>47</td>
<td>3.22</td>
<td>0.69</td>
<td>0.103</td>
</tr>
<tr>
<td>Arts, PE, and others</td>
<td>15</td>
<td>3.58</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>Multiple selected</td>
<td>9</td>
<td>3.07</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Invalid answers</td>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Results of Multiple-Regression Analysis**

Finally, the multiple regression result in Table 5 shows that only three variables contribute to the behavioral intention to use technology. In particular, only attitude and facilitating conditions demonstrate coefficients significantly different from zero, while the p-value for anxiety is only marginal. The result shows that attitude and facilitating conditions seem to the most
important factors of behavioral intension for the participants in our sample. In contrast, perceived usefulness and perceived ease of use, that many previous studies have found to be important factors, are eliminated from the stepwise regression model in our case.

Table 5: Results of Multiple-Regression (p<0.001: ***; p<0.01: **; p<0.05: *)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>p-value</th>
<th>Supported (p&lt;0.05)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>0.5722</td>
<td>0.3421</td>
<td>0.09608</td>
<td>Not supported</td>
</tr>
<tr>
<td>Attitude (ATT)</td>
<td>0.4764</td>
<td>0.0882</td>
<td>2.1e-07***</td>
<td>Supported</td>
</tr>
<tr>
<td>Facilitating conditions (FC)</td>
<td>0.3284</td>
<td>0.0885</td>
<td>0.00028***</td>
<td>Supported</td>
</tr>
<tr>
<td>Anxiety (ANX)</td>
<td>-0.1014</td>
<td>0.0501</td>
<td>0.04438*</td>
<td>Supported</td>
</tr>
<tr>
<td>Subjective norm (SN)</td>
<td>0.1545</td>
<td>0.0784</td>
<td>0.05018</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

Discussions

There are a few interesting points of discussion on the data. First, the result that behavioral intensions is independent of age group and subject taught is counter-intuitive because one may think that younger teachers (especially the digital native born after 1980 (Prensky, 2001)) may have stronger behavioral intension to use educational technology. Teachers of science and mathematics, that are closer to technology in nature than language and other arts subjects, may also be more willing to try new technologies in the workplace. Yet these assertions are not supported by the descriptive statistics.

A possible explanation is that facilitating conditions is one of the dominating factors of behavioral intension. As this construct is mostly independent of age and subject, it may have overridden any effects that may have arisen from these demographic differences. The dominance of facilitating conditions over perceived ease of use and perceived usefulness also shows that teachers are very pragmatic towards the use of technologies, regarding facilitating conditions as an important prerequisite of using the technology.

This does not mean that perceived usefulness and perceived ease of use, that are absent in the final regression model, do not have any effect on behavioral intension, but rather that they may act indirectly through other constructs such as attitude. The attitude represents how much the teachers like the idea of using educational technology at work. This attitude is a combined effect of other effects, and it is shown to be another dominating factor alongside facilitating conditions. To determine how this attitude relies on the other factors requires a more sophisticated statistical method such as structural equation modeling, which is planned in the next stage of the present study.

Finally, descriptive statistics shows that teachers rate below the mid-point on perceived usefulness, perceived ease of use, and all four types of facilitating conditions, despite the long-term investment of the government. It is beyond the scope
of the regression model to explain this phenomenon. One might conduct qualitative interviews with the teachers concerned to seek further explanation.

Conclusions

In conclusion, this study applies multiple-regression to identify the dominating factors of technology acceptance among in-service primary teachers in Hong Kong. The result shows that facilitating conditions and attitude are the two dominating factors of technology acceptance, while perceived usefulness and perceived ease of use are found to be unimportant. Further analysis of the relations between these constructs requires a more sophisticated statistical method, which has been planned in the next stage of our research project.
References


Learning Media of Currency Introduction for Children with Light Special Needs

Tri Sagirani, STMIK Surabaya, Indonesia
Tan Amelia, STMIK Surabaya, Indonesia
MJ Dewiyani S, STMIK Surabaya, Indonesia

Abstract
Application of Information Technology and Communication (ICT) has no longer been uncommon and has reached almost every aspect of human lives, including education and learning aspects. The learning media in this study is targeted at children with special needs. It is constructed based on the standard curriculum for mathematics, especially the topics related to numbers, measurement and currency to achieve the standard competency of being able to use currency in daily lives. Subject of this research is a group of children with special needs. These children with special needs can be identified by their range of IQ score between 50 and 70. These learning media are constructed by using Construct 2. It is a software used for building learning media without writing any source code. The learning media is tested intensively to children with special needs, with the teachers assistance in every learning section. Indicator to be measured is the ability of these children in a simulated situation. In that situation, these children are required to buy the things they want by mentioning the name of the things correctly, pointing out the value of note, executing the payment process by pointing the notes with bigger or equal values to the things’ price tags, and learning the change to be accepted after the payment process. The intensity and repetition adjusted to suit the requirements of children with special needs, the media supports the teachers in visualizing of currency introduction learning topic to their students.

Keywords: learning media, currency introduction, intellectual disability
Introduction

Application of Information Technology and Communication (ICT) has no longer been uncommon and has reached almost every aspect of human lives, including education and learning aspects. Utilization of ICT has become a principal need for supporting the effectiveness and quality of education process. Benefitting from ICT can support creativity and accuracy in developing and utilizing learning media.

According to Kemp & Dayton, learning media has eight important roles: (1) allow the learning to be passed on to be more standard; (2) learning can be more interesting; (3) to learn could be more interactive; (4) time required for learning is possible to be shortened; (5) quality of learning can be improved; (6) learning may be executed once wanted or needed; (7) positive attitude of students towards learning and its process should be able to be enhanced; (8) teachers who teach by using media can bring positive changes (Kemp & Dayton, 1980). For the purpose of promoting these roles, learning media that is correctly targeted should be the main concern.

Another argument about roles of learning media, presented by Heinich is that learning media holds an important role and it becomes one of decisive factors of successful learning activities (Heinich, 1996). Learning media also has practical values in the form of abilities or skills for: (1) turning an abstract concept to be a concrete one, for example human circulatory system; (2) carrying objects that are difficult or dangerous to be brought into learning environment, such as wild animals; (3) displaying objects which are too big to be carried into the class (i.e. temple, traditional market); (4) presenting objects that cannot be seen by using naked eyes, for example microorganism; (5) enabling students to be interacting with their environments (Arief et al., 2002).

Development of learning media is not only needed by common schools, but also by special schools for children with learning disabilities (a.k.a Sekolah Luar Biasa / SLB). SLB is an organization unit that operates in education for the purpose of assisting students with physical and/or intellectual disabilities to be able to develop their attitudes, knowledge and skills, as individuals or members of society in creating mutual relationships with social and cultural environments, with nature, as well as developing abilities at work or attending more advanced education. There is a classification of students or children with special needs in SLB, which has been structured in Government Policy. This classification includes the blind, deaf, physical disabled, mentally-disabled with lower and medium levels of disability, and social misfits. This classification is based on physical, mentally, or behavior abnormalities of the children. Subject in this paper is the group of mentally-disabled with lower level of disability one with range of IQ between 50 -70 (Daniel et al.,2012)(Yustinus, 2006).

Given the previous discussion on introduction section, a question to be answered by the research can be formulated as how to construct a learning media that can be favored by and be suitable for students SLB by benefitting from the use of information technology. This research has been successful in constructing and testing a set of learning media for students of SLB. This learning media contains software application for learning topic of introduction Rupiah (IDR) currency order to create a more interactive and conducive class. By using this application, it is expected that
children with lower level of can be prepared to learn how to live independently in society, especially in the comprehension area of using currency in daily activities.

**Children with Light Special Needs and Learning Media**

Lots of terminologies which are used for referring to mentally-disabled children, such as: mental retardation, mental handicapped, mental defektif. As it has been progressing, it is often to be recognized with the other terms like intellectual disability or developmental disability. American Association of Mental Retardation (AAMR), which is also known today as American Association of Intellectual Developmental Disability (AAIDD), defines (Daniel et al.,2012) “Intellectual disability is a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills.”

AAMD (American Association of Mental Defeciency) states that mentally-disabled children demonstrate significantly under average of intellectual functionality with the lack of adaptive behavior, happening during the growth/development face Kauffman, 2006. Mentally-disabled children have two important aspects, including intellectual functionality and adaptive skills (Yustinus, 2006). Both of these aspects influence how retarded their developments are and how limited the skill developments can be, which also imply on quality of education to be provided. Mentally-disabled children in with the lower level of disability may still have the ability to develop themselves, also the other abilities which are semi skills as well as ability to socialize in simple ways.

Mentally-disabled children in the lower level of disability are the children who face obstacles in intellectual aspect and social adaptation behaviors, although they have the abilities to grow (Daniel et al.,2012) in academic, social adaptation and work skills (Amin, 1995). Even so, mentally-disabled children can still be optimally educated under specific programs or assistances that suits to their characteristics. One learning, that prepares mentally-disabled children with lower level of disability to be able to live independently in society, is understanding of how to use money in day-to-day activities.

Various learning sources can be utilized for assisting students in understanding learning topics. The most favorite one is computer games (Ghada et al., 2012). Computer games can be used for helping children who have difficulties in learning by benefitting from serious games in learning (Ghada et al., 2012) (Marion & Barbara, 2012) (David et al., 2011). There are some principles that have to be understood in developing learning media in game basis (Marion & Barbara, 2012), such as: all required information should be available in various formats including text, audio, and graphic; the use of contrast colors to avoid minimizing user abilities; games must be able to present interesting and delightful aspects to users; and, supporting learning with integrated learning components in the games.

Learning to understand how to use money in daily lives is given to the mentally-disabled children with lower level of disability for the mathematics subject, with basic competencies to be achieved cover students’ abilities to calculate how much spending in shopping and how to use money for paying. For mentally-disabled children with lower level of disability, direct learning by visiting a store or market is not a right
way, regarding the limitations in their ability to adapt socially (Heinich, 1996). For that reason, learning media is developed to facilitate learning process before they finally can live independently in society. The constructed learning media is introduction to some types of fruits (banana, apple, orange, etc.) and each of them has certain price. Mentally-disabled children with lower level of disability learn to shop as they wish and pay certain amount of money based on the nominal displayed on the media screen. Students also learn to know and count the change they should receive.

**Methods of Approach**

Execution method, that is chosen to improve the learning process of students in SLB, is constructed by focusing on some priorities and it offers the method of approach as follow.

1) Observation of requirements of children with special needs in learning, characteristics and limitations owned by children with special needs.
2) Selection of subject that will be the focus of software application development. Learning process of students of SLB is to prepare themselves to be able to live more independently in the future once they become adults. This research has discovered the possibility to develop learning media for specific subjects and this learning media can be constructed by benefitting from ICT. One of requirements of children with special needs is to learn how to identify the currency and to spend money.
3) Creation of matrix for comparing standard competencies to be achieved to teaching material to be given, as well as construction of user interface design of the learning media.
4) Development of software application for learning media is done by using kinect, keyboard, mouse as input device.

**Result and Discussion**

In constructing this learning media, there are topics to be concerned, such as supporting tools for constructing the media, design development/development plan, development of learning media, and utilization of software application in learning process.

**Supporting tools for learning instrument construction**

In constructing learning media in game basis, there are some tools required to build the game, including software and hardware. Following are tools to be used for developing the game.

- Library phaser.io, this library is chosen as it can be modified and coded easily and directly connected to javascript code.
- Text editor (IDE) that will be used is IDE Webstrom. It is a product from jetbrain and is selected because it has good file structure and easy refactoring feature.
- Photoshop CS 3 tool is used for editing assets in the form of picture files for items (fruits), roles, and properties in the game.
- Titanium recorder (.apk), this application is run on Android platform. Function of this tool is for recording sounds. This application is used for creating sound files in .wav format, which will be converted into .ogg format.
- Xampp 1.7.3, this web server is used for creating database and running the computer program with php extension.
- MySql, it the database management system (DBMS) for this games application. This DBMS is used for recording player data which contains items, students, scores.
- Google Chrome (Browser) is required for running the games and portal for item management for administrator.
- Kinnect mouse, used for replacing functionality of mouse on computer, is driven by Kinect controller. For installation process, SDK Kinnect 1.6 is required.
- Visual Studio 2010 or above is used for compiling Kinnect mouse tools.

**Design Construction of Learning Media**

Utilization of ICT in the form of software application for learning media makes use of hardware, such as: mouse, keyboard, kinect, in order to support learning activities for children with light special needs. By using benefitting from science and technology, it is expected that learning motivations and results of the students can be improved. Besides, it is also promoted to enhance school quality in conducting education and teachings for preparing children with light special needs to become more independent in the future. How technology is put into use in the implemented software of learning media for learning topic of introduction to currency can be illustrated as follow.

![Figure 1. Design of Media System](image-url)
There are three users in the constructed learning media, including: Owner (ICT team at school), Administrator (teacher of the subject), and Game Player (siswa). It should be noted that administrator and owner users can be performed by the same person in the case of schools have no ICT team. Those three types of users hold the following functionalities.

1. Administrator user can perform data maintenance used for the games. The data holds information about items, picture and sound files.
2. Owner user can perform similar functionalities as administrator, but this user can also access the report of observations.
3. Player user can play the games.

Also, there are features on administrator website that can be used by administrator and owner.

1. Maintenance of data master that contains information, such as: students, objects/items to be sold, types of bank notes and coins to be used.
2. Types of bank notes and coins to be used can be inputted as: pictures, figures, and sound.
3. Nominal of bank notes and coins to be used have the minimum of hundreds and the maximum of hundred-thousand in rupiah. It is because developers see that no objects that are sold in grocery stores have nominal beyond one million rupiahs. However, it is okay to use unlimited pricing nominal in the game.
4. Types of objects/items to be used can be inputted as: pictures, figures, and sound.
5. Result report of the games which have been played by students is presented in the form of observation results.

Moreover, there are features on web application that can be played by game players.

1. Introduction to names, pictures and sound of offered objects to be bought.
2. There are three levels in the game, consisting of Easy, Intermediate, and Advance.
   a. Easy: User performs a transaction for buying one object and paying with exact amount of money without any change.
   b. Intermediate: User performs a transaction for buying an object ad paying with less or more nominal of bank notes and coins. If user pays more than price of the object, change will be received in Rupiah unit. If user pays less than the nominal of the price tag, application will inform and request the user to add more bank notes or coins to be paid.
   c. Advance: User buys many objects and can pay with more or less nominal of bank notes and coins. If user pays more than the total prices of the objects, the user will receive change in Rupiah unit. If the paid nominal is less than the total prices, then application will notify that the nominal is less than the actual prices and request the user to add more nominal to be paid.

Construction of Learning Instrument Application

In order to make learning topics easier to be processed, this media provides menu for inputting picture files of objects (fruits), recording files that describing referred objects. Similar menu is also used for inputting picture and sound files for currency.
required for learning process. The following picture is display example of menu for inputting picture and sound files.

![Menu for Inputting Picture and Sound Files](image)

**Figure 2. Menu for Inputting Picture and Sound Files**

In learning that benefit from this media, users will be grouped into three levels based on their abilities. The levels include *beginner, intermediate* and *advance*. Each level is different in the degree of difficulties in executing learning sessions. Differences in basic game rules on each level can be listed as follow.

<table>
<thead>
<tr>
<th>User Level</th>
<th>Number of Chosen Objects</th>
<th>Display Price</th>
<th>Display Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginner</td>
<td>1</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Advance</td>
<td>Can be more than 1</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

There is also menu in application that can be used for transaction processes of buying objects or payments.

![Menu for transaction processes](image)

**Figure 3. Menu for transaction processes**
In Figure 3 point a, there are options of objects (fruits) based on learning material that has been prepared before. Students choose fruits they want. Application will then present information of prices. Each object / fruit has different price. On the next menu, application will provide bank notes and coins that range from smallest nominal to the largest nominal that are currently still in use to date, according to the nominal that has to be paid (b, c). Students will learn to count the change nominal, and the result of this counting should be matched to the nominal written on the change of bank notes or coins. Learning activities of the students will be recorded and be saved on student database. Teacher can monitor development of student learning result through this learning media.

**Utilization of Learning Instrument in Class**

The next stage is utilization of learning media in class. Activities in this stage are implementation of system design which has been made previously into a software application. This application will be used as learning media for children with special needs in learning mathematics, especially the topic of identifying currency.

Learning media will be tested on four children with special needs, supported by intensive assistance by teachers on each learning session. Indicator that will be measured are: the ability to list name of each available fruit; ability to point out the nominal of each available bank note; ability to pay the selected fruits by pointing to the bank notes with greater or equal nominal than or to spending nominal, as well as learning to count change that should be received.

Based on the test, the average result of students’ comprehension before using the learning media can be specified as follow.

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Mastery Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Children take an object/ a fruit</td>
<td>Children can do it with limited help.</td>
</tr>
<tr>
<td>2</td>
<td>Children read the price</td>
<td>Children can do it with limited help.</td>
</tr>
<tr>
<td>3</td>
<td>Children write the price on worksheet</td>
<td>Children can do it with limited help.</td>
</tr>
<tr>
<td>4</td>
<td>Children pick up the available bank notes or coins for paying based on the written price</td>
<td>Some children can do it with limited help and still there may be others that cannot do it yet.</td>
</tr>
</tbody>
</table>

Given the preliminary conditions (as described in Table 2), students can then performing learning activities by utilizing the learning media, and the observation result of students can be presented as specified in Table 3.
Table 3. Learning Activities and Level of Learning Material Mastery (intervention)

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Mastery Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Children take an object / a fruit</td>
<td>Children can do it on their own</td>
</tr>
<tr>
<td>2</td>
<td>Children read the price tag</td>
<td>Children can do it with a little help</td>
</tr>
<tr>
<td>3</td>
<td>Children write down the price on worksheet</td>
<td>Children can do it with a little help</td>
</tr>
<tr>
<td>4</td>
<td>Children pick up the available bank notes or coins for paying based on written price</td>
<td>Children can do it with a little help</td>
</tr>
</tbody>
</table>

Recording and measuring abilities of students is done by using learning media for money identification, recording in deeper level, and conducting oral test by teachers.

**Conclusion**

In regards to quality, providing all kids with education that has good quality, especially for the children with special needs, is a big challenge. Learning for children with special needs should be prepared well. Utilization of the constructed learning media can help children with special needs to recognize and to understand, as well as to use currency in their lives. Intensity of this media utilization is very supportive for teachers in providing visualization to their students more easily. Giving meanings and values to learning process for children with special needs is also comparably important. The meaning symbolized by illustration of fruit and currency can make it easier to children with special needs to recognize types of fruits, while they are learning to identifying Rupiah (IDR) currency and spending money visually.
References


Test-Driven Development in a Traditional Fundamentals-First CS1 Course

Troy Kammerdiener, Heritage University, USA

Abstract
Test-driven development has been popular for several years. It has become an essential tool in the software development industry, whether or not it is accompanied by the rest of the extreme programming methodology of which it is a part. Since it is based upon unit testing, it is usually taught in computer science education at the CS2 or later level (if it is taught at all), or in an objects-first environment. We introduce a framework for allowing the concepts of test-driven development (and test-first programming) with console I/O, so that it can be used from the beginning of a traditional fundamentals-first programming course.

Keywords: Test-Driven Development, Test-First Programming, Fundamentals-First, CS1, Console I/O, JUnit, Web-CAT
Introduction

Unit testing is an essential activity in many software development environments. It allows programming teams to better coordinate their work by requiring a set of unit tests to be passed before any new modules may be added or changed in a software repository. It is considered a cornerstone of both Agile Software Development and one of its offshoots, Extreme Programming.

Computer science departments at many colleges and universities have attempted to integrate unit testing into their curricula at various levels. Most have added it as a component of an upper level course on software engineering or advanced programming electives. This is generally due to the programming overhead required by a basic testing harness such as JUnit. Traditional unit testing relies on testing a programming unit, i.e. a subprogram or function, for a given result set of result values from a given set of starting values. In Java this requires that students understand concepts of method construction and parameter passing at a minimum, and preferably include an understanding of class construction, both of which are topics that are often introduced late in CS1 or even early in CS2 in a fundamentals-first course structure. A few have attempted to include it early in CS1, but these courses use an objects-first approach.

In a fundamentals-first course structure, students first learn the use and declaration of variables, console or GUI I/O, decision statements, and repetition, along with documentation basics and program design. These topics usually use basic programming assignments with console or GUI I/O. These types of programs cannot be easily tested using standard unit test harnesses such as JUnit.

Motivation

We are a small liberal arts university, providing quality, accessible higher education to multicultural populations which have been educationally isolated. Many students enter our program with minimal preparation for college-level work, so we believe that a fundamentals-first course structure provides a gentler introduction to programming concepts, and will build their confidence for future work.

We had several goals in introducing test-driven development at an early stage in our programming curriculum:

- To give our students a thorough grasp and experience of the test-driven development methodology throughout our program, making them more marketable in the software development field.
- To improve our pedagogy by having students consider their programming projects from the functional level emphasized by testing early (or even developing tests first).
- To provide constant feedback during the program development process that provides hints on correct implementation of program specifications.

1 (Jones, 2004)
2 (Desai, Janzen, & Clements, 2009)
3 (Briggs & Gerard, 2007)
To improve the likelihood of working programs being submitted before grading, and to reduce the amount of manual grading needed.

Implementation

We decided to use the Web-CAT\textsuperscript{4} submission and evaluation system, which employs the JUnit testing harness. Making this work for our situation required (1) providing student support in setting up a development environment (2) installing the Web-CAT system on a server (3) providing a testing template which would adapt JUnit testing to work with console I/O, and (4) Creating programming assignments which utilized Web-CAT and JUnit reference tests to give students guidance.

Providing Development Environment Support

We used JGrasp\textsuperscript{5} as our development environment. Although Eclipse is a commonly used environment, and is a professional development tool as well, we felt that it introduced too much overhead (especially in the area of required project settings) for our introductory students. JGrasp provides good support for program editing, compiling and execution, allowing programs to be developed from a simple set of source code files. It also provides support for debugging and for the incorporation of extra tools such as checkstyle, JUnit, and Web-CAT. It does require some configuration, however, so we provided step-by-step instructions for setting up JGrasp. This included:

- Installation of the Java Development Kit
- Installation of JGrasp
- Installation of Checkstyle and JUnit
- Configuration of the JGrasp classpaths and JGrasp Tools for Checkstyle, JUnit, and Web-CAT

This was needed for many of our students, who do most of their work on their own computers off-campus. For those using campus computers, we were able to add the necessary software to our lab images, but they still required some reconfiguration due to our DeepFreeze environment. We created an automated batch file to handle this reconfiguration when students started their on-campus sessions.

Web-CAT

Web-CAT is an open source tool for automatically grading programming assignments, provided by the Virginia Polytechnic Institute and State University. It has been in continuous development since 2003, and is now quite mature with a relatively turn-key installation on a Unix server. It evaluates the completeness of student JUnit tests based upon how well they cover the source code of the program. It will also evaluate the student's program based upon a set of JUnit reference tests provided by the instructor. The students do not see these reference tests, but they can be used to provide hints about what needs to be corrected in the student program.

\textsuperscript{4} (Edwards, 2003)
\textsuperscript{5} (Auburn University)
addition, it performs static testing of program style (using CheckStyle⁶) and common programming errors (using PMD⁷), and has a flexible method for assigning grade deductions based on all these factors. Web-CAT provides students with continuous feedback beyond simple compiler and run-time errors. In a properly developed assignment, adding Web-CAT submission to the program development cycle shows students where they need to add their own tests, where they have failed to implement a required specification, and where they have included poor style or dangerous programming practices. They can then correct these problems and submit again. A program that has been refined down to the point where no automatic deductions are applied is likely to be correct, only needing manual checks by the instructor for specialized requirements, design, or style.

**Providing a JUnit Testing Template for Console I/O**

A typical JUnit test looks like the following:

```java
/** Test perimeter calculation. **/  
@Test public void perimeterTest()  
{  
    Triangle testTriangle = new Triangle(15.0,22.0,21.0);  
    Assert.assertEquals(58.0, testTriangle.perimeter(), 0.0001);  
}
```

The problem with this is that beginning students don’t know how to create a Triangle class, nor are they yet acquainted with creating a perimeter method. It is more likely that they would have a program that produces a console prompt for the length of the sides of the triangle, gets the input, and displays a console output of the perimeter. How can we adapt JUnit testing to this I/O oriented model?

To bridge this gap, we created a testing template which included some methods for handling console I/O. The basic strategy is to create a string for all of the expected console input for the entire program execution, and use the System.setIn() method to redirect input to come from this string. We also use System.setOut() to redirect output to a string that can be examined later. All this must be done before executing the method which uses this input and produces this output. This template included:

- A method called addToConsoleInput which takes a string as a parameter. This string includes all the input that would be typed at the console, including newlines and whitespace. addToConsoleInput redirects System.in to come from this string, rather than from the keyboard, and it also invokes the constructor of the program class. Students are instructed to simply replace `<<your class name>>` in the line:

  ```java
  new <<your class name>>>(
  ```

  of the addToConsoleInput method. They also have to add an attribute and a simple constructor to their program class:

---

⁶ (Burn & Ivanov, 2014)  
⁷ (Copeland, PMD, 2014)
static private Scanner keyboard;
public <<your class name>>()
{
    keyboard = new Scanner(System.in);
}

Note that this is all simple rote insertion. As far as these introductory students are concerned, these are black boxes that they need not understand at this time.

- A method called captureConsoleOutput which redirects System.out (the console output) to a string attribute of the testing class.
- A method called getOutputAfterText which takes a marker string as a parameter. It returns the text from the console output string which follows this marker string. A simpler version called getOutput simply returns the entire console output string.
- A sample testing method:
  @Test public void test1()
  {
      addToConsoleInput(
          "Text for console input goes here");
      captureConsoleOutput();
      <<your program class>>.main(null); // or a call
      // to some other method
      Assert.assertEquals("Output",
          "Desired output text goes here",
          getOutputAfterText(
              "Output text just to left of desired " +
              "console output goes here"));
  }

This accomplished our basic goal. Students were able to write tests that involved console input and output, without knowledge of classes or methods, and with only a few black-box insertions. In practice, students found it difficult to produce the console input accurately, or to capture the correct portion of the output text, due to the need for exact prediction and placement of newlines and whitespace. To improve this situation, a second version of the template was created which was loosely based on the Expect (interactive program scripting) system in Unix. This new template included:

- A method called send which takes a string as a parameter. This string includes all the input that would be typed at the console, including newlines and whitespace. It also redirects System.in to come from this string, rather than from the keyboard. Each send is recorded so that it can be matched with a corresponding expect later.
- A method called expect which takes a string as a parameter. This string includes all the output that is expected to be sent to the console, including newlines and whitespace. The expected strings are recorded so that they can be matched with a corresponding send later. It also redirects System.out to go to a string that can be examined later.
- A method called getNextExpected which returns the next value that was expected. It will start with the first value provided by the expect method, and iterate through all the values in sequence each time it is called.
• A method called getNextActual which returns the next value that was actually input from the console after a send. It is expected to be used in a pair of calls with getNextExpected.

This allows a much more intuitive testing template. Suppose we have a program I/O that looks like the following (text in italics is entered by the user):

Enter Side1: 6
Enter Side2: 8
Enter Side3: 9
Not a valid triangle.
Enter Side3: 10
The perimeter is 24

In the first version, an interactive test might look like this:
/** Test perimeter calculation. ***/
@Test public void perimeterTest()
{
    addToConsoleInput("6\n8\n9\n10\n");
captureConsoleOutput();
Triangle.main(null);
    Assert.assertEquals("Output",
    "24". getOutputAfterText("The perimeter is ");
}

Using the method above, the student must understand that although the input and the output are interleaved in interactive mode, when they are collected into a single input and output string it will be:
input -> "6\n8\n9\n10\n"
output -> "Enter Side1: Enter Side2: Enter Side3: Not a valid triangle.\nEnter Side3: The perimeter is 24"
which only adds to the conceptual overhead in writing tests. But using the send/expect version, it looks like this:
/** Test perimeter calculation. ***/
@Test public void perimeterTest()
{
    expect("Enter Side1: ");
    send("6");
    expect("Enter Side2: ");
    send("8");
    expect("Enter Side3: ");
    send("10");
    expect("The perimeter is 24");
    (new Triangle()).main(null);  // Black-box insertion –
    // just replace Triangle with the name of the student’s
    // program class
    for (int skip = 0; skip < 3; skip++) // Skip over the
    // first 3 expects
    {
        getNextExpected(); getNextActual();
}
Note that although the code is longer, it is much more transparent. We still have to predict the values that are expected, so that we can correctly divide the output string after the program executes. But the student does not have to figure out the intricacies of providing a single string for input and parsing the resulting output string. In addition, the amount of black-box code insertion is reduced to the single line which executes the program.

Creating Programming Assignments

Programming assignments have to be carefully designed to take advantage of Web-CAT and to allow students to perform appropriate testing at each level of their programming skills. Assignments must be constructed so that input and output results are predictable, and all input and output has to be through the console. This means that the assignment must explicitly require specific input prompts and output results. Unfortunately, this leaves no room for individual creativity, but it allows the program requirements to be tested by the instructor’s reference tests.

For example, in an early project in our CS1 course, students were asked to implement a simple slot machine, reinforcing if-then statements and logical expressions. The program had to be written so that spinner values could be either random, or set by input (so that input results would be predictable). So the following input and output formats had to be implemented exactly:

Enter the word 'test' to specify spinners, or 'spin' for random spinners: test
Enter 3 spinner values separated by spaces, each 1 to 3: 3 3 3
3 3 3
Jack Pot!

or

Enter 3 spinner values separated by spaces, each 1 to 3: 2 1 1
2 1 1
You Lose!

Input values (shown above in italics) did not have to be those specific values of course, but the output prompts and messages had to follow the exact format given. We can then create a set of reference tests for the program, which checks to see if (1) a spin of all the same numbers was identified as a jackpot (2) a spin of 2 numbers the same and one different was identified as a loss (3) a spin of 3 different numbers was identified as a loss, and (4) a random spin achieved some result. The reference tests for this were:

```java
/** Test all spinners different. **/
@Test public void test1() {
    expect("Enter the word 'test' to specify spinners, "+
```
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"or 'spin' for random spinners:");
send("test\n");
expect("Enter 3 spinner values separated by spaces, " +
"each 1 to 3:");
send("1 3 2\n");
expect("1 3 2");
expect("You Lose!");
(new SlotMachine()).main(null);
Assert.assertEquals(
"Did you use the EXACT prompts required?",
getNextExpected(),getNextActual());
Assert.assertEquals(
"Did you use the EXACT prompts required?",
getNextExpected(), getNextActual());
Assert.assertEquals(
"Are you displaying the correct spinner values?",
getNextActual());
Assert.assertEquals(
"What if all the spinners are different?",
getNextExpected(), getNextActual());
}
/** Test two spinners different. **/
@Test public void test2() {
expect("Enter the word 'test' to specify spinners, " +
"or 'spin' for random spinners:");
send("test\n");
expect("Enter 3 spinner values separated by spaces, " +
"each 1 to 3:");
send("3 3 2\n");
expect("3 3 2");
expect("You Lose!");
(new SlotMachine()).main(null);
Assert.assertEquals(
"Did you use the EXACT prompts required?",
getNextExpected(), getNextActual());
Assert.assertEquals(
"Did you use the EXACT prompts required?",
getNextExpected(), getNextActual());
Assert.assertEquals(
"Are you displaying the correct spinner values?",
getNextExpected(), getNextActual());
Assert.assertEquals(
"What if only two of the spinners are different?",
getNextExpected(), getNextActual());
}
/** Test all spinners the same. **/
@Test public void test3() {
expect("Enter the word 'test' to specify spinners, " +

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getNextExpected(),


"or 'spin' for random spinners:"
); send("test\n");
expect("Enter 3 spinner values separated by spaces, " + 
"each 1 to 3:"); send("2 2 2\n"); expect("2 2 2"); expect("Jack Pot!");
(new SlotMachine()).main(null);
Assert.assertEquals( 
"Did you use the EXACT prompts required?", 
getNextExpected(), getNextActual()); Assert.assertEquals( 
"Did you use the EXACT prompts required?", 
getNextExpected(), getNextActual()); Assert.assertEquals( 
"Are you displaying the correct spinner values?", 
getNextExpected(), getNextActual()); Assert.assertEquals( 
"What if all the spinners are the same?", 
getNextExpected(), getNextActual()); }

/** Test random spinners. **/
@Test public void test4() {
expect("Enter the word 'test' to specify spinners, " + 
"or 'spin' for random spinners:""); send("spin\n");
expect("? ? ?");
(expect("Jack Pot!"));
(new SlotMachine()).main(null);
Assert.assertEquals( 
"Did you use the EXACT prompts required?", 
getNextExpected(), getNextActual()); getNextExpected(); getNextActual(); // Skip over the 
// second expect
String spinResult = getNextActual();
Assert.assertTrue( 
"What if "spin" was entered instead of "test"?", 
spinResult.equals("Jack Pot!") || 
spinResult.equals("You Lose!"));
}

Note that each test includes some comment text in the Assert.assertEquals or 
Assert.assertTrue. If the test fails, Web-CAT will use this comment text as a “hint” 
which is presented to the student. The students cannot see the reference tests 
themselves. So a student who failed to have their program correctly consider the case 
of two spinners being the same and one different would get a scoring deduction, along 
with the hint:

What if only two of the spinners are different?
Developing the reference tests so that they completely check the program specifications and provide useful feedback to the student adds considerable overhead to the assignment development for the instructor, especially since the instructor must also write a complete implementation of the assigned program as well (to make sure that the tests work!) But it pays off in automating most of the assignment evaluation, and provides students with immediate feedback as part of their program development cycle.

**Conclusions and Future Work**

We have only used this system with one small class of CS1, so we do not yet have enough data to provide useful statistical results of the effectiveness of this approach. Preliminary feedback from students is that the continuous feedback of the system is helpful. We have developed a full set of assignments for CS1 using this approach, and hope to make it and our server available to other programming curricula at neighboring institutions and high schools, so we hope to get some more statistically relevant results on value of the system. Interested readers who would like to use our template may find it at:

http://heritagecomputerscience.com/~tkammerdiener/TDD14/TestTemplate.java.

In future development, we would like to provide a tool to do static analysis of graphical output, so that unit tests can do some basic comparison of a student’s graphical output window with a required graphical output. We would also like to extend the system to support some GUI I/O, such as simple dialog boxes.
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Contact email: Kammerdiener_T@heritage.edu
Website Vulnerability Scan for Information System of Toddler’s Growth and Development

Endah Sudarmilah, Universitas Muhammadiyah Surakarta, Indonesia
Wiwien Dinar Pratisti, Universitas Muhammadiyah Surakarta, Indonesia
Umi Fadlilah, Universitas Muhammadiyah Surakarta, Indonesia
Geri Gebyar Giwangkoro, Universitas Muhammadiyah Surakarta, Indonesia

Abstract
Web-Based Information System of Toddler’s Growth and Development is a client server application which has been information source as monitoring tools for the growth and development. It also be accessed easier by parents, posyandu and medical personnel that has been implemented.

On the other hand, the more easily to access this website also the more raises the security issue of information systems. Therefore, this study aimed to test the security of information systems Web-Based Information System of Toddler's Growth and Development which in turn to give recommendations on the issues raised by the application. Method used in this research was testing vulnerabilities that allow a cracker attacked system using a vulnerability software scanner.

The testing results that have been conduct was known that Web-Based Information System of Toddler's Growth and Development is unsafe, it shows the pages with the vulnerability of the High-level with malicious web alerts and the most vulnerable to attack by cracker is on the login page. It derives a recommendation on this system paying attention to security and performance on application and also solving the system vulnerabilities.

Keywords: Website, Vulnerability, Information System
Introduction

Currently, Information systems in the medical world are so needed, but there still have lack of using information systems to assist the work of the medical personnel, especially in helping the development of toddlers.

In this research, web-based information and monitoring systems for toddler growth was designed and built for help medical personnel as well as posyandu (an integrated service post for toddler’s monitoring growth) personnel in assisting parents in monitoring growth by looking at the nutritional status with the method of Anthropometry for measuring nutritional status toddler is weight, height or length and age (Indonesian Ministry of Health, 2010) (Indonesian Ministry of Health, 2011) (Wijaya, Awi Muliadi, 2011). As well as the development of toddlers who monitored her mental and motor development, and has more goals to become the portal database on child growth and development rates of posyandu and health centers which now is still done manually. Architecture of information systems and monitoring growing swell toddlers are web based which will then be implemented to work with the data governance posyandu and health centers (Sudarmilah, Endah, et al. 2013). This article will discuss the results of scanning the information system website vulnerabilities.

Related Research

Information and monitoring system is made with some of the software supporting the programming language PHP (Personal Home Page) is a scripting language embedded in HTML (Hypertext Markup Language) for the execution of server-side. PHP is used to extract the data/information that is desired by the user from the database and display it on a Web page (Nugroho, 2006).

Database Management System (DBMS) is software to manage and query database (Garry et al, 2009) that is used is MySQL which is an implementation of a relational database management system (RDBMS). SQL (Structured Query Language) is a database operations concept, especially for election or selection and data entry, which allows the operation of the data is done automatically with ease. (Nugroho, 2008).

This system using AHP decision support system (Analytical Hierarchy Process) is a method of decision making with multiple criteria, i.e. a comprehensive decision-making model, because it takes into account things both qualitative and quantitative. One of reliability of AHP is able to perform simultaneous and integrated analysis of qualitative parameters of quantitative or even that. The concept of AHP method is changing the values of qualitative quantitative values, so decisions taken can be more objective (Yuniartini, 2010).

Method

This researcher on testing using tools that are run with the specific measures used to test the security and performance of information systems. To conduct the analysis of information system in terms of security software used Acunetix vulnerability scanner for testing performance (Dukes, L. et al, 2013).
Result and Discussion

The implementation of this system has been feasibility tested online that can be accessed by anyone and everywhere with a domain and a particular web address. The system can be accessed online information systems hosting is done with web hosting, siposyandu.com.

Furthermore the results of the scan using the Acunetix vulnerability of this web application with the address http://siposyandu.com/ which showed vulnerability at level 3 (High) that provides information 240 alerts namely, 45 alerts on High alert, 166 alerts on category Medium, 17 alerts on Low category, and the 12 alerts on Informational categories. From the results of scanning using Acunetix in Figure 1 was showed the analysis of vulnerability in siposyandu.com information system based on the type of these.

![Figure 1: The Scanning Results Using Acunetix siposyandu.com.](image)

The granting of a security risk level refers to the recommendations of Acunetix application are described as follows.

a. **Blind SQL Injection**
   Threat level: High
   Risks:
   - Blind SQL Injection allows a person can log into the system without having to have an account.
   - Allows one to modify, delete, and add data that resides in the database.
• Shutting down the database, so can't give a service to the web server.

Recommendation:
• The script should be able to do the filtering parameters that can be used for the process of Blind SQL Injection.
• Limit the length of the input box.
• Hide error messages out of the SQL Server that is running.

---

**Figure 2 Recommendations for Blind SQL Injection**

b. **Cross Site Scripting**

   **Threat level: High**

   **Risks:**
   • An attacker can perform against cookie theft.
   • Allows attackers to deface or change the display either temporary or permanent nature of the website.

   **Recommendation:**
   • Perform filtering against meta character from user input.
   • Using the POST method is a method of data delivery started where variables are submitted are not included in the link that is used.

---

**Figure 3 Recommendations for Cross Site Scripting**

c. **Weak Passwords**

   **Threat level: High**
Risks:
- An attacker can easily break into the information system and utilize the information contained therein after gaining access.

Recommendation:
- Enforce a strong password policy.
- Do not permit weak passwords or passwords based on words in the dictionary.

![Figure 4 Recommendations for Weak Passwords](image)

d. **HTML forms without CSRF protection**

Threat level: Medium

Risks:
- Changing the victim's e-mail password, account information, or perform logout.
- Victims of "buying" stuff from the usual shopping sites visited.
- Victims conduct financial transactions without realizing it.
- Victims of the polls to vote a certain website with an options preset assailant.

Recommendation:
- Do not rely on the "Remember Me", "Stay Signed in" and "Save Password" in the use of services on the internet.
- Do not store passwords in your web browser.
- Always Logout from the website once completed using the service and delete all traces (History, saved passwords, cookies and authenticated sessions) from the browser.
Figure 5 Recommendations for CSRF

e. **User credentials are sent in clear text**

Threat level: Medium

Risks:
- The occurrence of attacks on data such as a user or password sent to the server to intercept over an unencrypted HTTP connection or not through HTTPS.

Recommendation:
- It is recommended to transfer data over an encrypted connection such as HTTPS.

Figure 6 Recommendations for User Credentials Are Sent In Clear Text

f. **Login page password-guessing attack**

Threat level: Low

Risks:
- Attackers can perform Brute-force attack to find the password by trying every possible password guessing there.

Recommendation:
• It is recommended to implement some kind of account lockout after experimenting login with a password that is not right.

![Figure 7 Recommendations to Login Page Password-Guessing Attacks](image)

<table>
<thead>
<tr>
<th>Alert group</th>
<th>Login page password-guessing attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>Low</td>
</tr>
<tr>
<td>Description</td>
<td>A common threat web developers face is a password-guessing attack known as a brute force attack. A brute-force attack is an attempt to discover a password by systematically trying every possible combination of letters, numbers, and symbols until you discover the one correct combination that works. This login page doesn't have any protection against password-guessing attacks (brute force attacks). It's recommended to implement some type of account lockout after a defined number of incorrect password attempts. Consult Web references for more information about fixing this problem.</td>
</tr>
<tr>
<td>Recommendations</td>
<td>It's recommended to implement some type of account lockout after a defined number of incorrect password attempts.</td>
</tr>
<tr>
<td>Alert variants</td>
<td>The scanner tested 10 invalid credentials and no account lockout was detected.</td>
</tr>
<tr>
<td>Details</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7 Recommendations to Login Page Password-Guessing Attacks

g. **Session Cookies without HttpOnly flag set and Secure Session Cookies without flag set**

Threat level: Low

Risks:

• An attacker can log in without a password by using "cookie name" and "Domain name" which will be filled with cookies and domain victim.

![Figure 8 Recommendations for Session Cookies without HttpOnly flag set and Secure Session Cookies without flag set](image)

<table>
<thead>
<tr>
<th>Alert group</th>
<th>Session Cookie without HttpOnly flag set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>Low</td>
</tr>
<tr>
<td>Description</td>
<td>This session cookie doesn't have the HTTPOnly flag set. When a cookie is set with the HTTPOnly flag, it instructs the browser that the cookie can only be accessed by the server and not by client-side scripts. This is an important security protection for session cookies.</td>
</tr>
<tr>
<td>Recommendations</td>
<td>If possible, you should set the HTTPOnly flag for this cookie.</td>
</tr>
<tr>
<td>Alert variants</td>
<td></td>
</tr>
</tbody>
</table>
| Details      | Cookie name: "PHFSESSID"  
Cookie domain: "www.siposyandu.com" |

<table>
<thead>
<tr>
<th>Alert group</th>
<th>Session Cookie without Secure flag set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>Low</td>
</tr>
<tr>
<td>Description</td>
<td>This session cookie doesn't have the Secure flag set. When a cookie is set with the Secure flag, it instructs the browser that the cookie can only be accessed over secure SSL channels. This is an important security protection for session cookies.</td>
</tr>
<tr>
<td>Recommendations</td>
<td>If possible, you should set the Secure flag for this cookie.</td>
</tr>
<tr>
<td>Alert variants</td>
<td></td>
</tr>
</tbody>
</table>
| Details      | Cookie name: "PHFSESSID"  
Cookie domain: "www.siposyandu.com" |

h. **Broken links**

Threat level: Informational

Risks:
• Broken links can make information systems exposed to a penalty from Google. And if exposed to penalties google Pagerank it will affect information systems and indexing by search engines.
• Broken links can degrade the quality of SEO blogs.
• Information systems may be considered spam by the search engines when too many broken links.
• And the loss of visitors are not able to find the information sought. And if like this, then the visitors slowly, reluctant to come back to the earlier information systems.

Recommendation:
• Deleting files indicated broken link.
• Replace dead links with new links and are still functioning.

---

**Table: Alert Group Broken links**

<table>
<thead>
<tr>
<th>Alert group</th>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken links</td>
<td>Informational</td>
<td>A broken link refers to any link that should take you to a document, image or webpage, that actually results in an error. This page was linked from the website but it is inaccessible.</td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
<td>Remove the links to this file or make it accessible.</td>
</tr>
<tr>
<td>Alert variants</td>
<td></td>
<td>No details are available.</td>
</tr>
</tbody>
</table>

---

**Figure 9 Recommendations for Broken links**

i. *Password type input with auto-complete enabled*

Threat level: Informational

Risks:
• It allows attackers to find and commit abuse of passwords.

Recommendation:
• Disable autocomplete passwords on sensitive pages such as the login page.

---

**Table: Alert Group Password type input with auto-complete enabled**

<table>
<thead>
<tr>
<th>Alert group</th>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password type input with auto-complete enabled</td>
<td>Informational</td>
<td>When a new name and password is entered in a form and the form is submitted, the browser asks if the password should be saved. Thereafter when the form is displayed, the name and password are filled in automatically or are completed as the name is entered. An attacker with local access could obtain the cleartext password from the browser cache.</td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
<td>The password autocomplete should be disabled in sensitive applications. To disable autocomplete, you may use a code similar to <code>&lt;INPUT TYPE=&quot;password&quot; AUTOCOMPLETE=&quot;off&quot;&gt;</code></td>
</tr>
<tr>
<td>Alert variants</td>
<td></td>
<td>Password type input named password from form named login_form with action ok login php?op-in has autocomplete enabled.</td>
</tr>
</tbody>
</table>

Figure 10 Recommendations for the Password type input with auto-complete enabled
Conclusion

The results of vulnerability scans using Acunetix for information systems of toddler’s growth and development in address http://siposyandu.com/ toddler who showed susceptibility to level 3 (high), which provides information 240 alerts covering 45 alerts in the category of High, Medium 166 alerts in the category, 17 alerts on Low category, and 12 in the category of Informational alerts. Vulnerability analysis on siposyandu.com information system based on the type of vulnerability can be recommended to repair the system.
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**Contact email:** Endah.Sudarmilah@ums.ac.id
Development of a System to Analyze Students’ Keystroke Sequence
in Programming Education

Tatsuyuki Takano, Kanto Gakuin University, Japan
Osamu Miyakawa, Tokyo Denki University, Japan
Takashi Kohama, Tokyo Denki University, Japan

Abstract
In programming education, the procedure used to input a program and its relation to
degree of comprehension of the program are seldom studied. In this paper, we report
on a study in which one input procedure was taught to a student and an algorithm that
judges whether the procedure is inputted correctly was developed and installed in the
system. Using the data inputted by the student the algorithm was able to correctly
determine whether the procedure used to input the program was correct. Further,
using the data acquired, an objective determination of whether a coding procedure is
right or wrong can be made from a graph.

Keywords: programming education, software engineering, degree of comprehension
Introduction

When training software engineers, programming introduction education is very important. In programming education, students submit source codes with a subject; however, the submitted source code is only the resulting input, information on how it was inputted is not included. The method used to write a program is important as it facilitates understanding of the program; for example, an indent is effective in enabling understanding of the contents of a program (Oman & Cook, 1988; Miara et al. 1983). A novice programmer may make many errors involving brackets or braces (Jackson et al. 2005). Such errors can be reduced by devising an input procedure in which corresponding parentheses containing a block of code are inputted prior to the block of code. We teach methods such as this to students in programming education. Further, to ascertain whether following this input procedure has an influence on compile errors or mounting capability, we created an algorithm that judges objectively whether the input procedure was followed.

This paper discusses the algorithm implemented in the system. The implemented algorithm compares the input procedure for the source code of the correct answer to that of the source code that the student inputs.

Keystroke Sequence

To aid in the explanation of typing procedure, let us look at the example source code, written in Java, displayed in Figure 1. The procedure is to input the characters used as pairs, such as curly braces and round brackets prior to other elements. Then, the inner elements are inputted. Consequently, the input procedure for the source code displayed in Figure 1 is as shown in stages 1 to 7 in Figure 2.

```java
public class Student {
    private String name;
    public Student(String name) {
    }
    public String getName() {
        return null;
    }
}
```

Figure 1: Sample Java source code
Algorithms

The outline of our proposed algorithm is shown in Figure 3.

Keystroke sequence data are created from the source code of an answer and the student's source code, and a result is obtained by comparing both of them. The keystroke sequence data creation method from the source code and input procedure in Figure 4 is illustrated in Figure 5.
Figure 4: Sample source code inputted by student

1. public class {
2.     private
3. }

Figure 5: Keystroke sequence data of student’s source code

Figure 5 shows how the keystroke sequence data is created from a student’s source code. First, the student’s source code is put in order as a character string, and a number given to each character by setting each entry sequenced to a keystroke index. The input is then sorted by keystroke index. The turn and keystroke index of a character are the same at this time. The lexical of a character string is then analyzed, the character string made a token sequence, and the minimum keystroke index in the token set up as the coding index. Next, an ascending sort is carried out according to the coding index, and the student's keystroke sequence data created.

We can explain how comparison of the keystroke sequence data and the student's keystroke sequence data is carried out using the answer source code displayed in
Figure 6. The lexical of the answer source code is analyzed and arranged in the token sequence created. The coding index looks for a corresponding parenthesis if a number is assigned in order and a parenthesis is found, and gives the following number when a parenthesis is found. Then, the coding index is calculated and it returns to the position of the original parenthesis and numbers. This is the index for the coding index, and an ascending sort is carried out. The algorithm also compares the length, when it is longer in that case than the student's data. The number of tokens compared that have a difference is considered as the result.

**Figure 6: Keystroke sequence data for the answer source code**

**System Integration**

This algorithm was added to a system previously developed by Tatsuyuki et al. (2011) for acquisition of students’ input. The system is outlined in Figure 7. A program is created using the editor in the system, and the student creates a Java program in client server form. Further, the inputted data is transmitted to the server side as XML data. The server was mainly developed using Grails.

**Figure 7: Student input system overview**
Results

We evaluated the data acquired by the system before and after the algorithm was used. The data patterns for two different input procedures are depicted in the graphs shown in Figures 8 and 9.

The vertical axis of each graph is the number of keystrokes, while the horizontal axis shows the score of the algorithm. Figure 8 shows the graph with repeated 1 and 0. When an input of a token is set to one and the token is inputted correctly, it will return to zero. Figure 9 shows the procedure that summarized the contents of the method at the end and inputted them. It is clear that the score is increasingly larger.

Discussion and Conclusion

As a result of using acquired input data, an objective determination of whether a coding procedure is right or wrong can be made from a graph. We plan to improve the system presented in this paper and use it in actual lessons to analyze incoming data and investigate its relevance to the students’ results in future work.
References


Designing Children’s Multimedia Learning Application in Developing Children’s Knowledge on Child Sexual Abuse

Azliza Othman, Universiti Sains Malaysia, Malaysia
Wan Ahmad Jaafar Wan Yahaya, Universiti Sains Malaysia, Malaysia
Balakrisnan Muniandy, Universiti Sains Malaysia, Malaysia

Abstract
Various educational applications have been successfully utilized multimedia in learning environment. Many researchers agree that multimedia can facilitate learning through its advantages. However, there are differences in developing multimedia application for young children and for adults. Children are different than adults in the way they think and learn, and this difference evolves over time. Particularly, the challenges faced by designers of applications for children include determining strategies to design applications that meet children’s capabilities, needs and expectations. Accordingly, this paper discusses the process of designing and discussing an application specifically for building-up children’s knowledge about Child Sexual Abuse (CSA). This paper also measures children’s knowledge before and after the demonstration of the application. During the design stage, guideline for Educational Websites for Children was referred to. The guidelines contain 10 elements of design guidelines for children and the elements are grouped into three categories which are navigation, appearance, and content. A group of 222 primary school children between 7 and 9 years old were involved. They were divided into gender groups. Knowledge and Awareness Survey (KAS) instrument have been used to evaluate the children’s knowledge of child sexual abuse before and after they used the application. The results reveal that children’s knowledge (in both groups) has increased after they used the application. Additionally, it was found that girls are more interested to the application compared to boys.

Keywords: knowledge, multimedia learning, children design guideline, child sexual abuse

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Introduction

Nowadays, computer technology plays an important role in education system. Consequently, instructional materials are developed based on the advancement of recent technologies. This enables teachers to utilize different teaching apparatus and modes to accelerate student learning in their teaching practices.

At the same time, multimedia has also been successfully utilized in learning environment for various educational applications and it has brought various advantages especially in improving children’s learning process because it extend the amount and types of information to learners (Shank, 2005) and it is very effective at maintaining user interest and reducing cost (Najjar, 1992). In addition, the use of elements in multimedia such as animation and video can help a lot in describing complicated concepts. Besides, learning with multimedia save time, is more pleasant and improve learning process (Hick, 1997).

Studies have revealed that developing multimedia applications for young children is different than those for adults. Shneiderman (1998) argued that any design should be based on perceptive of its intended users and he includes age and gender as among the important of user characteristics that should be considered. In addition, children have a different way of thinking and learning than adults, and this difference evolves over time until adulthood. It is noted that maturation educates about learning, but it does not mean that children are bound in what they can do in learning. As a result, Large and Beheshti (2005) found that particular interface design guidelines are required for young users and do not only relying on general design guidelines. On the other hand, Demner (2001) found that 66% of children agree that the Internet technology assists their learning process, and 34% would like to use it for lessons if they are home sick.

As a consequence of the great capabilities of multimedia in learning, this study attempts to design and develop a multimedia learning application with intention to deliver basic knowledge about CSA to children aged 7 to 9 years old. CSA is serious social problem that exists in almost all countries. In fact, child abuse could happen at every socio-economic level, across ethnic and cultural lines, within all religions and at all levels of education (Renk, 2002). Studies found that CSA victims are more traumatized in their life compared to other type of abuse (Bornstein, Kaplan, & Perry, 2007). Regarding that, UNICEF Malaysia (2009) reported that a child does not know that an adult cannot abuse their body. It is because children are not aware of danger and self-protection (Hitrec, 2011). Hence, it is important to provide information about CSA to the public especially to children so that they would understand better and they are also aware of the phenomenon.

In accordance, this paper describes and discusses the development of a multimedia learning application for children that incorporates design guidelines. It provides basic knowledge about sexual abuse to children. In detail, three categories namely navigation, appearance, and content are covered in the guidelines. The rest of the paper is organized as follow: the general view of multimedia learning is addressed first. Then, the children knowledge on sexual abuse follows. Next, a detailed description on the design guideline for children is outlined. In the last section, the paper discusses on how the application design may support children capabilities, needs and expectations.
Multimedia Learning

According to Mayer (2009), multimedia learning refers to learning through words and pictures. Mayer claims that multimedia learning can occur when people could construct mental model from words (such as spoken text and printed text) and pictures (such as illustrations, photos, animation, or video). Further, Wisegeek (2010) defines multimedia learning as the process of learning using multimedia presentation and teaching methods. Learning process usually happens in classroom or a simulated environment and can normally be applied to any subject. Generally, any sort of learning process can either be achieved or enhanced through a proper practice of multimedia applications. In fact, well-designed multimedia applications are able to improve student’s understanding and to offer meaningful experience during the cognitive process that eventually reduces cognitive load (Wisegeek, 2010). Multimedia learning process can be viewed as response strengthening, information acquisition or as knowledge construction (Mayer, 2009).

Children Knowledge on Child Sexual Abuse

Knowledge refers to an appropriate collection of information and it is a deterministic process. When someone had memorized information, then they have amassed knowledge. This knowledge has useful meaning to them and could be integrated for further knowledge. Basically, knowledge can be divided into two type; tacit knowledge and explicit knowledge. Tacit knowledge is hard to expressed and formalize. It is highly personal, difficult to communicate to others, and may also impossible to capture. In contrast, explicit knowledge is formal and systematic. It can be easily communicated and shared. Typically, it has been documented. In this study, explicit knowledge has been adopted in designing and developing learning application since the structure and learning content could easily presented into digital interface.

Regarding the knowledge about CSA, UNICEF Malaysia (2009) has found that children are normally not aware of their rights, that it is wrong for an adult to abuse their body. This fact also supported by Hitrec (2011) who found that children have too little knowledge on danger and self-protection. In addition, there are only very few studies and prevention programs focusing on educating children about CSA in Malaysia (Cheah, & Choo, 2011). In regards to this, this study believes that awareness programs on prevention should be organized constantly and more research works are required in conveying information in helping children facing dangerous situations. It has to be addressed using appropriate learning material and methods. Therefore, it is important to provide knowledge to the children about CSA using appropriate learning programs so that children will understand the danger of CSA and be more aware of this phenomenon.

Design Guideline for Children

Meloncon et al (2010) present several guidelines as a starting point that ensure educational websites meet children learning goals by considering children developmental abilities and web preferences. These guidelines were formed based on a evaluation of the existing literatures related to Web site design for children and their own usability tests of one educational Web site geared toward children. Table 1
presents the 10 elements in the guideline, which are categorized into three main groups which are navigation, appearance and content.

The ways children interact with technologies are different depending on their gender and age level which reflects their changing interests, characters, humors, and contexts. Most theories of child development start with Jean Piaget (1970). Based on Piaget’s theory, concept of children physical and mental development are categories in four stages which are sensory motor, pre-operational, concrete operational, and formal operational. The age of children for this study falls into concrete operational stage. Based on Butterworth and Harris (1994) as cited by Meloncon et al (2010) when considered to interacting with a computer application, children are able to use and control a mouse, and they can read more complete and complex texts. At this age children start to work together with peers based on a strong group identity and think logically (even though they still depend on concrete references). In addition, they start to develop the ability to categorize objects and start to relate and convey their existing knowledge and experience to a particular situation. However, the children still have limited sense of relationships in space and time.

Table 1: Design Guideline for Children.
(source: Meloncon, Haynes, Varelmann & Groh, 2010)

<table>
<thead>
<tr>
<th>Element</th>
<th>Consideration for Children</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Navigation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hierarchical</td>
<td>Children do not have a fully developed sense of space or temporal recall, and can easily</td>
<td>• Limit navigational topics.</td>
</tr>
<tr>
<td>Navigation</td>
<td>become lost in complex navigation.</td>
<td>• Use literal icons and directional image to point the way through the navigation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do not include search options, in text links, or pop-ups- all add an unnecessary layer of complexity.</td>
</tr>
<tr>
<td>Image Map</td>
<td>7 to 9 years old children find it easier to navigate visually. They also interpret icons</td>
<td>• Provide clickable hotspots obvious through rollover effects (e.g., blinking,</td>
</tr>
<tr>
<td></td>
<td>literally.</td>
<td>changing color).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use representational images that children can recognize from their everyday</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lives.</td>
</tr>
<tr>
<td>Multiple Cues</td>
<td>Children need specific prompts to stimulate their understanding of navigation.</td>
<td>• Provide various options for navigation (e.g., breadcrumbs, prominently-displayed “back” button).</td>
</tr>
<tr>
<td>Appearance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graphics</td>
<td>Children appreciate simple, playful graphics. They interpret icon literally.</td>
<td>• Use images from children’s everyday lives.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Age-appropriate mascots can be helpful, but they should play a role in the interface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Avoid graphics for visual interest</td>
</tr>
</tbody>
</table>
| Color | Children hate white backgrounds or empty space. They enjoy the variety of color combinations. | • Use vivid colors.  
• Avoid excessive use of white. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Games</td>
<td>Children enjoy games even it is simple.</td>
<td>• Incorporate games that play a role in the site’s learning objective.</td>
</tr>
</tbody>
</table>
| Accessibility | Complex content could make children feel confuse. | • Surpass minimum WCAG 2.0 guidelines so that all children can participate.  
• Keep sites simple or provide alternative to complex content. |

**Content**

| Age-Appropriate | Children can improve their reading ability. | • Use content appropriate for the target users. |
| Readability | Children’s recall is less than that of adults. Organizational cues (subheadings, etc.) do not help them. They are willing to read instruction. | • Use concrete words, active verbs, and concise sentence structure.  
• Organize content efficiently and effectively.  
• Provide clear directions and goals. |
| Page Length | Children are willing to scroll down the page. | • Limit the length of sentences and paragraphs to increase readability.  
• Segment page length based on concepts. |

**How the Design Guidelines Support Multimedia Learning Application**

Since the multimedia learning application in this study is design for children in order to increase their knowledge of child sexual abuse, a set of design guideline specific for children must be considered. In accordance, a set of guidelines for educational websites for children by Meloncon et al (2010) was adopted as the strategies to develop a prototype. These guidelines are classified into navigation, appearance and content. These guidelines were adopted in this study as the strategies to develop a prototype.

**Navigation**

This multimedia learning application limits the navigation to important topics since children have limited in developing their full sense of space or temporal recall, and complex navigation can make children easy to get lost. To support their recognition, icons (as seen in Figure 1) are used as part of navigation tools. The icons are simple and easy to click to make them attractive to children. Suitable metaphor is used to represent the function of each icon, which are located at the same place in each page (consistent) so that it could make users feel easy to recognize and avoid them lost in navigation.
Figure 1: Screenshot shows navigation through icon.

Appearance

In terms of appearance, the multimedia learning application makes use of daily apparatus in a house, in a classroom, and in a playground as the background elements. It maps children’s everyday life. All graphics and colors are also simple and playful. In addition, a character of a teacher appears in the application as an agent that communicates with the children. A teacher is considered appropriate for the users in this study because the children at this age are very familiar with situations at school. Also, the application incorporates simple educational games that play a role in the application’s objective.

Content

For specific target group, the contents are organized with clear hierarchical subtopics (as seen in Figure 2) and are delivered with simple, concise, and clear oral conversation.

Figure 2: Sub Topics in the Application.
Research Design and Methodology

The purposes of this study are to design and develop application of multimedia learning application with the aim to increase children’s knowledge on child sexual abuse. Therefore, this section discuss on the research design, sample, method of data collection and data analysis.

Quasi-experiment approach using pre-test and post-test has carried out to assess the children’s knowledge before and after they used the developed multimedia learning application. A group of 222 school children of Years 1, Year 2, and Year 3 from randomly selected schools were involved in the evaluation. In the test, Knowledge and Awareness Survey (KAS) was used as the instrument that measures children’s knowledge level on CSA before (pre-test) and after (post-test) the treatment. Each pre-test and post-test consist of 14 questions with True/False options.

In the test, the pre-test started first, in which the children answered the 14 questions. Then, they were given at least two sessions to explore the multimedia learning application. After exploring the application, the children then answered the similar 14 questions. To ensure that the children were free from bias (memorizing the sequence of questions may affect the result) the 14 questions were randomly rearranged so that the sequence of questions changes. The collected data were analyzed using descriptive statistics.

Results and Discussion

The purpose of this analysis is to measure children’s knowledge of CSA before and after they used multimedia learning application. In addition, this study also aims to assess children’s knowledge between boy and girl by comparing the mean value of post-test result with pre-test result for both genders.

Table 2 exhibits the score for pre-test and post-test. It can be seen that mean for pre-test and post-test are 9.42 and 10.68 respectively. This means that children’s knowledge slightly increases with a mean difference of 1.26 after they have explored the multimedia learning application. Minimum score also increase from 3 to 7. Based on the results, it could be deduced that the developed multimedia learning application has the potential to be an educational tool, particularly to be used in providing knowledge of CSA.

The finding of this study is parallel with studies reviewed by Daro (1992), which the programs assessed, produced a small but statistically significant gain in knowledge.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>222</td>
<td>3</td>
<td>14</td>
<td>9.42</td>
<td>2.190</td>
</tr>
<tr>
<td>Post-test</td>
<td>222</td>
<td>7</td>
<td>14</td>
<td>10.68</td>
<td>1.773</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>222</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Scores for Pre-test and Post-test.
Further, Table 3 summarizes the children’s knowledge before and after they have explored the developed multimedia learning application by gender (illustrated in graph in Figure 3). It can be seen that girl’s score is higher than the boy’s in both tests. It was found that girls tended to find the developed multimedia application more attracted compared to boys. However, both genders show an improvement after the explored the application.

This finding is similar to Finkelhor and Leatherman (1992), which their research found that girls are more interested, and think that the programs more helpful, and providing with new information. This finding also consistent with study by Shaffer, Garland, Vieland, Underwood, and Busner, (1991) regarding of teen suicide prevention programs.

Table 3: Children’s knowledge score by gender.

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>Boy</td>
<td>107</td>
<td>9.05</td>
<td>2.103</td>
<td>.203</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>115</td>
<td>9.77</td>
<td>2.222</td>
<td>.207</td>
</tr>
<tr>
<td>Post-test</td>
<td>Boy</td>
<td>107</td>
<td>10.39</td>
<td>1.742</td>
<td>.168</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>115</td>
<td>10.94</td>
<td>1.769</td>
<td>.165</td>
</tr>
</tbody>
</table>

Figure 3: Children’s knowledge score by gender

**Conclusion**

Realizing the capability of multimedia technology in facilitating learning and the importance of referring to appropriate design guidelines for children, this paper discusses the effects of applying multimedia and design guideline for children in designing and developing a multimedia learning application. The findings from quasi-experiment reveal that the multimedia learning application can facilitate children in understanding the learning content. The results also indicate that the multimedia learning application have a potential to attract children to use the application. Further, this study hopes that the multimedia learning application will meet the capabilities, needs, and expectations of the children in using multimedia application.
References


Wisegeek (2010). What is multimedia learning? Retrieved February 17, 2012 from

**Contact email:** azliza@uum.edu.my
Integration of Flipped Classroom Approach and Project-based Learning in an Undergraduate Engineering Course

Chao-Hsien Yeh, Feng Chia University, Taiwan
Mei-Huei Tsay, Central Taiwan University of Science and Technology, Taiwan

The Asian Conference on Society, Education and Technology 2014
Official Conference Proceedings

Abstract
Encouraged by the increasing numbers of successful cases both on Flipped Classroom approach and project-based learning around the world, the authors transformed the instructional method of an undergraduate engineering course at the fall semester of 2013. After 80% of original course slides were converted into video clips, students of the course were instructed to facilitate those course materials before the classes. In the formal course time, planned group discussions, presentations, or quiz on the course contents were undertaken by the students. Two weeks of traditional lecture format were delivered for the purpose of comparison. A course project of designing an ecological-friendly urban river reach was scheduled through 8 one-hour sections supplemented by discussion sheets or PPT files. When most of the students spent half to one hour per week to pre-view the videos, the average scores of 5 group quiz at flipped weeks were close to that of the group quiz at one traditional lecture week. However, 3 quiz for individual student were apparently lower for about 20 points out of 100 scale. With questionnaire of Self Directed Learning Readiness Scale applied at the beginning and the end of the semester, the result indicated that more than 80% of the students had increased their scores. From course feedback questionnaire, over 75% of the students confirmed that both flipped-classroom approach and project-based learning had positive effects on their learning in this course.
Introduction

As an introductory course, "Ecological Engineering" is planned to provide students the fundamental concept of “the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both” (Mitsch & Jørgensen, 2004); therefore, the course covers several application domains from river, slope land, urban, road, and to water quality. This course was initiated at 2002 as college selective course where the invited speakers presented their expertise for about 120 students. Two year later, it was categorized as a selective course for junior students of Department of Water Resources Engineering and Conservation with about 50 participants for years. Since 2006, six weeks of total 18 course weeks were designed and implemented as online-learning lectures supplemented by course materials, presentation slides, group discussions, homework, and online quiz on a learning management system. With gradual modifications of course activities both in face-to-face and e-learning environments, the end-of-semester appraisal scores of this course by students at 2011 and 2012 improved to 4.7 on 5-point scale and it becomes as a top 10% course in the university. At fall semester of 2013, the course activities of "flipped classroom" and project-based learning were simultaneously merged into this course to achieve the course goal of enhancing students' team-work skill. To document the process for future adjustments, this paper of action research collected various information from students along with their academic performance.

Course Design and Evaluation

In this section, two major modifications in the course design of this course, i.e. flipped classroom approach and project-based learning, are first described and followed by the illustration of evaluation on the learning characteristics of participants.

1. Course design of flipped learning

According to Flipped Learning Network (2014), flipped learning moves direct instruction from the group learning space to the individual learning space, and transforms the resulting group space into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter. Therefore, all the lecture units have to be produced and available before class time, and appropriate course activities have to be planned and implemented to reflect major content of those units. In this course, PowerPoint slides and supplemental screen presentations of each lecture were recorded by PowerCam (FormosaSoft Corp., 2014). By this free software, both the indicator motion of presenter and animated functions in PPT slides can be recorded along with presenter’s vocal instruction. The video clip will be automatically divided and marked into sections based on the pages of original PPT file. The edited video clips were upload to learning management system and FCUTV channel of our university (Figure 1) one week before the lecture such that the enrolled students can preview the video and the other course materials.

Three types of course activities were applied in the classroom for flipped learning, including group presentation, group quiz, and group discussion. Two weeks of traditional face-to-face lecturing were also implemented for comparative purpose.
The operation procedures, cognitive level based on Bloom's taxonomy (Krathwohl, 2002), and assessment of these activities are tabulated as Table 1.

Figure 1 Course lecture was recorded as video clip and uploaded in FCUTV channel.

Table 1 Four types of course activity in this course.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Operation Procedures</th>
<th>Cognitive Level</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Presentation</td>
<td>(1) Randomly designate one of 6-8 lecture units and its discussion agenda to one group. (2) All groups make 20 minutes discussion. (3) Each group makes 10 minutes presentation.</td>
<td>Analysis &amp; synthesis</td>
<td>Peer &amp; instructor</td>
</tr>
<tr>
<td>Group Quiz</td>
<td>(1) Members make 20-minute reviewing on the lecture contents. (2) Apply group multiple-choice quiz. (3) Lecture on the problems what most students failed.</td>
<td>Comprehension &amp; application</td>
<td>Written exam</td>
</tr>
<tr>
<td>Group Discussion</td>
<td>(1) Members discuss all the agendas provided at course hours. (2) Write the answers on the glass wall of classroom or the discussion board of BB.</td>
<td>Analysis, synthesis, &amp; evaluation</td>
<td>Peer &amp; instructor</td>
</tr>
<tr>
<td>Traditional Lecturing</td>
<td>(1) Oral lecturing the contents by instructor. (2) Apply multiple-choice quiz.</td>
<td>Knowledge &amp; comprehension</td>
<td>Written exam</td>
</tr>
</tbody>
</table>
2. Course design of project-based learning

Even defined differently in many literature, project-based learning can be characterized as a student-centered instructional approach that engages students’ interest and motivation around the complex activities of a project to solve real life problem through sustained, in-depth, and cooperative investigation and results in a product, presentation, or performance (Bransford and Stein, 1993; Harris and Katz, 2001; Moursund, 2001; Liu and Hsiao, 2002; Köse, 2010; Center for Occupational Research and Development, 2012). Therefore, the project of this course was set as designing an ecological-friendly urban river reach such that the course content can be integrated with the knowledge learned from previous related courses. In order to provide appropriate instructions to perform the operational steps of project-based learning (Nobori, 2012; Markham et al., 2003), eight one-hour sections were scheduled within the semester, i.e. Table 2, and they were supplemented by discussion sheets or PPT files.

Table 2 Flipped learning activities and PBL sections in the Course Schedule.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Flipped Activities</th>
<th>PBL Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Course delineation</td>
<td></td>
<td>W1: Grouping &amp; Targeting</td>
</tr>
<tr>
<td>02</td>
<td>No class (University holiday)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Lecture 1</td>
<td>Group presentation #1</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Lecture 2</td>
<td>Group quiz #1</td>
<td>W2: Issues Analysis</td>
</tr>
<tr>
<td>05</td>
<td>Lecture 3</td>
<td>Group presentation #2</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Lecture 4</td>
<td>Group quiz #2</td>
<td>W3: Information Collection</td>
</tr>
<tr>
<td>07</td>
<td>Lecture 5</td>
<td>Quiz #1</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Midterm exam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Practice on survey instrument</td>
<td></td>
<td>W4: Midterm Report</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>W5: Field Survey</td>
</tr>
<tr>
<td>11</td>
<td>Lecture 6</td>
<td>Group presentation #3</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Lecture 7</td>
<td>Group quiz #3</td>
<td>W6: Demand Analysis</td>
</tr>
<tr>
<td>13</td>
<td>Lecture 8</td>
<td>Group presentation #4</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Lecture 9</td>
<td>Group quiz #4</td>
<td>W7: Alternative Evaluation</td>
</tr>
<tr>
<td>15</td>
<td>Lecture 10</td>
<td>Quiz #2</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td>W8: Project Presentation</td>
</tr>
</tbody>
</table>

3. Evaluation on student and course

Since flipped learning moving direct instruction to the individual learning space (Flipped Learning Net, 2014), whether if student can finish the previewing of video clips before class should be the key factor. In a broad meaning, this individual learning seems to be related to student's self-directed learning readiness that is the result of an unique developmental journey where learners develop skills, knowledge, and attitudes as they engage in increasingly advanced forms of self-direction (Tsay et al., 2000). To understand the potential effect of self-directed learning for student, a modified Self-Directed Learning Readiness Scale (MSDLRS) questionnaire (Deng, 1994) was employed at the first and final week. Besides, an anonymous end-of-
semester questionnaire was also distributed to enrolled students as reference of course improvement for next school year.

**Implementation and Results**

Except two weeks for traditional lecturing, i.e. Week #4 and #7, seven video clips were made for eight weeks of flipped learning. As shown in Table 3, the length of video clips ranges from less than 40 minutes up to almost 80 minutes depending on the number of slides in original PPT files. At each week of flipped learning, answer sheets for anonymous questionnaire on previewing time were collected from students and the distributions of the previewing time were found as Table 4. Most students spent less than one hour each week on watching the video before the class no matter what the length is. Photos taken during the course sections of project-based learning are assembled in Figure 2.

Table 3 Production of lecture units for flipped learning.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>PPT Slides</th>
<th>Length of video clip</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>#1</td>
<td>33</td>
<td>1hr15min07sec</td>
</tr>
<tr>
<td>05</td>
<td>#3</td>
<td>35</td>
<td>47min12sec</td>
</tr>
<tr>
<td>06</td>
<td>#4</td>
<td>30</td>
<td>48min24sec</td>
</tr>
<tr>
<td>11</td>
<td>#6</td>
<td>160</td>
<td>38min19sec</td>
</tr>
<tr>
<td>12</td>
<td>#7</td>
<td>48</td>
<td>46min07sec</td>
</tr>
<tr>
<td>13 &amp; 14</td>
<td>#8 &amp; #9</td>
<td>85</td>
<td>52min54sec</td>
</tr>
<tr>
<td>15</td>
<td>#10</td>
<td>65</td>
<td>1hr19min50sec</td>
</tr>
</tbody>
</table>

Table 4 Previewing time for each week's flipped learning.

<table>
<thead>
<tr>
<th>Week</th>
<th>Self-report on previewing time (Hour)</th>
<th>Average time</th>
<th>Ratio to video length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>&lt; 0.5</td>
<td>0.5-1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>
1. Learning performance

In this course, three kinds of tests were applied under the environment of flipped learning, face-to-face lecturing, or on-line learning, Table 5. The average group scores of multiple choice tests and fill-the-blank tests are around seventy in flipped learning, they are very close to that of multiple choice test in face-to-face lecturing. However, three multiple choice tests for individual students had average scores around fifty, about 20 lower than those of group tests. The differences between highest and lowest scores in group tests are almost half of that in individual tests. The results indicated that difference on student’s learning performance came from how many students answered the questions, not because the type of test or course design.

Table 5 Tests scores under different environments, question types, and response form.

<table>
<thead>
<tr>
<th>Where</th>
<th>Sym.</th>
<th>Question Type</th>
<th>Response Form</th>
<th>No.</th>
<th>Average</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flipped learning</td>
<td>FG1</td>
<td>Multiple choice</td>
<td>Group</td>
<td>9</td>
<td>58.3</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>FG2</td>
<td></td>
<td></td>
<td>7</td>
<td>82.1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>FG3</td>
<td>Fill the blank</td>
<td></td>
<td>6</td>
<td>67.5</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>FG4</td>
<td></td>
<td></td>
<td>7</td>
<td>79.9</td>
<td>31</td>
</tr>
<tr>
<td>Face-to-face</td>
<td>TG</td>
<td>Multiple choice</td>
<td>Individual</td>
<td>6</td>
<td>70.0</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>TI</td>
<td></td>
<td></td>
<td>24</td>
<td>47.9</td>
<td>70</td>
</tr>
<tr>
<td>On-line</td>
<td>OI1</td>
<td>Multiple choice</td>
<td></td>
<td>15</td>
<td>52.7</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>OI2</td>
<td></td>
<td></td>
<td>17</td>
<td>48.1</td>
<td>75</td>
</tr>
</tbody>
</table>

2. Self-Direct Learning readiness

There were initially 29 students enrolled in this course, six students drop-off during the semester. Based on the 5-point scale MSDLRS questionnaires responded at first
week, the average points of these drop-off students are higher than those of completed students in all six categories (Table 6). While the difference of average points in "Independent Learning" between two groups of students is less than one tenth, the biggest difference in six categories comes from the most important category, i.e. "Effective Learning". At final week, 17 completed students answered the category questions of "Effective Learning". Even though three students gained lower points comparing to that of first week, eight students improved more than one point and four of these improving students increased their points more than two. This result confirmed that integration of flipped learning and project-based learning in this undergraduate engineering course had positive effect on self-directed learning readiness for most students.

Table 6 Student responses from MSDLRS questionnaire at first week.

<table>
<thead>
<tr>
<th>Category</th>
<th>Completed Students (23)</th>
<th>Drop-off Students (6)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Learning</td>
<td>2.59</td>
<td>3.27</td>
<td>-0.68</td>
</tr>
<tr>
<td>Enthusiastic Learning</td>
<td>2.04</td>
<td>2.43</td>
<td>-0.39</td>
</tr>
<tr>
<td>Learning Motivation</td>
<td>2.39</td>
<td>2.74</td>
<td>-0.35</td>
</tr>
<tr>
<td>Active Learning</td>
<td>2.43</td>
<td>2.70</td>
<td>-0.27</td>
</tr>
<tr>
<td>Independent Learning</td>
<td>3.26</td>
<td>3.33</td>
<td>-0.07</td>
</tr>
<tr>
<td>Annotative Learning</td>
<td>2.44</td>
<td>2.87</td>
<td>-0.43</td>
</tr>
</tbody>
</table>

3. Learning preference

A self-developed questionnaire for defining preference on the course design was distributed to students at final week, seen as Table 7. The distribution of average preparing time per week is close to those of weekly surveys in the Table 4. Almost all the preference or acceptance questions received more than 77% positive response (including positive and very positive), except the preference on group presentation which also had 54% positive response. For project-based learning, even more than two third of the students did not have any similar experience, about 85% students supported the conclusion that executing project does help on understanding course content. While over 73% students gave positive answers on most questions, only 60% of students liked project-based learning and recommended it for next year. Besides, there were three open questions in that questionnaire. On flipped classroom, most students expressed positive attitude, however some suggested that awareness of auto-learning should be emphasized before the course. On project-based learning, all students expressed positive attitude and some suggested that it should be applied to other courses. On overall experience, most students enjoyed this course, however, there were three students against on the design of grouping for its unfairness.
Table 7 Students' preference on flipped learning and project-based learning.

<table>
<thead>
<tr>
<th>Flipped Learning</th>
<th>None</th>
<th>&lt; 0.5</th>
<th>0.5−1</th>
<th>1−2</th>
<th>&gt; 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time of preparation before class (hour/week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale</td>
<td>Very negative</td>
<td>Negative</td>
<td>Neutral</td>
<td>Positive</td>
<td>Very positive</td>
</tr>
<tr>
<td>Group Presentation Preference</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Acceptance</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Preference on group quiz</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Acceptance on peer assessment</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Preference on flipped learning</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Effectiveness appraisal</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project-based Learning</th>
<th>None</th>
<th>Once</th>
<th>Twice</th>
<th>Once / semester</th>
<th>Twice / semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience of similar learning approach</td>
<td>18</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Scale</td>
<td>Very negative</td>
<td>Negative</td>
<td>Neutral</td>
<td>Positive</td>
<td>Very positive</td>
</tr>
<tr>
<td>Executing project does help on understanding course content.</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>The discussion agendas can guide the project.</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Group discussion helps you to finish the project.</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Preference of this method</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Effectiveness appraisal</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Recommendation for next year</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

Conclusions

After integrating on flipped learning and project-based learning into this course, more than 53% of the students expressed positive response on this design. About 43% of the students increased their Modified Self-Directed Learning Readiness score more than 1. Difference on student’s learning performance came from how many students answered the questions, not because the type of test or course design.
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Tsay, M., G. Morgan, & D. Quick (2000). *Predicting students' ratings of the importance of strategies to facilitate self-directed distance learning in Taiwan*, Distance Education, 21(1), 49-65.
**IDC Learning: Artificial Neural Networks … and our LMS gets “intelligent”!**

Gaetano Bruno Ronsivalle, Università degli Studi di Verona, Italy  
Simona Carta, WeMole s.r.l., Italy  
Vanessa Metus, WeMole s.r.l., Italy  
Marisa Orlando, WeMole s.r.l., Italy

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**Abstract**

The wide spread of online courses, both in academic and business field, helps reducing the costs of training, but has negative effects. The indiscriminate and redundant delivery of digital contents and questionnaires, together with standardized rigid tutoring actions often implies a deterioration of the quality of the courses and a growing disaffection of students towards e-learning. 

**IDC Learning** shows that the integration of Artificial Intelligence can mitigate the sense of "artificiality" and automatism characterizing the standard procedures of an LMS. **IDC Learning** is an innovative software module capable of directly “talking” to Moodle, the Open Source LMS. Its main objective consists in taking control of Moodle core functions in order to make its e-learning courses management methods more “intelligent”. **IDC Learning** is entirely based on Artificial Neural Networks - Multi-Layer Perceptron and Kohonen Maps – that were trained through supervised and unsupervised learning algorithms in order to: (a) identify the different students’ profiles and real-time adapt evaluation tests; (b) set up customized learning paths; and (c) guide the teaching staff to specific and sustainable tutoring actions. The module consists of three logic function blocks: (1) **I-Assessment** allows classifying the participants through assessment and measurement tools of observable indicators; (2) **D-Pathmaker** customizes content delivery depending on **I-Assessment** outputs; and (3) **C-Coaching** supports the tutoring activities and suggests possible corrective actions according to the students’ performances.

The first results of the experiments with **IDC Learning** in the field of adult education highlight an increase of the effectiveness level and perceived quality by students.

**Keywords:** Artificial Neural Networks, LMS, evaluation, customized path, tutoring, quality, e-learning
1. Introduction: some clichés on e-learning

In recent years, many education experts, business leaders, union organizers and academics have held forth and predicted e-learning imminent end. They say that this method of content delivery and training does not guarantee an effective learning, does not promote the acquisition of complex skills and alters the actual meaning of "training" in any context.

Some e-learning detractors also claim that studying on digital contents in a digital context, like an LMS, causes a sort of technological alienation and coercive solipsism. Online the student loses contact with the social dimension of education, usually attributed to the experience that he/she can live during a “classic” face-to-face lesson. Here, in a real classroom, each student comes into physical contact with other students, teachers and tutors. This physical interaction is presumed to foster learning and make the experience more meaningful, differently from the experience of an e-learning course that is considered something more similar to a boring and obvious video game.

Moreover, many e-learning critics believe that companies and public organizations mainly and only use this form of learning for economic reasons. They say that e-learning is the cheapest solution to organize training programmes and refresher courses, especially when the target is composed of large number of students. Therefore, e-learning is not an adequate methodological solution to train people, but only an easy way out to convey and share much information with many people at the same time, with little money.

Finally, many e-learning opponents say that the structure of an online course is too much rigid, because it comes from a simple and structured design activity that is not suited to the different students’ profiles. An LMS learning environment is “cold”, standardized, characterized by banal and linear automatic activities. According to them, e-learning causes a redundant, muddled and “noisy” learning process. In other words, an e-learning course is not “intelligent” and cannot create a learning experience that answers the learners’ specific and individual needs, that is able to value their differences and effectively support them in case of difficulty. This lack of "intelligence" makes e-learning an artificial, almost inhuman and dehumanizing tool.

2. LMS Platforms: these cold, artificial and inhuman deserts

Are these criticisms only clichés? Or are they really based on rigorous issues and solid foundations?

Maybe they are banal clichés, caused by a lack of awareness of the potential of e-learning, a certain amount of digital illiteracy and a strong aversion to change. But like all clichés, these statements contain something true.

First. It is undeniable that many e-learning courses do not care about any individual difference, but deliver the same contents and learning resources to all students, indiscriminately. This often depends (a) on the lack of initial assessment tools that are capable to profile students in an analytical way, (b) on the absence of criteria and rules to create customized training programmes, and (c) on instructional design
methods that follow linear, sequential and standardized patterns. Moreover, it also depends on an underdeveloped use of assessment tools.

Second. We must admit that in an LMS the automatic tools and procedures of online tutoring to support educational activities become less and less effective as the number of users increases. Tutoring actions often turn into alert or communication systems that are too simple, schematic (e.g. automatic reminders for a learning object launch, students’ delay in accessing the platform or completing activities), and irrelevant from a methodological point of view. This linear automatism is even more evident in blended learning courses with activities that require online interactions with other human beings (e.g. virtual classroom, chat, social environments, etc.). In these cases, the difference between the phases managed by human teachers and those entirely managed by computer systems is huge: after attending a virtual classroom with a "human" teacher, the student feels a cold inhumanity and a sad loneliness among the LMS buttons and screens.

Finally, in many e-learning courses, the student immediately understands that behind LMS glittering graphic interfaces, Flash or HTML5 animations, links and three-dimensional buttons, solitary forums, colorful online questionnaires, standardized final reports with his/her name, there is only and exclusively a machine. A stupid machine, without any kind of intelligence, unable to understand the importance of a learning experience. Therefore, the student understands to be inside an artificial container that is so far from his/her sensitivity and human emotions.

All these things produce a decline in the quality of the learning experience. In some cases, they undermine the effectiveness of online courses, do not guarantee a meaningful learning, and cause the students’ widespread disaffection towards training. In sum, all these things involuntarily feed all the clichés against e-learning.

3. Our idea of LMS

*IDC Learning* (Intelligent Dynamic Customized Learning) shows that the integration of Artificial Intelligence (AI) can mitigate this sense of "artificiality" and automatism characterizing LMS standard procedures. *IDC Learning* is an innovative software module capable of directly “talking” to Moodle, the Open Source LMS. Its main objective consists in taking control of Moodle core functions in order to make its e-learning courses management methods more “intelligent”.

Its innovative features guarantee positive results in terms of effectiveness, efficiency and perceived quality.

*IDC Learning* can completely customize the initial test according to the student’s specific features and his/her level of knowledge. In fact, as far as the student answers the questions, *IDC Learning* collects information on his/her knowledge system and, based on the picture that it starts to configure, decides how to go on. It can stop the test without administering any more questions than necessary, if the information is enough to depict a complete picture of the student’s knowledge or it can choose to gather some more information on other important areas of content, always identifying the right question at the right time. In both cases, *IDC Learning* aims at collecting the
best information to effectively and real time photograph the student’s knowledge system, by a limited and reduced number of questions.

This representation is nonlinear, reticular and complex, like in real life. By such a sophisticated picture, *IDC Learning* is capable to identify the student’s actual gaps and then choose the best learning resources in order to create the most suitable and effective training path for him/her, like a human teacher or tutor would do. The creation of this training path happens in real time, thanks to the integration of computational tools borrowed from Artificial Intelligence.

Through these “intelligent” algorithms, *IDC Learning* can immediately grasp all the interconnections among the different knowledge systems and then can easily represent their complexity. Its capacity of effectively representing and managing complex systems guarantees an interesting increase in the level of transparency, methodological coherence and empirical adequacy of the results in all the different measurement phases. Something very distant from a cold and mechanical linear logic.

Hence, these main features guarantee the effectiveness of the entire training process, but also its efficiency. In effect, *IDC Learning* succeeds in photographing the student’s knowledge/competence system by using a limited and reduced number of questions. This capacity positively affects the test duration, in particular with tests with large number of questions on widespread areas of knowledge and competence. Thanks to the use of AI, this information is gathered and used in order to let the network system learn endlessly. In fact, after the initial effort needed to design the networks, the system continues to live on his own, and to “grow” thanks to the collected data. Moreover, by simulating a human evaluator (in the phase of initial measurement) and a human tutor (in the phase of training programmes delivery), it succeeds in reducing human interventions, but at the same time always guarantees a high level of quality, even with large number of students.

Last, but not least, the students perceive *IDC Learning* as an “intelligent” presence that can help them identify what gaps in knowledge or competence they have, and which is the best, most rapid and effective way to fill them. Once in this system, the student can really “feel” the presence of *IDC Learning* and understand that it does not limit its investigation to a mere serial collection of single observations, but considers the relational structure of his/her answers, like a teacher or tutor would do in real life. This capacity makes the system different from the other ones on the market (based on linear structures that underestimate the complexity of the student knowledge and competence system) and increase the student’s confidence in it. Its capacity to create customized learning programmes and guarantee customized support during the delivery complete the positive framework.

4. Artificial Neural Networks … and our LMS gets “intelligent”!

What is the secret that allows our LMS to get “intelligent”?

*IDC Learning* is entirely based on Artificial Neural Networks (ANN) - Multi-Layer Perceptron (MLP) and Kohonen Maps – trained through supervised and unsupervised learning algorithms.
An ANN is a hardware and/or software system for information processing that reproduces some functions of the biological neural networks. It consists of “nodes” or “artificial neurons” of input and output, i.e. the calculation units for signal transmission, interconnected through weights.

A Multilayer Perceptron (MLP) is the composition of two or more basic artificial networks. In addition to a layer of input neurons and a layer of output neurons, an MLP has one or more layers of hidden neurons, too. In this network, each neuron of each layer is connected to all the neurons of the following layer. In general, the value of the output neurons depends on the values of input, the values of the synaptic weights, and the kind of activation function used. These mathematical models can be used to solve complex problems because they enjoy the fundamental property of “learning”. An ANN “learns” the underlying mechanisms of a phenomenon from the empirical data relating to its history. In fact, the training of an ANN is based on specific algorithms that imitate the research activity by trial and error through the introduction of a large number of examples and desired outputs describing the behavior of the phenomenon under consideration. Thanks to this “supervised learning” characterized by the gradual adjustment of the weights of the synaptic connections, we can reach the so-called “convergence”, that allows the ANN to produce output values close to the desired ones. This kind of network can be considered like a “black box” that can generate complexity.

Kohonen maps (also called SOM, Self-Organizing Maps) are artificial neural networks trained by unsupervised learning that simulate some of the functions of the cerebral cortex in processing and clustering visual information. They are mathematical models than can be implemented in software applications and are able to classify large amounts of data through an adaptive transformation and compression of multidimensional input signals. Through Kohonen maps we can capture the
structural logic and any inherent property of the entry patterns, without using any predefined criteria (expected output), and project the results of this processing onto an ideal screen represented by a topological map with 1, 2, 3, or $n$ dimensions. We can train these neural networks through competitive algorithms: output neurons are “winners” (active) in function of the smallest Euclidean distance from each input pattern. This progressively produces a restructuring (auto-reorganization) of the synaptic weights through an optimal segmentation of the data structure into a specific amount of activation “bubbles” or clusters.

Figure 2. A Kohonen Map

5. **IDC Learning logical and functional architecture**

*IDC Learning* module consists of three functional blocks: (1) *I-Assessment*, (2) *D-Pathmaker*, and (3) *C-Coaching*.

Figure 3. *IDC Learning* Module
5.1. I-Assessment

(1) I-Assessment allows to classify the participants through assessment and measurement tools of observable indicators. In order to simulate a human evaluator, it needs to “know” (and then have a representation of) the topic to be tested and to adapt the questionnaire to the student’s performance. According to this representation, and to the student’s answer, it can reach a complete description of his/her knowledge, without administering all the questions, but choosing how and if to go on with the test. Then, it needs a copy, a complete and detailed picture of the knowledge system, represented by an orbital map that clearly identifies the different topics and subtopics to be tested. In this orbital map, each topic and subtopic is related to learning objectives that are identified and described in terms of observable indicators and complexity levels. According to these two features, the best and most effective assessment tools to check student’s knowledge, together with the different learning resources needed to reach the learning objectives, are selected, designed and organized in structured clusters.

Figure 4. An example of “Orbital Map”
Now, this system needs a brain. This brain consists in an MLP that makes the test engine intelligent and effectively simulates a human evaluator. It starts with a random question, and then, according to the student’s answer, decides how to go on. As far as the items are administered, the MLP collects information on the student’s level of knowledge.

From the collected data, I-Assessment can gather two important kinds of information: 1) a clear picture of the entire orbital map of the student’s knowledge and competences (processed by the MLP), and 2) the identification of the student’s profile.

The analysis of the user’s features and the assignment of a specific profile is based on the functions of cluster analysis of a Kohonen neural map. The topology of the profiles results from a process of unsupervised learning of the Kohonen map through the input of patterns included in an archive of previously profiled users. In the database made by the system for the neural network learning, each user is associated with a record whose fields correspond to the descriptive variables of each single user: age, gender, level of education, professional qualifications, role, digital skills, and detailed picture of the skills related to the topic of the course. Thanks to this phase of learning from real data, the Kohonen map processes the different records of the database, self-organizes through sophisticated learning algorithms (that is why this kind of map is also known as a SOM, i.e. Self-organizing Map) and, finally, defines a set of clusters corresponding to specific users’ profiles. The cluster analysis activity allows to compress the amount of attributes of the vector that describes each user, by identifying sub-symbolic and geometric reticular correlations among the different variables.

Certainly, the module manager can restart the map learning process whenever he/she considers it appropriate. Alternatively, he/she can decide to let the network continue learning from empirical data, and guarantee the highest level of system flexibility and adaptability.

Thanks to learning, the group of functions managed by the Kohonen map in I-Assessment allows the system to "recognize" new users and to classify them according to the (static) descriptive variables and the results of the intelligent assessment. This profiling is crucial for the activities managed by the other two IDC Learning sub-modules and effectively simulates the complex activities managed by any teacher in order to check the students’ initial knowledge and individual peculiarities. In this way, it succeeds in guiding the following learning activities in an “intelligent” way.
5.2. **D-Pathmaker**

(2) *D-Pathmaker* customizes content delivery depending on *I-Assessment* outputs. The reticular description made through the orbital map allows to manage contents, objectives, items and learning resources in such an effective way that also the content delivery is highly customized according to the student’s performance in the initial evaluation phase. After finishing the test, *D-Pathmaker* receives a detailed picture of the student from *I-Assessment* and check his/her gaps. According to this picture, thanks to the specular correspondence of the items with the learning objectives, it succeeds in setting up customized learning paths that help the student to reach the learning objectives where he/she demonstrated gaps.

The information related to the user's profile - generated by the Kohonen map in *I-Assessment* – allows to calibrate and configure the learning path for each participant in a very detailed way. *D-Pathmaker* integrates the results of the initial assessment on contents with the additional data about the student’s features expressed through the initial cluster analysis.

Moreover, the profiling process of each learner can also go on and be constantly updated according to the evolution of his/her performance during the course, in training or online evaluation activities. In this way, the system can simulate the tasks of a “human” teacher in an "intelligent" way and can continually monitor the student’s activities (e.g. participation in training activities, level of interaction during the lessons, results on exercises, etc.) in order to better calibrate his/her teaching strategies in a flexible and adaptive way.
5.3. **C-Coaching**

(3) **C-Coaching** supports the tutoring activities and suggests possible corrective actions according to the students’ performances. In other words, it guides the teaching staff to specific and sustainable tutoring actions. How does it work?

First of all, this block extracts students’ data coming from the core functions of LMS tracking: it connects itself to a database containing information on the course and extracts the meaningful values for the tutoring activities (e.g. fruition percentages, connection times, results of assessment, etc). The system administrator can define the connections agenda (in relation to the various steps of the course), as well as the rhythms of data upgrading and connection to the database (e.g. daily, every 48h, once a week, etc.).

Secondly, it elaborates these data together with those coming from **I-Assessment** and **D-Pathmaker** through an ANN that elaborates an estimate of the non-effectiveness risk in relation to the whole population and to each single student profile. The module can be trained and continuously upgraded through insertion of new data or direct intervention of human experts.

At the end, **C-Coaching** compares the output of the ANN with control variables and, if there are non-coherent values (e.g. high probability of non-effectiveness risk), it produces or suggests a series of activities to the various actors involved in the training process. E.g. it manages alerts to remember students to participate to a specific activity (especially, when low percentage of presences has been recorded); it sends assessment results to didactic administrators or online tutors, with suggestions on possible actions; it defines customized supporting activities for students based on their fruition data and test results. The module has also a function to plan the threshold values for the control of the course (that correspond to the output variables of the ANN); a function to define tutoring actions and the conditions to activate their interventions (e.g. passing a critical threshold, alignment of two or more critical situations, etc.); a report on the evolution of the course and on the monitoring of
activities of *C-Coaching*: a database for the historical filing of data elaborated by the ANN.

Thanks to this structure, *C-Coaching* succeeds in guaranteeing a customized support to each student and helps him/her reaching the learning objectives in a very effective way.

![C-Coaching Diagram](image)

**Figure 7. C-Coaching**

6. **E-learning and Artificial Intelligence: the new alliance for online meaningful learning**

In the era of *Matrix, Avatar, Tron, 2001: A Space Odyssey, Minority Report* and *The Hitchhiker's Guide to the Galaxy*, information technology is often seen as a big shapeless mess. A shapeless mess that many organizations have chosen for the design and delivery of artificial learning courses in order to save money and reach the largest number of students, in every place and without any time limits.

However, few people have actually understood and understand the revolutionary potentiality of this tool that can turn a machine into a powerful ally of the human being for information and content processing during the acquisition of new knowledge, skills and competences. A revolutionary potentiality that is dimmed by a rigid, artificial and inhuman use of information technology through learning environments, like LMS, that are not effective, not usable, cold and “indifferent” to the specific students’ needs. For years e-learning has been the most exemplar product of this shapeless mess. Therefore, it has produced criticisms, hostilities and clichés that threatened its effectiveness and full inclusion among educators’, methodologists’, and academics’ effective “tools”.

Nevertheless, technology cannot and should not be a deterrent for the human being. Information Technology is the "intelligent" product of the creative and original application of our scientific knowledge and of a specific computer system for the resolution of problems that usually affect information management made by people. In the case of LMS and e-learning courses, computer technology can be a signal amplifier of the educational activity, but only if it is provided with that minimum of
"intelligence" that makes it a “human” tool for people. This is the meaning of our proposal. That is why we decided to introduce Artificial Neural Networks in a linear platform as Moodle. Our goal is to give an intelligent shape to a series of functions, procedures, instructions, rules, teaching patterns, and interaction tools in order to foster learning and reconfigure an artificial tool into a "human" shape.

This has been possible - and it will continue to be thanks to this research branch - thanks to the implementation of algorithms that can simulate the activities of an intelligent teaching staff: rigorous analysis and analytical review of students’ initial knowledge, configuration of customized learning paths, improvement of education through experience and error analysis, and rational support of study programmes.

In this sense, IDC Learning various fragments have been already tested in different contexts (academic, business, military, professional, etc.), with positive results both in terms of effectiveness and perceived quality by students. In these testing activities, we verified a higher degree of involvement and motivation of the participants, who perceived a clear change of direction. Many learners have emphasized the sense of this passage from the artificial and inhuman dimension of the online environment into an "intelligent" educational experience, characterized by adequate decisions, flexible programmes, adaptive assessment, and effective tutoring models. Moreover, they understood that an online course can be something different from a boring and banal video game.

That is why we believe that, against the clichés on e-learning, one possible solution is the integration of artificial intelligence. In order to guarantee a greater attention to the humanistic dimension of the learning experience and, finally, to foster a meaningful and unforgettable learning that is open to all the people who want to learn.
References


Developing a Game-Based Proprioception Reconstruction System for Patients with Ankle Sprain

Yu-Cheng Lin, Chung Shan Medical University, Taiwan
Tzu-Fang Sheu, Providence University, Taiwan
Hsiao Ping Lee, Chung Shan Medical University, Taiwan
Huai-Yung Teng, Chung Shan Medical University, Taiwan
De-Chen Chiu, Chung Shan Medical University, Taiwan

Abstract
Research results have revealed that ankle sprain is the top one cause for sport injury, indicating the relatively high demand of rehabilitation programme due to ankle sprain. For patients with ankle sprain, apart from providing treatment for joint and muscle tone, in order to maintain body balance and stability, proprioception reconstruction should also be considered to be one of the treatment required. Proprioception is defined as receptors which is located at areas like muscles, tendons and joint, that upon external stimulants, providing the body with sensory action and location. Proprioception reconstruction allows defeated sensory receptors to regain its sensory action and location, balance and stability through means of rehabilitative exercises. Conventional rehabilitation is done by monotonous, repetitive exercises, which generally lower patients' long term treatment compliance. In this study, we will be formulating a proprioception reconstruction system that is suitable for patients with ankle sprain. Kinect device and Unity 3D game engine are used in this system, incorporating entertainment into proprioception reconstruction requirements. It is expected that Kinect device provide communication between patients and machinery without the need of weaving and sensory device, which alleviate patients' physical burden. Non-conventional rehabilitation model not only provides a break through from the daunting exercises, but also enhances ankle-sprained patients' compliance and adherence to therapy. While catering treatment through entertainment, it also keeps the record of patients' activities as data base for further rehabilitation evaluation.

Keywords: ankle sprain, Kinect device, Unity 3D game engine, proprioception reconstruction
INTRODUCTION

In general, after patients experienced treatment of acute phase, they can normally walk and take the load without feeling pain. Then, they enter the phase of active rehabilitation. In this phase, we put emphasis on the recovery of joint activity, muscle tone and flexibility, especially proprioception[1] training, in order to maintain body balance and stability.

Proprioception training concentrate on balance. In addition to using the complete rehabilitation equipment, patients can train by himself with standing on one foot to achieve the goal of balance training. Like any other rehabilitation, maintaining the same position for a long time is such boring. Therefore, patients are hard to keep interest and lack of sustained treatment motivation and then give up treating and affect the rehabilitation effect. In view of this, we aim on satisfying the demand of footproprioception, develop rehabilitation aids to overcome the difficulty of proprioception rehabilitation.

In this study, Microsoft Kinect[2] is the main interactive media, detecting user's body movement and constructing natural and instant human-computer interaction mode. Kinect[3] equipped with three lenses, including color image camera, infrared emitters and CMOS infrared camera. The infrared grating received by CMOS camera consists a good 3D depth-sensing system.

In this study, we will develop a proprioception reconstruction system that is suitable for patients with ankle sprain. Its operation is quite intuitive and simple. The system triggers photographic system on Kinect device when it starts. The camera captures user’s skeleton information and in-depth information, analysis whether or not their body movement sin three-dimensional space correspond with rehabilitation movements by means of action algorithm. It records the data of rehabilitation process and evaluates them. Then, it provides instant feedback for the users as a basic of improvement. Finally, collect and organize the specific information needed into a report, which allows therapists to set up following treatment programs.

EXPERIMENT

The developing environment of system is constructed on the PC. Two main works are writing a program and simulating it. In terms of writing a program, we adopt C# as the main programming language and use built-in MonoDevelop [4] of Unity 3D to integrate development environment and standardize the library. On the other hand, it matches with the OpenNI[5] library that is for free to drive the associated functions and develop interface. In program simulating, development environment of the built-in MonoDevelop provides not only a complete compilation environment, but also a very perfect simulation tool that the program can be simulated directly on the PC without extra software.

The system can be divided into four main modules. Driving and controlling the Kinect device, capturing and analyzing the motion, effectiveness evaluation, and data integration. Their relationships are shown in Figure 1. First, the core program of the system uses Sensor Kinect class in OpenNI. The relevant function directly drives the imaging device equipped in Kinect and use User Generator, Depth Generator class. It
Catches user’s deep information and information from the skeleton images. Second, put emphasis on the "foot joints", do a comprehensive analysis on user’s skeleton information and deep information. Find out the user’s location in 3D space, the direction and the motion trail of foot movement. General speaking, we can detect the speed, the included angle and the angle of rotation of skeleton joint to calculate its move mode and time consumption in 3D space. Then, we compare them with the movement in system to determine whether or not that fits the need of proprioception rebuild. During the process, we should record the relative data including the times of moving, swing angle, movement accuracy, and the time required for evaluation of rehabilitation results.

Figure 1: System Architecture

FEATURES OF THE GAME

- Operating system is simple, and users can operate independently without the assistance of others.
- During system operation without the need of weaving and sensory device, operating with body movements is fairly intuitive and simple.
- With precise detection, identification and analysis capabilities, can effectively judge the correctness of the action.
- Without a dedicated training space and rehabilitation props, can be set up in most of the grounds, at any time rehabilitation.
- Equipment is simple, low cost, just PC and Kinect body sensor that is able to set up the system.
- Unlike traditional rehabilitation model, to achieve the effect of human-computer interaction through somato sensory device.
- Has specifically designed for patients with ankle sprain story scenes and rehabilitation actions into one, through the game progresses, while achieving entertainment and therapeutic function.
Complete evaluation mechanism, can be the results immediate feedback on the screen, providing users improved as a reference.

CONCLUSION

The results show that in the past, the highest ankle sprain injury in the first place, because of relatively high mean ankle sprain rehabilitation needs demand, however, tedious rehabilitation process often leads to the wishes of the patient receiving treatment to reduce, thus unable to achieve good rehabilitation results, the proportion of the affected area again wounded up to 80%, therefore, by the development of this system to effectively improve the patient's willingness to accept treatment, with considerable clinical significance and necessity.

Our system interface is in Figure 2. There are four buttons in the start screen, including "Start", "Instruction", "Introduction", and "Exit". When you meet enemy, the character stops moving, weaving right hand to attack, and weaving left hand to defense. These two movements could help patients fully engaged in the game, and gain body mobility. When you encounter a large amount of enemies, perform a single-knee raise to wipe out them. This process is called proprioception reconstruction. The instruction screen shows the introduction. The introduction screen shows control of the game.

Figure 2: System Interface
REFERENCES


Contact email: a0919807547@gmail.com
Instructional support for improving students’ planning skills to solve Physics problems

Andrew Bimba, University of Malaya, Malaysia
Siti Soraya Abdul Rahman, University of Malaya, Malaysia
Rukaini Abdullah, University of Malaya, Malaysia

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Abstract
Deep analysis on students’ cognition (i.e. mental representation in solving physics problem) is crucial to develop tool to support learning. In this paper, we describe a study of how students plan and solve physics introductory mechanics problems. In the study, students were given several physics problems to solve, with varying level of difficulties. For each problem given, students were asked (1) to identify eight categories of information related to the problem (i.e., known / unknown variables, principle, units, just to name a few), (2) to write out (plan) their solution steps, and finally (3) to solve the problem. Findings from the study showed that students’ problem solving process indicates that they have partial schema formation. These findings corroborate with the existing theory and claim of students’ fragile knowledge, mental representation, and partial schema development. Finally, the computer-based instructional support is discussed based on these findings.

Keywords: Physics problems, Problem solving, Cognition, Mental representations, Schema, Learning Tool
1.0 Introduction

The human mind is seen as a system that processes information through the use of rules and strategies just like a computer (Thomas, 2011). These information processing theories focus on how individuals perceive events, encode information perceived and relate it to existing knowledge in memory. The theories also focus on how new information is stored in memory and retrieved when required. To store and to retrieve information is fundamental to all aspects of cognition. For instance the cognitive processes such as thinking and problem solving rely heavily on the use of previous experience. Nearly everything we do is subject to our capability to recall the past (Groome, 2005). As we perform various activities, we develop structures in our minds to interpret experiences. These structures are developed to allow an easy and efficient access to knowledge when required.

The primary goal of educating physics students is to enable them attain expert competency. But, prior works have identified that physics lessons often do not help students gain the knowledge and skills needed in physics problem solving (McDermott, 2001; Henderson, 2005). It has also been discovered that experts within their domain, have a better structured knowledge, apply a more goal oriented strategy during problem solving and are more metacognitive than novices (Chi et al., 1981; Snyder, 2000; Docktor et al., 2012; Zimmerman, 2006). Taasoobshirazi & Farley (2013) identified the variables that contribute to expertise in physics problem solving and what differentiates experts from novice. These variables include, the problem strategy used; the way problem was categorized; metacognitive strategy (pictorial problem representation) used.

Most research, focused on the individual variables that lead to expertise in physics problem solving (Larkin et al., 1980; Chi et al., 1981; Kohl and Finkelstein, 2008; Docktor et al., 2012). We therefore, focused on the relationship between these variables and how they affect the problem solution. These will help physics instructors to focus on the important variables affecting problem solving success while teaching. Previous works in physics problem solving are reviewed in the next section. The model of physics problem solving adopted is described in Section 3.

2.0 Background: Physics Problem Solving

Problem solving is seen as one of the most significant types of cognitive processing that occurs frequently during learning. Several theorists have considered problem solving to be the main process in learning, mainly in domains such as science and mathematics (Anderson, 1993). A problem could be in several forms such as to locate an object, calculate a solution, answer a question, secure a job etc. The effort taken by an individual to attain a goal, for which the solution is not obvious, is referred to as problem solving. Problems have certain similarities, irrespective of the domain area and complexity. Every problem has an initial state (i.e. the current knowledge of the problem solver) and a goal (i.e. what the problem solver attempts to attain). Often problems require the solver to breakdown the main goal to sub-goals. These sub-goals when effectively mastered results to attaining the major goal. Problem solving requires performing some cognitive activities on the initial state and sub-goals in order to achieve the final goal (Schunk, 2012). Physics is generally regarded as a difficult subject. Existing literature has shown some major differences between
experts and novices in terms of physics problem solving. These differences are in their problem solving approach (Larkin et al., 1980), mental representation (Chi et al., 1981) and external representation (Kohl and Finkelstein, 2008). In the next section we will discuss more on the differences between the expert and novice problem solver.

2.1 Novice and Expert Problem Solvers

In an experiment, to solve introductory calculus based physics text problems, Larkin et al. (1980) observed the approach taken by experts and novices. They discovered that the experts use a working-forward approach, which was directed by a good analysis and precise physics representations. The experts achieved this based on their vast experience and structured knowledge of physics principles (Maloney, 2011). Alternatively, the novices used a heuristic approach, because they lacked the required experience and knowledge.

Chi et al. (1981) highlighted the fact that the major difference between a “Novice” and an “Expert” in solving physics problems is in how the problem is represented in memory. Various experiments have shown that “Novice” categorizes physics problems based on the surface content encountered only, while the “Expert” considers not only the surface content but also the underlying principles and concepts (Chi et al., 1981; Hardiman et al., 1989; Blessing et al., 1996; Snyder, 2000; Docktor et al., 2012). Investigations on physics problem representation has proven that “Expert” problem solvers who are able to categorize problems based on principles and concepts are better problem solvers than “Novice” who depend on surface features. The problem solver uses this representation in solving the problem. This makes it a very important process in problem solving. Problem solvers can make good progress if they construct an effective representation (Chu & MacGregor, 2011).

Kohl and Finkelstein (2008) observed that, both novices and experts use external representation when handling physics problems involving, diagrams, graphs and verbal descriptions. However, the two groups differ in how they utilize the external representation. The experts and some intelligent novices spend time making sense of the problem from their free-body diagrams. While it was observed that the novices draw the free-body diagrams based on obligation. In the next section, we discuss on a physics problem solving model.

2.2 Model of Physics Problem Solving

In our current study, we analysed three main physics problem solving components, namely categorization skills, use of strategy, and free-body diagrams. This is similar to the structural equation modelling used by Taasoobshirazi & Carr (2009). Our goal is to determine how these key components affect students’ success in solving physics problems. The scoring for the various components identified is explained as follows:

- **Use of Strategy** - The student’s strategies were evaluated based on either working-forward or working-backward. Typically students start by writing equations that involve the given or desired quantities in the problem statement and then work backwards. While a proficient solver think of the appropriate physics concept and devise a plan, which leads to working forward from the given information to the desired solution. For example considering a problem
for which the goal is to find the final velocity of a block when it reaches the end of an inclined plane. An expert will approach the problem by first noting the motion of the block along the slope considering frictional force and gravity. That will lead to the equation \( F = ma \) (force = mass x acceleration). That equation in turn leads to an equation relating the final velocity, which is the goal. But novices begin by focusing on the goal of finding the final velocity. Students received zero points for using the working-backward strategy and one point for using the working-forward strategy.

- **Free-Body Diagram** - The quality of student’s free-body diagrams was also scored. This was done by comparing the diagrams to a defined sketch for each problem. The defined sketches had all the factors which represent a complete diagram. For example a complete sketch for the first problem included the weight of the object, the spring or spring constant and the extension of the spring for a single spring and two similar springs in parallel. While in the second problem, a complete sketch included the force acting on a trolley and its velocity. Students received one point for each main factor pictorially represented.

- **Categorization Skills** - Students ability to identify the relevant features within the problem such as known, unknown, objects, problem domain, principle and any related concept, was graded. One mark was awarded to any correct data identified within the problem. Note that the definition of categorization skill in our study is somewhat differ from the study conducted by Taasoobshirazi & Farley (2013).

- **Problem Solution** - The students’ problem-solution was scored based on their ability to use the right equation and produce the right answer. To determine the equation score, the students’ answers were given one point if all the correct equations needed to solve the problem are provided and zero if a wrong equation is used. Similarly, for the students' were awarded one point for a correct answer when the right equation was used and zero points for incorrect answers. However, if the equation is correct and a simple calculation error occurred, full credit was still given for the problem.

3.0 A study on students’ plan and solution of Physics problems

An experiment was carried out to determine how students plan and solve physics problems. The main aim is to test the effect of the students’ categorization skills, use of strategy and quality of free-body diagrams, on their final solution. The objectives are two-fold: (1) To understand students’ mental representation during physics problem solving, (2) To propose computer-based instructional support, i.e. the Planning module.

3.1 Participants

The participants in this experiment were 37 pre-university students from Centre of Science Foundation, of the University of Malaya. The students are enrolled in the physical major and biological science major. The experiment was conducted at the
beginning of the second semester, after offering introductory courses in mechanics, measurement, optics and waves.

3.2 Procedure and materials

The students were given 8 problems from various domains in introductory mechanics together with necessary worksheets. The problems were grouped into 2 sets of 4 problems. The problems, with varying level of difficulties are explained in Table 1. The students started by attempting questions in Set 1. A break of 15 minutes was given, before they attempted the questions in Set 2. For each problem, students were instructed, (1) to identify 8 categories of information related to the problem -- known/unknown variables, principle(s), objects, units, and problem domain (2) to write out (plan) their solution steps and to draw a free-body diagram, and finally (3) to solve the problem.

Table 1: Varying level of difficulties between problems in Set 1 and Set 2

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Similarities and Differences</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Identical problems</td>
<td>A2</td>
</tr>
<tr>
<td></td>
<td>Same Unknown</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>Less identical than between A1 and A2</td>
<td>B2</td>
</tr>
<tr>
<td></td>
<td>Same principle but different equation</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Less identical than between B1 and B2</td>
<td>C2</td>
</tr>
<tr>
<td></td>
<td>Same sub-domain but different principle</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>Less identical than between C1 and C2</td>
<td>D2</td>
</tr>
<tr>
<td></td>
<td>Different domains</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Results and discussion

The analysis of the Mann-Whitney U test was conducted, which aimed at comparing differences in the scores between students who used backward strategy and students who used forward strategy. A Bonferroni adjustment to the alpha value of .05 (i.e. divided by the number of comparisons made) was used for the analysis. As an effect size measure (for non-parametric test), we used the effect size $r$, that is, values of .1 indicate small effect, .3 indicate medium effect, .5 indicate large effect (Cohen, 1988).

As previously described in Section 2.2., the variables and outcome measures are categorization scores, free-body diagram scores, and problem solution scores. Note that, the strategy scores were used as categorical variable to categorized post-hoc students into two groups, namely backward strategy group and backward strategy group.

In this paper, the analysis of results was discussed for problem B2 and C2 only. Roughly speaking, 76% to 97% of students used forward strategy to solve various problems. This is to no surprise, given that these students have completed one semester and thus have sufficient knowledge on physics mechanics prior to the experiment. Therefore, it is almost impossible to run statistical analysis to compare between the two strategy groups. Moreover, the mean for the problem solution scores for these two problems are too obvious to be considered for further analysis.
Table 2: Mean and standard deviation

<table>
<thead>
<tr>
<th></th>
<th>Backward strategy</th>
<th>Forward strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td><strong>Problem B2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Categorisation</td>
<td>21</td>
<td>5.86</td>
</tr>
<tr>
<td>Free-body diagram</td>
<td>21</td>
<td>0.62</td>
</tr>
<tr>
<td>Problem solution</td>
<td>21</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Problem C2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Categorisation</td>
<td>27</td>
<td>7.70</td>
</tr>
<tr>
<td>Free-body diagram</td>
<td>27</td>
<td>0.56</td>
</tr>
<tr>
<td>Problem solution</td>
<td>27</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Note for Table 2: Categorization score (ranging from 0 to 12, depending on the problem); free-body diagram score (a complete sketch that include factors needed for inclusive diagram, ranging from 0 to 4, depending on the problem); strategy score (0 for backward strategy, 1 for forward strategy); solution score (ranging from 0 to 4, depending on the problem).

Table 3: Mann-Whitney U test of the scores of the students who used backward strategy and the students who used forward strategy for the two problems

<table>
<thead>
<tr>
<th></th>
<th>U-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem B2</strong></td>
<td></td>
</tr>
<tr>
<td>Categorisation</td>
<td>$U = 141.50, p = .40, r = -.14$</td>
</tr>
<tr>
<td>Free-body diagram</td>
<td>$U = 150.50, p = .52, r = -.11$</td>
</tr>
<tr>
<td>Problem solution</td>
<td>$U = 50.50, p = .000, r = -.68$</td>
</tr>
<tr>
<td><strong>Problem C2</strong></td>
<td></td>
</tr>
<tr>
<td>Categorisation</td>
<td>$U = 101.50, p = .25, r = -.19$</td>
</tr>
<tr>
<td>Free-body diagram</td>
<td>$U = 105.00, p = .19, r = -.22$</td>
</tr>
<tr>
<td>Problem solution</td>
<td>$U = 2.50, p = .000, r = -.85$</td>
</tr>
</tbody>
</table>

Table 2 shows the mean and standard deviation of students’ score for the categorization skill, free-body diagram quality, and solution accuracy for problem B2 and problem C2 according to the strategy used. The forward strategy group showed higher mean for the solution scores compared to the backward strategy group. For problem B2, the mean for the solution score was 0.14 and 2.00 for the backward and forward strategy group, respectively. For problem C2, the mean for the solution score for the backward strategy group was 0.19 while the mean for the forward strategy group was 1.90. Another interesting result is that the forward strategy group also showed higher mean categorization score than the backward strategy group for both B2 and C2. However, their mean free-body diagram score was lower than the backward strategy group for both problems.
Table 3 shows the results of the Mann-Whitney U Test. The results showed no significant differences (between students who used forward strategy and students who used backward strategy) in the categorization score and free-body diagram score for both B2 and C2. Interestingly, the results of the Mann-Whitney U test revealed significant difference in the problem solution score (for B2) of those who used forward strategy and those who used backward strategy, with large effect size, \( U = 50.50, z = -4.15, p = .000, r = -.68. \) Similarly, there was a significant difference (with large effect size) in the problem solution score for C2, \( U = 2.50, z = -5.16, p = .000, r = -.85. \)

Those who used forward strategy exhibited the strategy used by experts by first thinking about the physics concepts or principles in devising their solution plan instead of immediately delving into the equation involving the givens in the problem. The use of such strategy leads to better categorization of information and solution. This study corroborates other studies that show physics experts are better problem solvers due to their deep structure knowledge compared to novices who typically rely on the surface structure of the problem. Much to our surprise, students who used forward strategy did not fully utilize external representation such as free-body to visualize the problem. This is contradicted to the study conducted by Kohl & Finkelstein (2008) who revealed that successful problem solver and expert-alike often utilize external representations when solving physics problems. Additionally, not much has been reported on the relationship between these two strategies and free-body diagrams in physics problem solving. Hence further investigation is needed.

4.0 Computer-based instructional support for planning to Physics problem

Based on the results of the analysis (as previously discussed in Section 3.3), we propose a computer-based instructional support tool. The tool focuses on a cognitive approach to learning, which deals with the mental processes involved in acquiring skills to solve physics problems. It is hoped that this tool able to help students to gradually instil a metacognitive planning (Taasoobshirazi and Farley, 2013) when solving physics problems and eventually towards working-forward strategy.

4.1 Planning module

One of the most important components of problem solving is planning. This stage involves drawing pictorial representations of the problem, identifying the correct principle and equations. Typically, during problem solving, a problem solver draws free-body diagrams to indicate the main variables and their interactions. Making these pictorial representations at the beginning helps the solver determine which approach and principles are appropriate in solving the problem. After identifying the relevant principles, the solver can determine which equation is appropriate in solving the problem. The planning module allows the solver to implement this approach seamlessly. In this module, problem solvers are also guided with similar worked examples, when they encounter difficulties.

The planning module allows a problem solver to plan and develop a solution in three steps. The first step involves drawing a free-body diagram as shown in Figure 1. This allows the solver to have a pictorial representation of the problem. With the aid of this representation, the solver finds it easier to identify the principles and equation
required to solve the problem. In the second step, the solver identifies the principle and equations required to solve the problem from drop-down tree of principles and equations as seen in Figure 2.

After selecting the appropriate principle and equations, the solver moves to the final step where the variables are substituted into the equations. The final result is then calculated as shown in Figure 3.
For example, consider the following sample question:

A workman pushes a carton of mass 50 kg up an inclined plane into a lorry. The inclined plane makes an angle of 45° with the horizontal floor and the frictional force between the inclined plane and the carton is 135 N. If the workman pushes the carton with a force of 500 N, what is the acceleration of the carton?

The solver is able to draw a pictorial representation (i.e. free-body diagram) of the problem as seen in Figure 4. With this free-body diagram, the solver is able to visualize the forces acting on the carton and the effect of the inclined plane. With this, the solver can easily identify Newton’s second law and trigonometry as the principle involved in approaching a solution. Then, the appropriate equations can be applied on the principle identified. Based on Newton’s second law, (the acceleration a of a body is parallel and directly proportional to the net force F acting on the body, is in the direction of the net force, and is inversely proportional to the mass m of the body, i.e., F = ma) the force acting on carton (its weight) is calculated using the formula “W = mg” where W is the weight of the cartoon, m is the mass of the cartoon and g is the acceleration of the body due to gravity (10 m/s). Using trigonometry, the formula based on sine rule is used to resolve the force due to the weight of the carton W sin θ. The resultant force is then calculated by resolving all the forces acting parallel to the carton (Fr = W sin θ + fr - f). Finally the acceleration of the carton is calculated using formula from Newton’s second law (a = F/m). The final output is a mental representation of the solution which comprises of the geometric representation and derived values from the solution.

Figure 3: Solution for the Planning module

Figure 4: Free-Body Diagram
5.0 Conclusion

This paper has presented a study of how students plan and solve physics introductory mechanics problems. Findings from this study corroborate existing studies, which indicate the fragility of physics knowledge and partial schema development among students. Results of this study also revealed important implications for physics teaching in a similar vein with the study of Taasoobshirazi & Farley (2013). That is to say, several important factors affecting problem solving success namely, the ability to identify relevant problem features, the quality of a free-body diagram, and the strategy use. Finally, this paper concludes with computer-based instructional support called the Planning module aimed to provide students with better planning to physics problem solving.
References


Contact email: siti_soraya@um.edu.my
General Attitude and Acceptance of Holography in Teaching Among Lecturers in Nigerian Colleges of Education

Suleiman A. Ahmad, College of Education Azare, Nigeria
Isyaku M. Abdullahi, College of Education Azare, Nigeria
Muhammad U., Abubakar Tafawa University Bauchi Nigeria

Abstract
E-learning is a byproduct of instructional design. Thus online learning designers, in their approaches are expected to be familiar with the epistemological underpinnings of several theories and their consequences on the process of instruction. In the same vein constructivism holds assumptions, that learning is an active process whereby the learner constructs knowledge base on experience. Secondly, learning occurs when there is disequilibrium. It therefore takes place in a social context. Recently, technological developments are playing an important role in improving the educational process especially the integration of holographic presentation in the area. A hologram is a three-dimensional record of the positive interference of laser light waves. Teacher training in virtual holographic classrooms could help the new teachers adapt to a real problematic classroom with such tools. Nigeria being one of the moderately growing economy and a successful and relatively stable democracy, educational development is always on the increase due to commitment of government in the area. Holography is a virgin area in the Nigerian educational mindset. Colleges of education in Nigeria are basically teacher training institutions. Teachers are the backbone of education every development. This brought about the need of this study to investigate on the perception, appreciation attitude as well as acceptance of holography in teaching among the academicians in colleges of education in the Nigerian context. This study therefore in a small sample of 100 teachers survey opinions and reported the results in a descriptive statistics as well as variance (t-test and ANOVA) with regards to gender and designation. On the scale of structural equation modeling (SEM) tool and SPSS regression analysis as well, it presents the actual model of the modified technology acceptance model TAM. The finding indicates less positive attitude and less general acceptance of the holographic system in the teaching processes by teachers in the Nigerian College of Education.

Keywords: TAM, Holography, Teaching, Colleges, Nigeria
Introduction

Hologram Technology

Holography can be referring to as a method of obtaining photographic image in three-dimensions. The word hologram is Greek, the root words are *holos*, “whole”; *gram*, “message”) and translates into ‘whole picture’. Holograms differ from ordinary photographs, because the holograms record an extremely accurate three-dimensional (3D) image of the original object. A hologram is a three-dimensional record of the positive interference of laser light waves. The structure of a synthetic hologram is made of thousands of 3D computer graphic images corresponding to as much points of view on a three-dimensional scene. These can be done without a lens, that is why is sometimes called lens less photography. Dennis Gabor in 1947 had the credit of father of holography for theorizing these principles. His write up become the foundation of modern holography. A hologram looks so realistic because it is an exact recording of the light waves reflected from the object. Holograms do not usually reproduce the true colors of the original object. The image’s color mainly depends on the color of the laser used to make the hologram and is also determined by processing methods. Multi-colored images are created by using different lasers. The most common type of laser used is helium-neon (HeNe). Even though some holograms are made from diodes from red laser pointers, they are usually unstable and less coherent. Although, holography is generally referred to as “lens-less photography,” it requires lenses. Unlike photography, holographic lenses spread out beamed light in hologram. The beam splitter is used to divide a beam of light into two (Wilson 2010).

Laser technology

Without light there will be no hologram. The light as is known scientifically is an output of the excited atoms that give off energy. The atoms themselves are the building blocks of all matter and they consist of positively charged nucleus of protons and neutrons that are orbited by a cloud of negatively charged electrons. Laser beam is a produced collection rays of light. Laser technology forms the platform for holography. Albert Einstein was the first to suggest the idea regarding the laser back in 1917. Einstein postulated that light was made up of a series of particles which he called photons and were traveling in a continuous move as wave. The technical term for “LASER” is an acronym which stands for “Light Amplification by Stimulated Emission of Radiation.” Thus, stimulated emission refers to the act of one light particle (photon) stimulating the emission of another photon. Radiation therefore is energy that travels in a wave and spreads out as it goes. In lasers, the radiation refers to that energy emitted by the laser in the form of radiating light particles or photons. Other forms of radiation include radio waves, microwaves, infrared waves, ultraviolet rays, and gamma rays.

Holograms process

In (Figure 1) below it illustrates a basic set up of how holograms work. The process involves using a laser, a beam splitter, two mirrors, two lenses and the object itself. The laser beams light into the beam splitter, which divides the light into two (Wilson, 2010).
Before the first lasers, the first holograms weren’t three-dimensional, but flat two-dimensional transparencies made from the very slightly coherent light of a sodium vapor lamp. In 1962 Emmett Leith and Juris Upatiensks, at the University of Michigan started making of three-dimensional holograms. Now hologram can be projected in a complete 360 degree holographic display (figure 2).

Sometimes back the president of the Microsoft Corporation Bill Gates appeared holographically in Kuala Lumpur to address a group of people. Prince Charles also addressed a crowd in Abu Dhabi via holography (Mail Online, 2007); (Jacob, 2008). Now a day, I have a dream one day I will holographically make my conference presentation somewhere. As a teacher, holography can impact my lesson through tool approach presentation. It can be use to easily bring teaching materials/aids for the learners to view. It can be seen now a difficult task, unrealistic, unnecessary and undesirable. None the less good catch is for the early bird. It has never been early starting from the scratch. Albert Einstein German-born U.S. physicist puts that “if an
idea is not absurd at first, then there is no hope for it.” Brighter doors are open for better hopes on holography.

**Purpose**

The purpose of this research is to put forward innovative ways in which holographic technologies can be applied in education. Thus, this work focuses on holography and its application in education. This research intends to promote further research and development in the field of holography and its application in education considering the fact that it’s a virgin area to many academics especially in Nigeria. It therefore needs to be explored.

**Objectives**

This study aims:

i. To investigate on the attitude toward holography in teaching among Nigerian colleges of education teachers

ii. To find out the extent of acceptance of holography in teaching among Nigerian colleges of education Educators

iii. To identify the gender difference among Nigerian colleges of education educators in the attitude towards holography in teaching.

iv. To identify the attitudinal difference towards holography in teaching among Nigerian colleges of education educators in terms of their designation/level.

**Hypotheses**

The research therefore addresses the following hypothesis;

1. There is no significant attitude toward holography in teaching among Nigerian colleges of education teachers
2. Nigerian colleges of education educators do not significantly accept holography in teaching
3. There is no significant gender difference in the attitude towards holography in teaching among Nigerian colleges of education teachers
4. There is no significant difference in terms of designation/level in the attitude towards holography in teaching among Nigerian colleges of education teachers

**Literature**

**How holography works**

The way holography operates is by creating the illusion of three-dimensional imagery. A light source is projected onto the surface of an object and scattered. A second light illuminates the object to create interference between both sources. Essentially, the two light sources interact with each other and cause diffraction, which appears as a 3D image.
Holography in Future in Nigeria

The theory of constructivism stresses great importance on improving open learning experience and by doing. Nonetheless, for the past two decades major progress has taken place in the field of ICT usage in learning environments. The advantages offered by ICT in education sector have led many educational institutions to integrate ICT services into their respective academic departments especially in the advanced societies and very few third world countries. These rapid developments result tremendous changes in many fields and endeavors of life education inclusive. Therefore, educational institutions quickly took advantages of constructivist technological services by integrating ICT into education, which in turn has produced new models of education such as e-learning, m-learning, interactive learning and blended learning. Recently, technological developments are playing an important role in improving the educational process especially the integration of holographic presentation in the area. Holography will surely enhance research going on in the field of virtual office concepts and video conferencing. Those studying holographic technologies will be preferred by educators and students and business trainers. Avatars can be introduced to assist youngsters in eLearning. This will help with teaching in overloaded classrooms and increases the learning of the students. However none of the Nigerian tertiary institution practically employs or even attempted to test the holography as a course or as practical experience in the process of teaching and learning.
The art of ‘public speaking fears’ was defeated. Training teachers in virtual holographic classrooms could help the new teachers adapt to a real problematic situation in classroom (Winslow, 2007). Of course such virtual artificial intelligence tools or holographic assistants can come in many forms such as ‘one on one’ with holographic avatars or for use in training of adults in real life simulation. A college class may have a guest speaker and soon such virtual holographic speakers ought to be a little bit cheaper compare to the physical speakers because no flight risk, no hosting and feeding (Harrison, 2009). Presentation and demonstrations on distance e-learning initiatives where the holographic images are broadcast/beam over the internet would be made possible sooner and everywhere (Bobolicu, 2009; Lance, 2007; Suleiman, 2014).

Alas! Power being a basic requirement to the technological development is yet to be adequate in my country Nigeria. There is less or lack of so many infrastructural and technological facilities in most tertiary institutions in the country. The ICT penetration is very low and the digital divide is quite wide. Nigeria has a total number of 109 Universities, 102 Colleges of Education and 81 polytechnics, 36 Colleges Agriculture, 27 Monotechnics and 50 Colleges of Health Technology (FGN/NUC, 2014) (FGN/NBTE, 2014). In (2013) for instance the government allocated and spent over $2.84 billion (N426.53 billion) in running these institutions (Suleiman, 2014) (TETFund, 2014). All these geared toward improving dynamism and positive change and innovations in ascertaining quality education for a viable development.

Recently, technological developments are playing an important role in improving the educational process especially the integration of holographic presentation in the area.
It has also produced new models of education such as e-learning, m-learning, interactive learning and blended learning. Teacher Training in virtual Holographic Classrooms could help the new teachers adapt to a real problematic classroom with such tools (Husain 2010). Nigeria being one of the moderately growing economy and a successful and relatively stable democracy, educational development is always on the increase due to commitment of government in the area. Holography is a virgin area in the Nigerian educational mindset. Most Nigerian tertiary institutions have teacher training programs but holography is not well recognized to be teaching tool in such departments. However, it is well established that teachers are the backbone of education every development (Suleiman, 2014).

**Holography and Education**

By now, holography is already being used in various aspects of our lives. There are also ongoing researches in holography by educational institutions to elevate holography from its infant stage. However, holography as it is has already been tested for the benefit of educational institutions.

Holography being in its infant stage has not been widely used in education even in the advance countries. However, application of holography in education is not new; it has been used in the past in a school but technological requirements are hampering its applications (BBC, 2000). In the year 2000, a hologram of Catharine Darnton, a Mathematics teacher was successfully beamed into an exhibition centre in a school in South London. Although, the distance of transition was minimal, long distance projection is possible since the images are transmitted over the internet.

![Figure: 5 demonstration of a Holoteacher](www.news.bbc.co.uk/2/hi/in_depth/education/2000)

Holography differs from video conferencing because the teacher’s full 3D image can be beamed and appears to be in the classroom. While in video conferencing users can easily notice the image on a screen from a one camera (BBC, 2000). Several benefits were identified with the use of holography to teachers. Darnton, states "I teach further mathematics, we've only got six candidates in the school doing that. The economics make those sorts of classes difficult to lay on," she said. "But if you could have a single teacher being able to see three or four classrooms across a borough or something like that, then perhaps those sorts of subjects would be viable (BBC, 2000)."
The holographic projection of Darnton was made possible by Edex, the largest supplier of internet connections in United Kingdom in educational technology market. According to Edex, for the system to be usable, fast internet connection is required. Thus, Edex is advocating for a fast national network for education (BBC, 2000). Haptic holography’s applicability in education is further enhanced by the possibility of allowing people to feel the presence of the holographic environment and interact with it by touching (fig 6). This is a system that uses airborne ultrasound tactile display which was developed and demonstrated at University of Tokyo by group of researchers (Takayuki Iwamoto & Mari Tatezono) led by Hiroyuki Shinoda. Although such display cannot be feel or sense without use of retro-reflective device yet there is need for such physical interaction with the holographic environment especially in interactive educational fields for teaching, training and learning (fig 7) (Takayuki, Mari & Hiroyuki, 2009).

In this area we can take advantage of holography in different forms. For example, holograms now allow students to be taught by a "virtual teacher" who could be many
kilometers away. The process goes a step beyond video conferencing in that the hologram teacher appears to be in the classroom, and can be seen and can speak to the pupils as if they were all in the same room (Husain 2010). The system used by Edex was shown in London (BBC, 2000). Moreover, holography can enhance the educational process by bringing famous characters back to life again from the past. They can speak about themselves and/or explain something as an assistant teacher. In Seoul's for instance, ‘Alive Gallery Project Holograms’ and ‘3-D Animation Technology’ bring world-renowned masterpieces of Western Art to life again. In that project visitors can see the exhibited hologram in 3D animation of ‘Mona Lisa’ (fig.8) answering questions from students, such as "why don't you have any eyebrows?" She is answering, “when I was alive, a woman who had big forehead was considered a beauty … so most women had their eyebrows taken off for beauty” (Chavis, 2009); (Suleiman, 2014).

Figure: 8: Display of the Hologram Mona Lisa (www.bridgeimages.com)

Augmented Reality and holography

Holography could be understood in different forms such as augmented reality and SixthSense. This gives an adjusted real world where images or text are displayed upon real objects (Burdea & Coiffet, 2003). Augmented reality is also becoming part of our everyday life which includes mobile appliances, shopping malls, training, and more importantly education. Sixth Sense illustrates augmented reality system which can let one (teacher/learner) to project a holographic keyboard on the table top and/or phone pad onto one’s hand (fig. 10) (Bang Bang, 2009). The Sixth Sense augmented reality systems is an innovation by the Pranav Mistry in 1997 at MIT's Medialab, it is a wearable gestural Ambient Intelligence device. The SixthSense adjusts our physical environment with digital information and enables our natural hand to connect with the displayed information (Tscheligi, 2009). SixthSense consolidates our environments (physical and virtual) with digital information (fig. 11) on daily news, weather forecast, travel schedules, global markets prices and so forth.
Virtual Reality and holography

Virtual reality (VR) is another different form of holography and it is here and everywhere now; simply because even students at remote places can attend lectures in virtual environment. Virtual reality allows for mobility since students can access the virtual campus from many other different locations. This idea emanates back in 1960s from the works of Raymond Goertz at Argonne National Laboratory in Argonne, Illinois, and Ivan Sutherland at the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts all USA. The process of virtual reality creates a three-dimensional computer-generated representation of either a real or proposed object or environment. There exists that kind of symbiotic relationship between virtual reality and holography. Holography takes us a step further by bringing the virtual environment into our physical presence. There are several potentials and predictions of how the holography technology can be used as an educational tool in the future (Barbara 2010; Bellis 2010). Holographic technologies are currently being used for many purposes such as security stamps for currencies, display of goods and services for marketing purposes and now for educational purposes.
Holography may be used in various ways in the educational sector and can change the way people learn in the future. For instance, using holography to beam a live teacher to various locations around the world may enhance learning and solve some educational problems. One of the problems identified is the shortage of teachers in educational institutions. Holography can also enhance learning processes and standard of education. Imagine oneself in a classroom in Nigeria and a renowned researcher or teacher from any part of the world, Japan for instance is beamed through into the classroom over there in Nigeria to interact and collaborate with learners. One can interact with the researcher in real-time and it appears exactly like everyone is in the same room. Researchers and teachers will not only be able to use verbal communication but also body language and virtual images to share and exchange information. In addition, education tools which may be physically unavailable due to cost or scarcity can be projected into the other classrooms as holograms to serve as teaching materials.

**Methodology**

The design of this study is a quantitative research that surveyed on a piloted small sample (100) assessed from few targeted teacher training institutions in Nigeria consisting of two from each of the geo-political zone of the country. The researchers collected data by distributing 130 questionnaires physically and by email to some randomly and purposefully selected subjects in form of snowball from the targeted institutions of the accessible population in the scope area of the research that is Nigeria. The distribution and collection was also done through the National Commission for College of Education which is the accreditation body for all the colleges of educations in Nigeria. The distribution cut across various strata with regards to gender and academic level or designation in institutions from the 12 targeted colleges of education in Nigeria of which only two were selected from each geo-political zone of the country (Table 1).

Considering the fact that Nigeria has numerous federal, state and privately funded college of education numbered to about 102 (21 federal, 45 state and, 36 private) (NCCE/ FGN, 2014). The population comprised only of all the academic staff in the public universities in Nigeria totaled to about 17,951 (assistant lecturer to chief lecturer) (NCCE, 2013). This population was chosen for the fact that the colleges of education academic staff had been involved in provision and using ICT tools in their service delivery in the country and to some extent they are moderately funded alongside other tertiary institutions.

TAM has been applied in numerous studies testing user acceptance of word processors (Davis et al., 1989), spreadsheet applications (Mathieson, 1991), e-mail (Szajna, 1996), web browser (Morris & Dillon, 1997), telemedicine (Hu et al., 1999), websites (Koufaris, 2002), e-collaboration (Dasgupta, Granger & McGarry, 2002), and blackboard (Landry, Griffith & Hartman, 2006) the e-learning (Masrom, 2007). Davis, (1989) proposes that ease of use and usefulness of technology are predictors of user attitude towards using the technology, subsequent behavioral intentions and actual usage. Perceived ease of use was also considered to influence perceived usefulness of technology.
Table: 1 List of colleges of education targeted

<table>
<thead>
<tr>
<th>S/N</th>
<th>Institutions Sampled</th>
<th>Zone</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Federal College of Education Akoka</td>
<td>South West</td>
<td>Lagos</td>
</tr>
<tr>
<td>2</td>
<td>College of Education (Special) Oyo</td>
<td>South West</td>
<td>Oyo</td>
</tr>
<tr>
<td>3</td>
<td>Federal College of Education Obudu</td>
<td>South South</td>
<td>Cross Rivers</td>
</tr>
<tr>
<td>4</td>
<td>College of Education Warri</td>
<td>South South</td>
<td>Delta</td>
</tr>
<tr>
<td>5</td>
<td>Federal College of Education (Tech) Umunze</td>
<td>South East</td>
<td>Anambra</td>
</tr>
<tr>
<td>6</td>
<td>College of Education Enugu</td>
<td>South East</td>
<td>Enugu</td>
</tr>
<tr>
<td>7</td>
<td>Federal College of Education Okene</td>
<td>North Central</td>
<td>Kogi</td>
</tr>
<tr>
<td>8</td>
<td>College of Education Minna</td>
<td>North Central</td>
<td>Niger</td>
</tr>
<tr>
<td>9</td>
<td>College of Education Maiduguri</td>
<td>North East</td>
<td>Maiduguri</td>
</tr>
<tr>
<td>10</td>
<td>Federal College of Education Yola</td>
<td>North East</td>
<td>Adamawa</td>
</tr>
<tr>
<td>11</td>
<td>Federal College of Education Gusauf</td>
<td>North West</td>
<td>Zamfara</td>
</tr>
<tr>
<td>12</td>
<td>College of Education Kano</td>
<td>North West</td>
<td>Kano</td>
</tr>
</tbody>
</table>

Findings and Discussions

Quantitative

The distribution of the demography indicates gender level (table 2) of the frequency 59 female and 41 male (mean=1.4/SD=.49) while the academic level or designation (table 3) shows middle level having the highest of 49 and the lowest is indicated as other with the frequency of 11 respondents. (mean=2.1/SD=.91)

Table 2: Frequency distribution on the gender among Nigerian college of education teachers

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEMALE</td>
<td>59</td>
<td>59.0</td>
<td>59.0</td>
<td>59.0</td>
<td>1.41</td>
<td>.494</td>
</tr>
<tr>
<td>MALE</td>
<td>41</td>
<td>41.0</td>
<td>41.0</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Frequency distribution on the designation/level among Nigerian college of education Teachers

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower level (L3-AS)</td>
<td>25</td>
<td>25.0</td>
<td>25.0</td>
<td>25.0</td>
<td>2.12</td>
<td>.913</td>
</tr>
<tr>
<td>middle level (L2)</td>
<td>49</td>
<td>49.0</td>
<td>49.0</td>
<td>74.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper level (CL-PL)</td>
<td>15</td>
<td>15.0</td>
<td>15.0</td>
<td>89.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other (emeritus/contract/instructor)</td>
<td>11</td>
<td>11.0</td>
<td>11.0</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The reliability test was carried out on the main construct attitude thus, the Cronbach Alpha reliability indicates .841 at the initial this suggests high internal consistency reliability (table 4).
Table 4: Reliability Cronbach's Alpha

<table>
<thead>
<tr>
<th>Reliability Statistics</th>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.841</td>
<td>35</td>
</tr>
</tbody>
</table>

To address the issues on the general attitude and acceptance of holography in teaching among Nigerian colleges of education educators the proposed technology acceptance model (TAM) was tested with regression analysis and the actual model (figure 11) and the regression statistics (table 5 and 6) were present as follows:

Figure: 11: SEM actual models on attitude and acceptance of holography in teaching among Nigerian colleges of education educators
Table 5: Regression model summary on the actual model on attitude and acceptance of holography in teaching among Nigerian colleges of education educators

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>a. Predictors: (Constant), ANXTY, EASE, AVL, INT, USE</td>
</tr>
</tbody>
</table>

Table 6: Regression model coefficients on attitude and acceptance of holography in teaching among Nigerian colleges of education educators

<table>
<thead>
<tr>
<th>Coefficients6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>AVL</td>
</tr>
<tr>
<td>USE</td>
</tr>
<tr>
<td>EASE</td>
</tr>
<tr>
<td>INT</td>
</tr>
<tr>
<td>ANXTY</td>
</tr>
<tr>
<td>a. Dependent Variable: ATT</td>
</tr>
</tbody>
</table>

The table 5 and 6 present the regression analysis of the actualized model where the significance level were presented ranging from highest (beta=0.15) \( (p=0.15) \) on availability to lowest (beta=0.005) \( (p=0.96) \) on anxiety. The r square level indicates \( (0.025) \) representing \( (2.5\%) \) which is quite less significant considering the standard error of the estimate at \( (2.79) \). This suggests that the model is not quite fit, meaning that the availability, intention, use, ease of use and level anxiety over holography partially influence attitude positively which consequently lead to the less general acceptance of the holography in teaching among the teachers of colleges of education in Nigeria. It can be glean that the higher the availability the higher the attitude. Similarly, it suggest that the higher the anxiety the lower the attitude. It also indicates that the lower negative in the intention to use holography the higher the attitude towards it.

To also address the issues on the attitudinal differences in terms of gender and designation among the educators of Nigerian colleges of education the t-test and ANOVA results were presented (tables:7,8 & 9) as follows:

Table 7: Independent sample t-test on the attitudinal difference on holography in terms of gender among Nigerian college of education teachers

<table>
<thead>
<tr>
<th>ATT</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assumed</td>
<td>1.149</td>
<td>.286</td>
</tr>
</tbody>
</table>
On table 7 it shows the variance on general attitude toward holography in terms of gender among the College of Education teachers in Nigeria. The overall result indicates no significant gender differences in their attitude toward holography in teaching because the result shows the significance level of (0.286) and F value of (1.15) with the degree of freedom (df = 98). Thereby the calculated value indicates to be greater than the critical value (p>0.05).

Table 8: One way ANOVA on attitudinal difference on holography in terms of designation/level among Nigerian college of education teachers

<table>
<thead>
<tr>
<th>ATT</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>23.489</td>
<td>3</td>
<td>7.830</td>
<td>1.029</td>
<td>0.383</td>
</tr>
<tr>
<td>Within Groups</td>
<td>730.625</td>
<td>96</td>
<td>7.611</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>754.114</td>
<td>99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Bonferroni multiple comparisons test on attitudinal difference on holography in terms of designation/level among Nigerian college of education teachers

<table>
<thead>
<tr>
<th>ATT Bonferroni</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) Designation/Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Level (AL-L3)</td>
<td>-.21510</td>
<td>.65367</td>
<td>1.000</td>
<td>-1.8076</td>
</tr>
<tr>
<td></td>
<td>-1.41769</td>
<td>.81447</td>
<td>.255</td>
<td>-3.4019</td>
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<tr>
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<td>.65367</td>
<td>1.000</td>
<td>-.13774</td>
</tr>
<tr>
<td></td>
<td>-1.20259</td>
<td>.71681</td>
<td>.290</td>
<td>-.29489</td>
</tr>
<tr>
<td>Upper Level (PL-CL)</td>
<td>1.41769</td>
<td>.81447</td>
<td>.255</td>
<td>-.5665</td>
</tr>
<tr>
<td></td>
<td>1.20259</td>
<td>.71681</td>
<td>.290</td>
<td>-.5437</td>
</tr>
</tbody>
</table>

On table 8 it shows the variance on general attitude toward holography in terms of designation/level among the College of Education teachers in Nigeria. The overall result indicates significance differences in their attitude toward holography in teaching in terms of designation/level because the result shows the significance level of (0.383) and F value of (1.02) with the total degree of freedom (df) of (99). Thereby the calculated value indicates to be greater than the critical value (p>0.05). The gap can be identified from the Bonferroni test on Multiple Comparisons (table 9) especially in the significance level and the mean difference between the lower level (L3-AL) cadre and the upper level (PL-CL). The former assumed to have higher degree of significance of (1.00) and the mean difference of (-0.21) while the latter appears to have significance of (0.25) and the mean difference of (1.41) on the attitude toward the holography. Thus the difference is wider between the lower level and the upper level.
Table 10: Pearson correlation on the relationship on: availability, intention, use, ease of use, anxiety, attitude and acceptance of holography in teaching among Nigerian colleges of education teachers

<table>
<thead>
<tr>
<th></th>
<th>ATT</th>
<th>AVL</th>
<th>USE</th>
<th>EASE</th>
<th>INT</th>
<th>ANXTY</th>
<th>ACCEPT</th>
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<tr>
<td>ATT</td>
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<td>.149</td>
<td>.044</td>
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<td>-.025</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>.134</td>
<td>.148</td>
<td>-.040</td>
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<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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<td></td>
<td></td>
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<tr>
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<td>Pearson Correlation</td>
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<td>.127</td>
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<tr>
<td>EASE</td>
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<td>.000</td>
<td>.253</td>
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<td></td>
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</tr>
<tr>
<td>INT</td>
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</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>Sig. (2-tailed)</td>
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</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).

On table 10 it shows the correlations on availability, intention, use, ease of use, anxiety, as well as attitude toward holography and its acceptance in teaching among the college of education teachers in Nigeria. The result indicates significance with quite significance between availability and use (.225*), ease of use and acceptance (.253*), and intention to use and anxiety (.239*). On the other hand the result also suggests none significance between attitude and availability (.149), availability and intention (.134), availability and anxiety (.134) as well as between attitude and acceptance (.134). The result as well shows negatively none significance on the use and ease of use (-.225*) and quite negatively high none significance between intention and acceptance (-.021). It further suggest quite high none significance between ease of use and intention (.012) and a perfect none significance between ease of use and anxiety (.00).

Discussion of result

From these results some few major things were identified. The results show that majority have agreed to have like holography and also agreed to use holography in teaching as well as encourage others to employ it as well. However, it indicates less availability of the tools in their institution many of the respondents have interest in acquiring such kit for their usage even though it shows that the tools may be difficult to use especially to non technologist and are very expensive to afford now a day. The result moreover, indicates positive relationship between the holography and enhancement of teaching and learning. Although hologram technology enhances performed, effectiveness and improves productivity it will not only change the face of education, especially in tertiary education but all aspect of life. That means hologram
technology could be a future tool not only for teachers in the phase of higher education but almost all human endeavours of life. Holography will be a tool of teacher, because the holography is mainly seen as an effective tool for the teacher in the future as it eases the teaching process especially for those teachers with proficient ICT knowledge and solve the problem of inadequate teachers. It is overwhelmingly agreed that using holography is worthwhile thus it is postulated that in the near future not far away this holographic tools just as common projectors would be available in every place thus, holographic projectors would be everywhere because of increase in positive attitude and zero phobic attitude as well as collaborations that would exist in using such tools among individuals and across different global institutions and organizations.

However, ideas vary on whether the integration of the hologram into education it could be readily accepted or rejected and be prevented. For this, some phobic attitudes among the respondents were revealed in dealing with holography. However that would not be a major factor which would prevent them to deal with this technology. This is because it is vulnerable to so many interruptions at any given moment which may invariably disrupt the smooth flow of the learning process. This is in consideration specifically with the general requirement of such hologram technology in learning environment. In Nigeria adequate power supply and high level of techno failures are the possible barriers identified with holography when to be integrated into the learning environment. Other things were non commitments as well as poor maintenance culture. These are some of the views noted on the idea that holography as a teaching tool may get hindered from its integration into the Nigeria learning environment. For example, majority of the respondents confirmed that holography reinforces the learning process, as well as potentially being an effective teaching tool for the future. However, this technology would not change the face of education as claimed by many teachers. Moreover, other teachers hold the thought that the main barriers that can resist the integration of such holographic technology into the Nigerian learning environment are the high cost of purchase and installation and requirements of a high-speed internet connection, subscription and the qualified personnel to manage it.

Possibly teachers can be replaced by holograms. This sounds like a science fiction. Nonetheless is there anything that would happen if holographic teachers could be sent to you? The reality is that this technology has been created to bring live holograms from one location and beam them into any other desired location in the world. It has been possible, because nothing is impossible.

**Conclusion and Summary**

These findings, suggested main barriers that may hinder the integration of holography into learning environments. Although holography is very expensive and difficult to integrate with the learning environment, it is of much very interesting to use this technology in the teaching process even if it is very expensive to implement at present. Holographic Technologies are not just about art or business communication, they are about safety, security, education, planning and the strength of our civilization here and beyond. This phenomenon should lead other researchers to investigate whether Holography will be an effective tool for the teachers in the future. Furthermore, the researchers wished to explore the main barriers that might prevent
holography being integrated into a learning environment this is in order to move towards an answer in this issue.

As one of the limitations of the study, some of the questionnaires were not returned. It investigated on the general perception as well as the relationship between the holography and teaching learning process at different levels of education and gender. It also examine if holography will enhance teaching learning process in the future. If hologram technology will support the learning process then what sort of challenges and prospect are there in. The teachers especially in higher education emphasized the importance of the hologram in supporting the educational process.

**Recommendations**

For educational institutions to take full advantage of holography, some technologies need to be developed or introduced. Architectural design of classrooms may also require modification to accommodate the implementation of holography.

The amount of data needed to transmit and project a holographic environment or real time hologram is enormous. Hence, one of the barriers to holographic environments becoming reality is the Internet speed requirement of 1000 times faster than today’s Internet standard. Other technologies required to be able to fully utilize the holographic technology are haptics and display technologies. Haptic sensors are needed to allow people interact with the holographic projection by touching and super computers that can make trillions of calculation to produce the holographic environment (Bonsor 2010).

Another essential infrastructure need to use holography is the display system. The display medium determines how realistic the projected hologram appears. The display also determines the viewing angle capability and affects the infrastructural requirement on the receiving end. Holographic displays capable of projecting holograms into free air are preferable because they may allow interaction with human. Thus, generating holograms which are touchable using airborne ultrasound tactile display such as the one demonstrated in 2009 at University of Tokyo Japan (fig 6). Display into free air will also save space which may have been used for physical display systems. In this regard Japan claims to broadcast their 2022 world cup to about 360 spectators by means of holography to 400 stadiums within 208 countries.

Lack of adequate equipment is a daunting problem which makes studying in some Nigerian educational institutions theoretical, non interactive and based on illusion. For instance, in an engineering program in higher institutions in Nigeria, most teachers rely on theory, such attitude needs to be redress and address.

**Acknowledgement:** Our sincere appreciation to Tertiary Education Trust Fund (TETFund) in Nigeria for supporting this conference attendance.
Bibliography


The Effect of Theme Preference on Academic Word List Use:  
A Case Study of Smartphone Video Recording Feature

Nicolas A Gromik, University of New England, Australia

Abstract
67 Japanese English as a Foreign Language undergraduate learners completed one smartphone video production per week for 12 weeks, based on a teacher-selected theme. Designed as a case study for this specific context, the data collected on a weekly basis students Academic Word (AWL) use and their perception of the theme, as well as data pertaining to theme evaluation in a post-intervention survey. The analysis compared the mean use of academic words against the various themes to determine their effect on AWL use. The findings indicate that there is a correlation between theme preference and the use of lexical items from the Academic Word List. The outcome from this research indicates that smartphone video recording feature can be used to engage language learners to speak in the target language about themes that are relevant to them and thus increase speaking abilities and word usage.
Introduction

The emergence and the mobility of smartphone technology have stimulated educator interest to consider new teaching practices for exposing language learning content to students. Short Message Service (SMS) has received to date the most attention because it is easier to control the amount of text input, purposes and tasks students must complete, as well as to control the amount and the quality of text output (see for example Levy & Kennedy, 2005; Thornton & Houser, 2005; or Stockwell, 2010). Another smartphone feature that has received some attention is the photo camera feature available on most smartphones. Research concerning smartphone photography has gained research interest (Foster, 2009; Gai, 2009; Gye, 2007; Hjorth, 2007; Kato, Okabe, Ito & Uemoto, 2005; Reading, 2008; Scifo, 2009). In Turkey for example, Uzunboylu, Cavus and Ercag (2009) have used the smartphone photo taking feature to engage undergraduate students to document and share visual evidence of environmental degradation for discussion on a project website. Both of these features require the smartphone subscriber to use and send SMS, therefore relying primarily on writing to share content with peers. Due to technology advancements it might be possible to consider the benefits of using the smartphone video recording feature as a potential learning tool.

Viewing videos on smartphones

Some researchers have developed interest in understanding the effect of viewing videos on smartphones. For example, Lee et al.’s (2011) results indicated that volunteering participants were able to understand and enhance their ability to perform CPR after viewing demonstrations on cellular phones. Similarly, Fiore-Silfvast et al. (2013) reported that viewing videos on smartphones was an effective method for midwives to disseminate information to patients. Hansen, Kortbek and Gronbaek (2013) used the smartphone video viewing feature to expose tourists to mobile urban drama and storytelling. Most research on the use of the smartphone video feature place the phone subscribers in the position of viewers of third party produced video content. However, research by Gromik (2008) suggests that it might be possible to use the smartphone video recording feature as a learning tool to increase target language exposure.

Using smartphones to produce videos

Video production has been used extensively in a wide range of educational settings and for various learning objectives. For example, Leijen, Lam, Wildschut, Simons and Admiraal (2009) engaged dance students to use filming and editing to reflect and comment on their dancing performances. Gromik (2008) reports on the literature to reveal that filming can be used as reflective diaries to promote reflective learning development. Researchers have found that making reflective videos can benefit both teachers (Barton & Haydn 2006; Gebhard 2005) and students (Triggs & John 2004). As the literature asserts, the ability to see oneself perform can be beneficial and revealing for a learner (Hoelker, Nimmannit, & Nakamura 1999; Leijen et al. 2009; Liu 1997). Levy and Kennedy (2005) used computer video capture to record students’ behavior during their audio conferencing study of Italian as a foreign language to provide evidence for this assertion within the specific context of the language learning classroom. The researchers found that these recordings became an effective tool for
assisting students in visualizing and subsequently correcting their errors. However, as the research by Levy and Kennedy (2005) reveals, using digital video cameras even handheld can be cumbersome to carry and use. Technology advancements of smartphones and its video recording feature could be used as a language learning tool.

The use of the smartphone video recording feature has received little attention from the research community. Yet as Gromik’s (2009) study demonstrated, it was possible for university students to use the video recording feature on their smartphones to produce speaking performances to share with their teacher. Maxfield and Romano (2013) also reported on the possibility for pre-service teachers to use the video recording feature on their iPads to “capture the first day of school experience” to then create a “combined video montage” to share with their peers (p. 140). Smartphone developments combined with social networking site afford learners the opportunities to share their opinions using a range of options; audio-visual recordings being one of them.

**Theoretical Framework**

The concept of creating videos with a smartphone involves students using the tool to produce content. Such method reflects the practice of socio-constructionism theory (Papert, 1991), which asserts that it is through interaction and collaboration with peers, and the use of tools from the natural context and environment, that learners negotiate and gain new knowledge (Vygotsky, 1978). The emergence of mobile technology and the many features they carry, enable smartphone subscribers to use these features to collect data, information, still or moving images and record audio or audio-visual evidence they can use to acquire, understand and retain content that is relevant to them or to their learning and to share this digitally recorded data with peers through social networking sites. Vygotsky’s claim was that students learned anytime anywhere in and outside of class time. Applying a socio-constructionist framework would lead to the hypothesis that with the emergence of more powerful smartphones learners could capitalize on their learning experiences outside class and share these with their peers, thus increasing the construction of knowledge and content through social exposure and reflections.

**Context**

Japanese learners of English receive six years of English exposure prior to commencing their university education (Gromik, 2006; Hirata & Hirata, 2007; Stapleton, 2005). During these six years and their first year of university English education, Japanese students deepen their knowledge and expertise with writing and reading comprehension and cognizance of grammar rules more than with speaking ability (Johnson & Hefferman, 2006; Yamada & Akahori, 2007). Thus learning English in Japan is much a memorization activity, which may provide learners very little motivation to retain and apply these individual lexical items in speaking activities. Learning a language can be demotivating and language forgotten.

For this reason, introducing the smartphone video recording feature needs to be embedded in an activity that will motivate the students to use the technology, the language, learning strategies and speaking skills in order for the learning to be beneficial.
**Authentic Learning**

Authentic learning places the learner in the position of producer through activities such as role-play, problem or case-based learning in a real-world context and environment (Gulikers, Bastiaens & Martens, 2005; Lombardi, 2007; Reeves, Herrington & Oliver, 2002). By engaging students to produce content from real-world experiences or observations they are able to perceive a problem, think of a solution and demonstrate the implication of their opinion (Lombardi, 2007). Completing such an activity could have more relevance to the learner because it provides them with the opportunity to define, investigate and apply their prior knowledge and skills in order to “create polished products valuable in their own right” and to share this product with peers (Reeves, Herrington & Oliver, 2002, p. 564). Not only can students collaborate in the production process, but the production outcome can become a shared item that encourages students to reflect on possibilities for improvement.

Integrating authentic learning as part of the smartphone video production task may engage learners to apply their prior language skills and competencies to give them the confidence to speak in the target language about meaningful content of importance to them. The use of the technology enables learners to produce authentic audio-visual documentation about their exploration of real-life issues or themes (Gulikers et al. 2005).

**Theme-based Learning**

Theme-based learning is “structured around topics relevant to the students’ experience” (MacDonal, Badger, & White, 1999, p. 87). Theme-based learning enables students to consider a theme, and to rely on their prior knowledge and experiences in order to produce a new form of knowledge or interpretation based on the students’ interests (Huang, Liu, Chu & Cheng, 2007). Using the smartphone video recording feature, students could observe, record and construct knowledge that would provide video evidence of their ability to apply their prior knowledge of content and target language to discuss an issue relevant to them. Blending theme-based learning with smartphone video filming places greater emphasis on student-centered learning. Cummins and Swain (1986) add that theme-based learning enable learners to produce their language output within the context they live (see also Chaplin & Manske, 2005). These authors state that “in context-embedded communication … the language is supported by a wide range of meaningful paralinguistic and situational clues” (p. 152). While learners are provided with the themes, they have to interpret their understanding of the theme, select the location and content to be discussed on their video, and use the target language to express their opinion effectively. Such a learning method, according to Chaplin and Manske (2005), enables students to be more motivated as the theme connects their personal interest with relevant course specific issues.

The outcome of using theme-based learning is that students will interpret the theme differently and thus will use different visual cues as well as opinions regarding the selected theme. Once students share their videos with their peers, the viewers are exposed to a great range of opinions and interpretations, as well as exposed to a greater range of target language expressions and creative output.
The theme and the smartphone video recording feature enable learners to immerse into their social environment, to negotiate meaning and intentions and thus gain new knowledge and understanding of the target language and their ability to express their opinion effectively.

Filming and language production process

Producing a video is a complex process that involves addressing an issue or expressing an opinion, remembering the speech and speaking in the target language, filming and framing the necessary visual cues, recording, and reflecting on the whole performance output (Gromik, 2009; Hansen et al. 2013). With a smartphone there may not be a need to edit a short video, however if the producer is not satisfied with the performance, after reflecting on the visual output, he/she may have to record the whole scene again. Such video production method fits with the language learning approach, whereby students need to plan, perform and reflect on their performance in order to feel confident that this is the best they can do. Viewing their performance enables them to listen to their opinion in order to ensure that they are satisfied with their response. If the students are not satisfied with their performance, they can then review their notes, fix their speech and improve the content they are discussing.

Research Question

This paper investigates the effect of theme-based learning on academic word use per smartphone video-produced performance output. The preposition suggests that due to the degree of theme difficulty, students are more likely to use a greater number of academic words to express their opinion regarding such topic.

Methodology

Participants

67 Japanese undergraduate English language learners consented to participate in this research (M= 59, F= 8). The participants’ age ranged from 19 to 22 years old with the mean being 20 years old. The number of Arts & Letters students registered in the course was 22 male and 3 female students. From the Law department, there were 18 male and 4 female students. While there were no females in the Engineering A group (n=11), there were 8 male and 1 female in the Engineering B group.

Task

Students were required to produce one weekly video performance using their smartphone video recording feature and to email this performance to the teacher for review. At the beginning of the semester, students were provided with the list of all the themes they would need to discuss (see Table 1 below. To ensure that students had some prior understanding of the themes, these were included as part of the classroom activities (either for analysis or discussion).
Table 1. Weekly themes

<table>
<thead>
<tr>
<th>Week</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What do you think of this course? (beginning of term)</td>
</tr>
<tr>
<td>2</td>
<td>What did you do during golden week?</td>
</tr>
<tr>
<td>3</td>
<td>What did you think of the speaking style?</td>
</tr>
<tr>
<td>4</td>
<td>What did you think of the content?</td>
</tr>
<tr>
<td>5</td>
<td>How will you improve your next presentation?</td>
</tr>
<tr>
<td>6</td>
<td>Describe your favorite shop in town</td>
</tr>
<tr>
<td>7</td>
<td>Describe your favorite painting</td>
</tr>
<tr>
<td>8</td>
<td>How would you save the environment?</td>
</tr>
<tr>
<td>9</td>
<td>Describe your favorite intention</td>
</tr>
<tr>
<td>10</td>
<td>What do you think of peer presentation?</td>
</tr>
<tr>
<td>11</td>
<td>What will you do during the summer holiday?</td>
</tr>
<tr>
<td>12</td>
<td>What do you think of the course? (end of term)</td>
</tr>
</tbody>
</table>

Students had three days to prepare, video record their best performance, and submit their final production. Students received no assistance from the lecturer. They could communicate with their peers to discuss best video production practices, and they could reflect on their peer’s performances to improve their video production and speaking skills.

**Data Collection Method**

Given the specific context, the innovative use of the smartphone video recording feature and learning method, case study research is preferable for investigating the use of the smartphone video recording feature as a language learning tool by Japanese undergraduate (Verschuren, 2003).

Quantitative data were collected via a post-intervention survey, weekly diaries as well as students’ video recorded speaking performances. The post-intervention survey included 29 items (20 closed questions and 9 open-ended questions). The weekly diaries aimed to collect information concerning students’ preparation, recording practice, speech memorizing strategies, and a rating of the whole video production process. The evidence of the weekly video speaking performances was transcribed and collected. This set of evidence included students’ speaking time, and the amount of words spoken per second. The lexical items used by students in their video was also gathered and analysed in term of the first 1000 words, the second 2000 words and items from the Academic Word List (Cobbs, n.d.)

**Data Analysis**

A mixed model analysis of the data was conducted with SPSS 21. The Academic Word List was identified as the dependent variable. Theme preference, error recognition, enjoyment rate, perception of the benefits of producing smartphone videos on a regular basis, the theme approach, technology evaluation, technology use difficulties, ratings of the video and audio recording quality, preparation and speech preparation and production strategies, preparation time at five minute intervals were labeled independent variables. The statistical analysis aims to identify the variable that led to the increase use of lexical items from the Academic Word List.
Table 2 above represents the descriptive statistics of the total range of words used by students in their speech performances over a twelve-week period. This evidence confirms that students used a greater range of K1000 words in all of their speech performances. However, the research investigates the effect of the theme on the use of AWL lexical items.

Table 3 below provides an overview of the maximum number of AWL lexical items used per themes. It is noticeable that themes 4, 7, 8 11 and 12 engaged the participants to place more focus on the use of AWL vocabulary.

Table 3. Total of AWL per theme

To provide an example of K1000, K2000 and AWL lexical items, two student samples are provided. In Sample 1 below, the words in bold represent off list words, that is word that the software cannot recognize. In this instance Sendai is the capital city of the Tohoku region and Seiyu is a national store. The word in bold, and italics (beneficial) represents a word from the Academic Word List. The words underlined represents the K1000 words and the words in italics represent the K2000 words, that the student used do address the theme, describe your favorite shop in Sendai, the theme for week six.
My favourite shop in Sendai is Seiyu. I always buy foods and drink at Seiyu. Seiyu is necessary in my daily life Seiyu has two beneficial points. First it is convenient because Seiyu is open around the clock second goods at Seiyu are cheap. If I save the cost of foods I can buy other things so I will continue to go shopping.

In other words the statement above has 37 K1000 words, 5 K2000 words and one AWL item. In contrast the following statement below has 35 K1000 words, 4 K2000 words and 4 AWL items.

Today I would like to talk about how will I save the environment. When I go outside for example, to go shopping, I ride the bicycle more than my motor bicycle. My motor bicycle makes CO2 so to ride motor bicycle promotes global warming. In conclusion motor bicycle is very useful thing but for the environment we need to think which we should use, thank you.

Both statements above lead to observation that, first the use of AWL items is dependent on students’ needs and second is related to the theme. However, it could be argued that the selection of words is accidental. Nonetheless the theme engages students to use K1000 and K2000 words that they are familiar with and may have prior knowledge of, and they independently begin to investigate new lexical items necessary to tell their story.

### Type III Tests of Fixed Effects

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<td>11</td>
<td>654.736</td>
<td>11.98</td>
<td>.000</td>
</tr>
<tr>
<td>Post-test Theme Preference</td>
<td>2</td>
<td>688.694</td>
<td>2.943</td>
<td>.053</td>
</tr>
<tr>
<td>Errors reported per week</td>
<td>1</td>
<td>679.751</td>
<td>1.277</td>
<td>.259</td>
</tr>
<tr>
<td>Rating of enjoyment per week</td>
<td>1</td>
<td>449.062</td>
<td>.035</td>
<td>.851</td>
</tr>
<tr>
<td>Impact of regularity of production</td>
<td>1</td>
<td>44.728</td>
<td>.670</td>
<td>.417</td>
</tr>
<tr>
<td>Impact of regularity of theme</td>
<td>1</td>
<td>49.104</td>
<td>1.616</td>
<td>.210</td>
</tr>
<tr>
<td>Perceived improvement in pronunciation</td>
<td>4</td>
<td>50.313</td>
<td>.870</td>
<td>.488</td>
</tr>
<tr>
<td>Perceived improvement speaking without notes</td>
<td>3</td>
<td>53.548</td>
<td>.775</td>
<td>.513</td>
</tr>
<tr>
<td>Impact of teacher evaluation</td>
<td>1</td>
<td>46.744</td>
<td>.011</td>
<td>.917</td>
</tr>
<tr>
<td>Impact of technical difficulties</td>
<td>1</td>
<td>50.370</td>
<td>.260</td>
<td>.612</td>
</tr>
<tr>
<td>Audio quality rating</td>
<td>2</td>
<td>46.615</td>
<td>.146</td>
<td>.864</td>
</tr>
<tr>
<td>Video quality rating</td>
<td>2</td>
<td>47.194</td>
<td>.167</td>
<td>.847</td>
</tr>
<tr>
<td>Recording</td>
<td>12</td>
<td>686.519</td>
<td>.468</td>
<td>.933</td>
</tr>
<tr>
<td>Preparation strategy</td>
<td>5</td>
<td>627.957</td>
<td>.628</td>
<td>.678</td>
</tr>
<tr>
<td>Speaking strategy</td>
<td>8</td>
<td>683.605</td>
<td>.823</td>
<td>.582</td>
</tr>
<tr>
<td>Speech production strategy</td>
<td>17</td>
<td>684.395</td>
<td>.822</td>
<td>.668</td>
</tr>
</tbody>
</table>
Table 4 above, reports on the Fixed Effects analysis used to determine the impact of certain constant variables over time. As this Table indicates there is a statistical significance with the theme as a major influencing factor for the use of lexical items from the Academic Word List ($F= 11.98$, $p= .000$). The next possible influencing factor could be the preparation time ($F= 3.29$, $p= .071$). The evidence suggests that the estimate of fixed effect was .033, indicating that at five minute intervals of preparation time a student would need 2 hours and 54 minutes to include and use 1 academic word in their speech. Therefore preparation time would not be considered a near significant influencing variable to engage the students to use more academic words.

Each video performance was transcribed and the lexical items were grouped. All academic words for each theme per week were tabulated, analyzed and the mean reported in Table 5 below.

### Estimates$^a$

<table>
<thead>
<tr>
<th>Theme</th>
<th>Mean</th>
<th>Std. Error</th>
<th>df</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you think of this course (beginning of term)</td>
<td>.089$^b$</td>
<td>.536</td>
<td>78.965</td>
<td>-.977</td>
<td>1.155</td>
<td></td>
</tr>
<tr>
<td>What did you do during golden week</td>
<td>-.090$^b$</td>
<td>.538</td>
<td>79.957</td>
<td>-1.162</td>
<td>.982</td>
<td></td>
</tr>
<tr>
<td>What did you think of the speaking style</td>
<td>.118$^b$</td>
<td>.538</td>
<td>80.105</td>
<td>-.953</td>
<td>1.189</td>
<td></td>
</tr>
<tr>
<td>What did you think of the content</td>
<td>1.234$^b$</td>
<td>.544</td>
<td>83.123</td>
<td>.151</td>
<td>2.316</td>
<td></td>
</tr>
<tr>
<td>How will you improve your next presentation</td>
<td>.265$^b$</td>
<td>.549</td>
<td>85.525</td>
<td>-.826</td>
<td>1.356</td>
<td></td>
</tr>
<tr>
<td>Describe your favorite shop in town</td>
<td>-.189$^b$</td>
<td>.550</td>
<td>86.462</td>
<td>-1.283</td>
<td>.905</td>
<td></td>
</tr>
<tr>
<td>Describe your favorite painting</td>
<td>.125$^b$</td>
<td>.546</td>
<td>84.219</td>
<td>-.961</td>
<td>1.212</td>
<td></td>
</tr>
<tr>
<td>How would you save the environment</td>
<td>1.439$^b$</td>
<td>.543</td>
<td>82.674</td>
<td>.358</td>
<td>2.519</td>
<td></td>
</tr>
<tr>
<td>Describe your favorite intention</td>
<td>.359$^b$</td>
<td>.539</td>
<td>80.210</td>
<td>-.713</td>
<td>1.431</td>
<td></td>
</tr>
<tr>
<td>What do you think of peer presentation</td>
<td>.773$^b$</td>
<td>.547</td>
<td>84.576</td>
<td>-.315</td>
<td>1.861</td>
<td></td>
</tr>
<tr>
<td>What will you do during the summer holiday</td>
<td>.485$^b$</td>
<td>.545</td>
<td>83.641</td>
<td>-.599</td>
<td>1.570</td>
<td></td>
</tr>
<tr>
<td>What do you think of the course (end of term)</td>
<td>.814$^b$</td>
<td>.545</td>
<td>83.144</td>
<td>-.271</td>
<td>1.898</td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: T1 - Academic Word List word group (raw score).
b. Covariates appearing in the model are evaluated at the following values: preparation time of 5 minute interval = 6.3302.

Table 5. Mean estimate of AWL items used
As the evidence on Table 5 above suggests, the theme “How would you save the environment?” indicates a high mean score of 1.439. Amongst the twelve themes, the environment theme seems to be a high influencing factor for the use of lexical items from the Academic Word List. By contrast the theme “Describe your favorite shop in town” has a negative mean score (M= -.189) indicating that this theme did not engage students to increase their use of lexical items from the Academic Word List.

Since the theme “How would you save the environment?” was the most influential, a Pairwise Comparison using Bonferroni analysis was conducted to analyze the significant difference between this theme and all the other themes.

<table>
<thead>
<tr>
<th>Theme (I)</th>
<th>Themes (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Df</th>
<th>Sig.</th>
<th>95% Confidence Interval for Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you save the environment</td>
<td>What do you think of this course Week 2?</td>
<td>1.349*</td>
<td>.226</td>
<td>672.308</td>
<td>.000</td>
<td>.586 - 2.113</td>
</tr>
<tr>
<td></td>
<td>What did you do during golden week?</td>
<td>1.529*</td>
<td>.222</td>
<td>668.873</td>
<td>.000</td>
<td>.776 - 2.281</td>
</tr>
<tr>
<td></td>
<td>What did you think of the speaking style?</td>
<td>1.321*</td>
<td>.205</td>
<td>654.057</td>
<td>.000</td>
<td>.628 - 2.013</td>
</tr>
<tr>
<td></td>
<td>What did you think of the content?</td>
<td>.205</td>
<td>.200</td>
<td>648.137</td>
<td>1.000</td>
<td>- .473 - .883</td>
</tr>
<tr>
<td></td>
<td>How will you improve your next presentation?</td>
<td>1.174*</td>
<td>.202</td>
<td>649.025</td>
<td>.000</td>
<td>.492 - 1.856</td>
</tr>
<tr>
<td></td>
<td>Describe your favorite shop in town</td>
<td>1.627*</td>
<td>.207</td>
<td>651.074</td>
<td>.000</td>
<td>.928 - 2.327</td>
</tr>
<tr>
<td></td>
<td>Describe your favorite painting</td>
<td>1.313*</td>
<td>.206</td>
<td>651.001</td>
<td>.000</td>
<td>.617 - 2.009</td>
</tr>
<tr>
<td></td>
<td>Describe your favorite intention</td>
<td>1.080*</td>
<td>.204</td>
<td>651.589</td>
<td>.000</td>
<td>.390 - 1.770</td>
</tr>
<tr>
<td></td>
<td>What do you think of peer presentation?</td>
<td>.665</td>
<td>.202</td>
<td>649.802</td>
<td>.069</td>
<td>-.019 - 1.349</td>
</tr>
</tbody>
</table>

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Based on estimated marginal mean
*. The mean difference is significant at the .05 level.
a. Dependent Variable: T1 - Academic Word List word group (raw score).
c. Adjustment for multiple comparisons: Bonferroni.
Table 6. Bonferroni analysis

Table 6 above reveals that compared to the other themes, the theme “How would you save the environment?” significantly engages students to use more lexical items from the Academic Word List. However there is no significant difference between the environment theme and the theme “What did you think of the content of your peers’ presentation?” (p= 1), “What do you think of the course? Week 13” (p=.143) and “What do you think of your peers’ presentations” (p= .069), indicating that these three themes may have the potential to engage students to include more lexical items from the Academic Word List in their speech.

Discussion

In traditional methods of teaching and learning, content and drills are usually central to the task. For example, In Stockwell’s (2010) task, students were engaged to learn lexical items and to demonstrate their comprehension of these items. However the objective of theme-based learning is to position the student at the center of their learning and to engage them to rely on their prior knowledge of the lexical items, the content and to express their opinion about a particular theme to explore new forms of knowledge (Pica, 1987).

The emergence of computationally powerful smartphones means that students can learn anytime, anywhere and at their own pace. Using the video recording feature infers that students can begin to reflect on their experiences with their surroundings and peers to discuss their opinions. Such a learning method aligns with the socio-cultural theory, which stipulates that learners are not empty vessels and therefore through interaction with socio-economic and cultural environment they can begin to extrapolate and interpret information of importance to them.

The evidence suggests that some of the themes did engage (or disengaged) these particular participants from using lexical items from the Academic Word List. While the evidence indicated that one particular theme afforded students greater opportunities to use AWL items, other themes seemed to have limited effect on the use of AWL items. On the contrary, it would appear that easier themes promote a greater use of K1000 and K2000, indicating that these themes engaged students to use their prior knowledge of the target language extensively and thus resulted in
participants using lexical items they were already familiar with, rather than utilizing more advanced words.

Duquette, Renie and Laurier (1998) asserted that the use of visual cues such as still or animated images engaged learners to acquire lexical items (cited in Smidt & Hegelheimer, 2004, p. 519). The creation of smartphone-based video recorded speaking performances to discuss an issue regarding a particular theme can engage learners to increase their confidence in using a wide range of K1000 and K2000 lexical items. However, further research is needed to investigate the careful selection of themes that would require the use of AWL lexical items.

**Limitations**

As a case study, the experience of this small sample group limits the generalizability of the findings. In addition, the research did not explicitly identify whether or not students used Academic words implicitly or explicitly and whether they recycled any of the vocabulary they had acquired. Laufer and Hulstijn (2001) assert that accidental vocabulary acquisition is “the learning of one thing, for example vocabulary, when the student’s primary objective is to do something else” (p.10). While the evidence suggests that the theme has influenced learners to increase their use of Academic Words List items, the retention of these lexical items remains to be investigated.

**Conclusion**

Increasingly smartphone are becoming more powerful and include a wider range of features, which enable subscribers to complete a wider range of activities on this device. For example subscribers can now take photos or videos of information available in their surroundings to share with their peers on social networking sites. Given these affordances and potentials, this paper investigated the use of the smartphone video recording feature as a tool to produce student-centered performances. While previous research have investigated the educational benefits of delivering content via sms to students, few have reported on the merits of the smartphone video recording feature. This paper investigated the effect of them-based learning on the use of lexical items from the Academic Words List (AWL). The results support that providing relevant themes will engage students to use more AWL lexical items. Future research is necessary to explore further the use of smartphone video recording feature to engage participants from various faculties to produce theme-based content relevant audio-visual performances, and to evaluate the effect of theme-based learning on content specific academic word selection.
References


Kuan-Siew Khor, Sunway University Business School, Malaysia
Thurasamy Ramayah, Universiti Sains Malaysia, Malaysia
Yong-Keong William Eng, Sunway University Business School, Malaysia
Haniruzila Hanifah, Universiti Sains Malaysia, Malaysia

Abstract
The dwindling of natural resources and higher demand for landfill space fuelled the concept of sustainable consumption. For decades, buy and throwaway society created a string of negative environmental consequences and a positive change is taking place as developed nations take the lead in closing the supply chain loop via extended producer responsibility (EPR). Returns with higher residual value deserve attention because extending the useful life of equipment which underperformed earlier than expected generates an array of business benefits. The viability of reverse logistics activities depended on the effectiveness of reclaiming valuable constituents for reuse in as-new or used equipments. Drawing on the interests of sustainable development, this study investigates the mediating effect of green product design on the economic performance of reverse logistics among electrical and electronic (E&E) manufacturing firms in Malaysia. While ecodesign and reverse logistics were analyzed as components of green supply chain management in previous studies, this study intend to affirm the role of green product design particularly design for disassembly (DfD) and design for the environment (DfE) on the economic performance of reverse logistics. Since the characteristics of product design exert profound impact on waste minimization and elimination, this conceptual paper present a series of propositions to guide future empirical investigations in examining the relationships between reverse logistics and green design aspects on economic performance.

Keywords: Green product design; Reverse logistics; E&E; Malaysia; Design for disassembly; Design for the environment
1.0 Introduction

In view of environmental degradation, various stakeholders are becoming involved in shifting the throwaway society towards sustainable living. 3R program are among the initiatives that elevate the wellbeing of surrounding community and environment through reduce, reuse and recycling activities. Judging on rapid technological obsolescence and growth of secondary market for second hand goods, the local E&E manufacturing industry should commit resources in environmental proactive initiatives to deter negative environmental impacts effectively such as extending product lifecycle through the implementation of reverse logistics activities. Some manufacturers have invested in sustainable products and generated benefits from the green market industry such as reducing consumption of resources and reducing environmental impact during production, usage and post-usage phases (Mollenkopf & Closs, 2005; Rock & Angel, 2007). These environmental initiatives complement extended producer responsibilities (EPR) where producers are obliged to take financial and physical responsibility through take back programs to reduce the volume and toxicity of landfill waste (Lee and No, 2010; Terazono et al., 2007).

Since a legal framework to enforce EPR have yet to exist, Agamuthu and Dennis (2011) pointed out that most of the product recovery programs among Malaysian manufacturers are limited to voluntary participation. Only a handful of local companies accept used equipments from downstream customers as part of after sales services and it is unusual that firms collect them for proper recycling and disposal. It is only a matter of time that EPR is introduced to increase the traffic of returns and improve the efficiency of reverse logistics via bulk reprocessing. As reusability of products discourages viability of product recovery, Amelia et al. (2009) and Go et al. (2010) emphasized the importance of design for reuse to enhance reclamation of automotive parts. Similar conditions can be observed in the E&E manufacturing environment and more attention must be invested in reverse logistics particularly promotion of product redesign that accounted for barriers that deter recyclability. Even though a number of studies analyzed the components of green supply chain management (GSCM) such as green purchasing, green product design, green manufacturing, green distribution and reverse logistics (Zhu, Sarkis & Lai, 2007; Eltayeb, Zailani & Ramayah, 2011; Khor & Udin, 2013), all of them focused on performance outcome of GSCM. In contrast, this study looks into the role of green designing on the economic performance of reverse logistics.

2.0 Literature Review

2.1 Reverse logistics

Prahinski and Kocabasoglu (2006) defined reverse supply chain management as 'effective and efficient management of the series of activities required to retrieve a product from a customer and either dispose of it or recover value'. There are five major processes to reverse supply chain management and they are product acquisition, reverse logistics, inspection and disposition, remanufacturing, and distribution and sales. Instead of exemplifying reverse logistics as transportation, warehousing, distribution and inventory management activities, this study treats reverse logistics as equivalent to asset recovery, where as-new or used products re-enter various marketing channels to extend the lifecycle of electrical and electronic equipments.
This study defines reverse logistics as ‘disposition options which are industry and product-specific, where decision-making highly depends on conservable value in used products. Products are reincarnated for efficient consumption and disposal of resources by recovering materials and energy invested within products, modules or components to reuse in forward supply chain to gain environmental and business benefits.’

With comparison to practices in developed countries, the local manufacturing environment is not familiar with accepting and processing returns beyond warranty terms. Although the Minister of Housing and Local Government are authorised to enforce Clause 101 and Clause 102 of Solid Waste and Public Cleansing Management Bill 2007, which provide for (1) reduction, reuse and recycling of controlled solid waste, and (2) take back system and deposit refund system, the lack of framework for enforcement only managed to induce voluntary product take back programs. Despite the existence of such regulations, the absence of legislative enforcement system failed to regulate product recovery activities. This does not mean that reverse logistics activities are non-existence but rather, spare parts are in demand among third party remanufacturers or second hand repair workshops. In the case of Malaysia, Tengku (2011) pointed out that unlicensed or illegal operator conducted unregulated backyard dismantling and recycling activities in unsafe manners and inherently expose surrounding environment to the threats of harmful substances. With respect to Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal, the Department of Environment (DoE) Malaysia introduced the ‘Guideline for the Classification of Used Electrical and Electronic Equipment’ to deter the exportation of e-waste that disguised as second hand goods. Since these restrictions preserve supplies at local waste streams and led to abundance of retrievable precious metals within end-of-use or end-of-life products, Malaysian manufacturers ought to weigh the benefits of EPR to take advantage of economies of scale recovery. Considering shorter technological clockspeed and higher rate of product obsolescence, the availability of valuable and functional assets is capable of reducing material costs especially for reconditioned and remanufactured EEEs.

2.2 Green Product Design

Based on Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), producers are required to augment the rate of reuse and recycling of components, materials and substances up to the range of 50 to 75 percent of average weight per appliance for various categories of WEEE. In line with this target, the Directive recommended that appropriate measures are taken during design and production of EEEs to facilitate dismantling and recovery unless the specific design features served as safety measures or meant to contain the effects of pollution. In other words, the recoverability of products is dependent on the readiness of the product to be recovered. Coined from the concept of product stewardship, the design team is obliged to incorporate green design aspects into products during the stage of product development to effectively alter the patterns of production and consumption.

According to Khor (2013), green product design ought to be employed as a corporate proactive approach that integrates product design and environmental considerations without compromising product’s function and quality, including innovations for recovering product value throughout its life cycle prior to disposal. Of late, a number
of producers have joined the bandwagon of green by adopting less complex approaches such as reduction of material and/or energy consumption. However, more efforts must be invested on design for disassembly, reuse and recycling to mobilize green economy and achieve greater green leaps. Since most the hard value of asset recovery is extracted during disassembly process, this study looks into the utilization of modular subassemblies, accessibility of valuable components or parts, and separability of joining elements. For instance, producers can implement minor design changes that put forth immense benefits to facilitate value recovery such as minimize the quantity of fastening elements, use of snap fits in lieu of screws, and avoid the use welds or adhesives (Desai & Mital, 2003; Mathieux, Froelich & Moszkowicz, 2008; Tien, Chung & Tsai, 2002; Veerakamolmal, 1999). While disassemblability of products accommodates the reuse of parts or components, the recyclability of product only yields recyclable materials. Unless there are economies of scale in product recycling, the cost of harvesting recycled material is unattractive to businesses. Generally, most firms have established procedure for recycling scheduled waste to comply with environmental management standards. Since in-house recycling and bulk recovery are rare instances, designing for recycling is not a pressing issue as compared to design for disassembly and design for the environment, where both directly affect the intricacy of product inspection and high value recovery.

2.3 The Direct Effects of Green Product Design and Reverse Logistics on Economic Performance

While the value of returns in the U.S. market may exceed $100 billion dollars per year (Stock & Mulki, 2009), the existence of product take back and recovery activities is only a fraction of total sales among firms in developing nations particularly Asian countries. Generally, Guide et al. (2000) indicated that uncertainty of timing, quantity and quality of returned products complicates the management of inventories. On top of it, the lack of market for recycled materials indicates the lack of financial prospects, thus impeding producers’ interest in reprocessing end-of-use and end-of-life equipment. In contrast, firms can develop an array of secondary market to liquidate reusable or preowned equipments and recover the transportation and handling cost for extending products’ lifecycle. These options include, but not limited to online auction site, factory outlets, value retailers, pawn shops, dollar stores, flea markets and charities (Rogers, Rogers, and Lembke, 2010). The availability of secondary market is a viable reason for generating positive environmental and economic outcome from the sales of excess inventories or materials via investment recovery (Zhu and Sarkis, 2007).

Although extending product lifecycle could be a viable business, the asset recovery operations face immense challenges in extracting subassemblies and components that are of good and functional condition. The complexities involved in reprocessing are unappealing to businesses due to the cost of asset recovery. Considering that most products are not designed for easy disassembly, the economic viability of reverse logistics product disposition is challenged by high cost in hiring skilled labor to dismantle EEEs (Kumar & Putnam, 2008). Unlike forward manufacturing assembly where driving down production cost per unit is one of the business goals, the backward supply chain incur substantial resources to extract valuable components and manufacture used products for secondary markets. Although one can argue that the profit margin of asset recovery is much lesser due to handling and transportation
costs, the cost reduction opportunities from reusing materials particularly whole products or functional subassemblies justify the viability for engaging greener businesses. Additionally, Ayres et al. (1997) presented evidences on the profitability of reverse logistics i.e. dismantle to retrieve good parts and active recycling at IBM SEMEA, manufacture as-new products at Rank Xerox, recycle integrated circuits to serve niche market at Aurora Electronics, and more. Other manufacturing companies rode on proper recycling and disposal of end-users’ EEEs as social responsibility initiatives to serve a growing consumer base who are receptive towards environmentally friendly activities.

Reverse logistics activities are being implemented out of concern for the environment. However, Skinner, Bryant and Richey (2008) revealed that reverse logistics disposition strategies do not result in superior economic performance. Nonetheless, Khor and Udin (2012) showed that some disposition options specifically repair, remanufacture and recycle and disposal associate with economic outcome but none indicated improvement in environmental performance. For that reason, this study acknowledges that economic performance is important and focused on profitability and sales growth as measures of reverse logistics. On the other hand, the performance of green product design, also known as ecodesign, consistently generate positive effects because minor changes including favourable choice of materials and minimization or substitution of hazardous substances are ‘low-hanging fruits’ that allow firms to look good among eco-conscious customers. Since a wide selection of studies conducted in various industry settings substantiated the economic performance of ecodesign, this study takes a slightly different direction and emulates Khor and Udin (2013) in analyzing design for disassembly and design for the environment as components of green product design. Based on previous literatures, this study proposed that:

P1: Reverse logistics has a significant relationship with economic performance.
P2: Green product design has a significant relationship with economic performance.

2.4 The Mediating Effects of Green Product Design

A number of studies have empirically examined the performance of green supply chain management (Eltayeb et al., 2011; Khor and Udin, 2013; Ninlawan et al., 2010; Sroufe, 2003; Zhu & Sarkis, 2007) but none investigated the indirect effects of green product design on the performance of reverse logistics. While the value of recoverable assets determines the success of reverse logistics, the recoverability of assets depended on the product characteristics that support material recovery. Recall that green products are conceptualised to reduce the demand for material and energy. The asset recovery operations ought to communicate the challenges that deter effective retrieval so that designers can take relevant measures during the conceptualization of new equipments. Therefore, the greenness of products is determined by how demand for natural resources declines due to efficient use of nonrenewable resources. Some green products had been successful in reducing the demand for energy but many failed to fulfill the objectives of sustainable development because most of the materials were not recyclable or recycled through proper channels. Based on Krikke et al. (1998), the extent of disassembly required by product repair, recondition, remanufacture and recycling activities increases across respective levels specifically product, module, part and material level. Although various studies examined green
product design as design that reduce or eliminate the use of hazardous substance, this study attempt to emphasize the importance of designing for disassembly to facilitate extraction of reusable constituents because the value of recyclable material is relatively minuscule.

Various issues that hinder parts recovery or materials recycling are communicated to design personnel so as to redesign the structure and composition of equipments (Ayres et al., 1997; Talbot, Lefebvre and Lefebvre, 2007; van Hoek, 1999). The interdependence between green product design and reverse logistics product disposition determines the success of product take back and recovery programs. For instance, Ferrer (2001) enlisted bonding, joint-stamping, riveting and welding as fastenings that aid effective product assembly but these joints were almost impossible to disengage without damaging (e.g. cosmetic damages) at least one of the conjoined parts and/or components. As choices of joints disrupt effective reuse of recoverable value, the asset recovery operations generates poor recovery rate, missed cost reduction opportunities and high demand for specialized personnel. These instances become feedback to designers’ learning curve and rationalized the integration of green design aspects when developing future products. Note that collaboration between personnel from asset recovery and design departments is important to iron out various complexities encountered during the process of recovery and recycling. For instance, some recommendations include us of breakable snap fits in lieu of screws if they do not impact the structural strength of products, use environmentally preferred materials to ease the handling of hazardous materials, and response to designers on frequency of malfunctions that occur prior to their expected lifespan.

Since previous researches provide solid empirical grounding on effects of reverse logistics and green product design, the current study intend to examine the mediating effects of green product design based on the following propositions:

P3: Reverse logistics has a significant relationship with green product design.
P3a: Reverse logistics has a significant relationship with design for disassembly.
P3b: Reverse logistics has a significant relationship with design for the environment.
P4: Green product design mediates the relationship between reverse logistics and economic performance.
P4a: Design for disassembly mediates the relationship between reverse logistics and economic performance.
P4b: Design for the environment mediates the relationship between reverse logistics and economic performance.

3.0 Theoretical Framework and Instrument Development

The current model is synthesized from the empirical studies conducted by Zhu et al. (2007), Eltayeb et al. (2011), Sroufe (2003), Skinner et al. (2008) and Talbot et al. (2007). Based on previous literatures, Figure 1 depicts the theoretical framework of this study where green product design specifically design for disassembly and design for the environment exert indirect effects on the relationship between reverse logistics and economic performance. The examination of recoverable products for closing the supply chain loop begins with product disassembly. As time-sensitive approach is required to manage the value of reusable equipment, disassemblability takes
precedence over recoverability since the inspection and testing phase starts off with accessibility and separability of high-value parts.

![Figure 1: Theoretical Framework](image)

With reference to Table 1, the measurement items for reverse logistics, green product design and economic performance of reverse logistics are adapted from literatures across the field of reverse supply chain management, green supply chain management and environmental management. Respondents are required to evaluate the extent of existence of green supply chain practices and level of significant economic performance based on five-point Likert type scale. Recall that the extended producer responsibility policy will be eventually introduced to induce environmental commitment among E&E manufacturing firms because the global environment including Europe, United States, Japan, Korea, Taiwan and China have introduced legislations to govern WEEEs. In staying ahead of the competition, product designers are encouraged to adopt forward thinking to build green reputation among environmentally conscious customers and reduce the cost burden associated with product take back and recovery programs.

Table 1

**Variables and Measurement Items**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reverse Logistics</strong></td>
<td></td>
</tr>
<tr>
<td>1. Repair is the correction of faults in a product.</td>
<td>Ijomah et al. (2007)</td>
</tr>
<tr>
<td>2. Recondition replaces all major components that have failed or that are on the point of failure.</td>
<td>King et al. (2006)</td>
</tr>
<tr>
<td>3. Remanufacture is the work for returning product to at least OEM original performance specification.</td>
<td>Krikke et al. (1998)</td>
</tr>
<tr>
<td>4. Recycle involves reusing materials from used products and components.</td>
<td>Skinner et al. (2008)</td>
</tr>
<tr>
<td><strong>Green product design</strong></td>
<td></td>
</tr>
<tr>
<td>Design for Disassembly</td>
<td></td>
</tr>
<tr>
<td>2. Design products that use snap fits in lieu of screws.</td>
<td>Cerdan et al. (2009)</td>
</tr>
<tr>
<td>3. Design products that minimize the number of fasteners.</td>
<td>Dowie (1994)</td>
</tr>
</tbody>
</table>
5. Design products that ease accessibility of joining elements.
6. Design products that consider the weight, shape and size of structure for disassembly.

**Design for the Environment**

1. Use pollution-free raw materials in production.  
   Eltayeb et al. (2011)
2. Use raw materials that are compliant with environmental protection regulations.  
   González-Benito & González-Benito (2005)
3. Design of products that reduce consumption of materials.  
   Tien et al. (2002)
4. Design of products to avoid or substitute the use of hazardous substances.  
   Zhu et al. 2007

**Economic Performance**

1. Significant improvement in revenue from after sale services.  
   Daugherty et al. (2001)  
   Eltayeb & Zailani (2011)
2. Significant reduction in cost of goods sold for recovered products.  
   Klassen & McLaughlin (1996)  
   Rao (2002)
3. Significant reduction in the cost for purchasing raw materials, components or subassemblies.  
   Talbot et al. (2008)
4. Significant improvement in market share.  
   Montabon et al. (2000)  
   Zhu et al. (2007)
5. Significant improvement in corporate environmental reputation among environmentally conscious customers.

**4.0 Conclusion**

This conceptual paper wishes to highlight the importance of green product design in reducing the volume of landfill wastes. Although negative environmental consequences have caught the attention of various external stakeholders, producers seemed to exert lack of enthusiasm towards product take back and recovery programs because the complexities encountered during the stage of product reprocessing overwhelm profit generating opportunities. There is substantial value in extending the lifecycle of end-of-use and end-of-life equipments because many retire prior to their expected lifespan due to failure of few critical parts. Nevertheless, some forward-thinking manufacturers obliged by the concept of product stewardship to compete including rethinking environmental impact of product lifecycle via redesigning for reuse. The framework of this paper recognised the economic benefits of reverse logistics and acknowledged that it is best that the product development team address some barriers that deter the business viability of equipment recovery. Future research should gather empirical evidences to determine the effectiveness of simultaneous reverse logistics and green product designing implementation. The prospects of dual initiatives in securing monetary value while reducing negative environmental impacts ought to entice producers to adopt environmentally responsible businesses.
References


**Contact email:** kuansiewk@sunway.edu.my, ramayah@usm.my, williame@sunway.edu.my, lala86lala@yahoo.com.my
The Study of Factors Affecting the Application of Theories for Inventory Management of Auto-Parts Manufacturing Companies

Anuwat Charoensuk, Thai-Nichi Institute of Technology, Thailand
Pongsak Saithanya, Thai-Nichi Institute of Technology, Thailand

Abstract
The aim of this research is to study the factors that affect theories applied to the inventory management of auto-parts manufacturing companies. The sampling group was the executives who were responsible for inventory management of 342 auto-parts manufacturing companies located in industrial estates of Bangkok, Samut Prakan, and Eastern areas. The research instrument was the 5-point Likert scales questionnaire. The data were analyzed by a statistical analysis software program for percentage, mean, standard deviation, and factor analysis.

From the factor analysis, the factors that affected the theoretical application to the inventory management of auto-parts manufacturing companies consisted of 10 factors including organization awareness, organizations’ internal cooperation, supports from their organization and colleagues, knowledge management system, organization culture, importance of workers, organization’s quality and management, workers’ skills, knowledge application, and receiving skills.

The operation that applied the knowledge from theories to inventory management needed to consider the operation of the entire system simultaneously. The operation should not be done part by part because each part worked relatedly to each other and supported each other. Therefore, the operation of only one particular part not only made the management fail, but companies may also lose their capital cost and time as well as their workers’ spirit and will power.

Keywords: Applied Theories, Inventory Management, Factor Analysis
Introduction

Inventory management has been an important key for organization management in any manufactures as it helps them to make important decision, gain more benefits, cut the cost and still be able to satisfy customers. Zappone (2006) addresses that minimizing the cost mainly relates to inventory and also the study of inventory has the main aim to help a company save the large amount of money. Closs (1989) asserts that with reliable and effective inventory control, a company could be able to lower the cost and stay in competitive with other companies.

Inventory management has gained more attention for quite a long time. Hadley and Within (1964) state that to cope with the inventory management, inventory theory was an important tool. They explain that traditionally, the inventory theory was developed from a construction of a mathematical model. Various inventory theories were developed and the obstacles of applying the theories in real-life situation were investigated to help the inventory managers dealing with different kinds of situations.

An organization could gain many benefits from a good inventory control system. Clodfelter (as cited by Mpwanya, 2005) addresses that a good inventory control system could maintain the balance of sales and inventory to avoid being overstocked or understocked. It provides information that identifies slow-selling and best seller merchandises so that companies could plan in advance what they would do with those merchandises. Besides, a good inventory control system could also indicates shortages and shrinkage of merchandises and finally reduce employee shoplifting.

Nowadays, there are many more companies and more competition. Advanced technology is created all the time. Customer demands are not the same. Therefore, companies need to act quickly to these changes (Ortegan & Lin, 2004). Inventory management theories play a more important role as a solution to inventory’s problems. Many inventory management theories and models have been created such as reorder point \((r)\), Economic Order Quantity (EOQ), Just-In-Time, Deterministic Control theory, or 2BIN.

Each theory or model was designed to serve different purposes. For example, the reorder point model was designed to help a manager making a decision when to reorder and how much to reorder (Braglia, Gabbielli, & Zammori, 2013). The reorder point model is related to EOQ. Schwarz (2005) states that EOQ is the “cost-minimizing order-quantity” (pp. 135). It comes in a position to help making a decision how much to reorder. It involves with the cost of ordering and storage. If a company orders a lot of merchandises at a time, it could save time and money on ordering but pay more on storage. In vise versa, a company could save money for storage if fewer merchandises, but pay more money and spend more time to reorder. Therefore, EOQ comes in to help making the decision of ordering the merchandises by considering the customer demands.

Just-In-Time (JIT) is another widely used theory for inventory management. Olhager (2002) states that JIT has been used for the last two decades starting from 1980s. JIT refers to “resource utilization, that is, units of material, subassemblies, and components arrive in a manufacturing setting “just in time” for their use” (Singh, Singh, Mand, & Singh, 2013, pp. 86). That means suppliers deliver merchandises to
manufactures just in time for the production and manufactures produce just the right amount for the customer demands. The main aim of JIT is to reduce lead-time and lot size (Olhager, 2002). Therefore, the delivery speed would be improved and there would be no waste of merchandises in the stock. Or it would say that the main aim of JIT is zero lead-time, zero inventory, and zero failures.

Statement of the problem

With the rapid changes of the society, the customer demands are changed along with the advancements of technology. Companies need to adapt themselves to fulfill customer need and to cope with the hi-technology. Inventory management plays a crucial role in all kinds of manufacturing companies. However, it is very critical how a company would deal with its inventory management various theories have been designed to solve different problems that could happen in a company. A company needs to wisely choose inventory theories or methods that are appropriated to them. Thus, the application of inventory theories has played a major role in the company success. However, the problem that was found, especially in Thailand, is that many companies are still facing with the problems of an empty stock or too many supplies in stock. One main reason that causes them the problems is that those companies do not pay attention to apply an inventory management theory in the real-life situation even though their executives and employees have all the knowledge of the theories. Therefore, this aspect has come to the researchers’ attention if there any factors that could be a barrier holding them to not apply their knowledge of inventory management theories to their works.

Furthermore, this present study focused on auto-parts manufacturing industry because it is one of the largest industry in Thailand. In year 2010, it brought profits to Thailand about $13.37 billion which was ranged in second of top ten export products of Thailand (Thailand Board of Investment, 2010). Thailand is also known as the Detroit of Asia as it is the South East Asia’s largest and most advanced automotive industry (Nag, Banerjee, & Chatterjee, 2007). Automobile industry is a strategic target for developing countries like Thailand and the auto-parts industry is the value added for the whole automobile industry (Takahashi, 2001). Thailand is the biggest automobile market in ASEAN region that offers attractive incentive and flexible economic policy to attract the foreign investment. The industry needs to have enough quality workforces to handle its growing. For example, in year 2012, with the goal to produce 2 – 2.1 million cars, Thai auto-parts industry plans to hire 30,000 – 40,000 employees more in order to reach the year’s goal (National News Bureau of Thailand, 2012).

The auto-parts manufacturing industry is the industry in Thailand that hire the largest number of Thai employees with various profession. A major problem that usually happens in the auto-parts manufacturing industry is the inventory management problem because the employees need to deal with many big and small parts of automobile. It is quite a hard work to manage their stock and fulfill the customer demand. As a result, to solve the problem, the auto-parts manufacturing companies should apply an inventory management theory that is suitable to their situation. However, the problem is the company seems to be reluctant to apply those theories. Consequently, it would be worth to investigate what factors that cause this immediate problem.
Research objective

The study aims to investigate factors affecting the application of theories to inventory management of auto-part manufacturing companies.

Significance of the study

The study reveals the factors that affect the application of theories to inventory management of auto-part manufacturing companies as well as the opinion of companies’ executives on those factors. Moreover, the results of the study could be used as a guide to improve and develop the inventory management system of the auto-part manufacturing companies.

Framework of the study

Research Methodology

1. Participants

The participants were the executives including supervisors, assistant managers, and managers from 342 auto-part manufacturing companies located in industrial estates of Bangkok, Samut Prakan, and Eastern areas. Systematic random sampling was used to select the samples from 1,831 auto-part manufacturing companies.

2. Research Instrument

The research instrument was a 5 point-Likert scale questionnaire ranging from; 1 means the least affect, 2 means rarely affect, 3 means moderate affect, 4 means much affect, and 5 means the most affect. The questionnaire consisted of three parts. The first parts was the general information of participants and their companies including their gender, age, education levels, current position, years of working, company size,
numbers of employees, authorized capital, and investment sources. The second part was the items on factors affecting the application of theories to inventory management. The last part was an open-ended question that allowed participants to add more suggestions and comments.

The questionnaire was developed by first identifying the objective and content. The content was developed based on the framework of the study. The questionnaire was examined for its content validity by three experts to find the index of item objective congruence (IOC). Then the questionnaire was revised and tried in order to find its reliability. Cronbach’s alpha coefficient was used to analyze the data. The questionnaire was revised again before its actual use. Finally, the main part of the questionnaire (the second part) contained 42 items divided into 7 parts or 7 different factors. Those were operation systems (6 items), employees’ qualification (5 items), organization culture (10 items), employee supporting policy (11 items), technology and quality (3 items), executives’ supports (2 items), team work and flexibility (5 items).

3. Data collection and data analysis

The researchers needed to collect the data from at least 328 companies and were aware that not all companies would be willing to participate. Therefore, the questionnaire was distributed to 1,000 auto- parts manufacturing companies. Finally, 342 companies participated and replied the questionnaire. Then the data were analyzed using descriptive analysis and factor analysis.

Results

From the first part of questionnaire, Table 1 below demonstrates the basic data of all participants including their companies’ basic information. The information from this part could be an important factor that affected other factors in this present study.
From Table 1, most executives are at the ages of 31-35 years old (35.7%) and have worked for 5-10 years (43.3%). They mostly have the Bachelor degree (71%). For the companies, most of them have some investment from foreigners (76.6) and hold the authorized capital of at least 201 million baht (24.6%). Most of them are medium size companies with at least 300 employees (34.5%).

Table 2 – Table 5 demonstrates the data of the different inventory management theories that are applied in the auto-parts manufacturing companies.
From Table 2, the inventory management theories that are mostly used by many companies are Inventory Counting System (38.4%), Inventory Control System (36.3%) and JIT/TPS (31.9%). The theory that is used the least is 2 BIN (6.4%).

When classified by the company size, the inventory management theory that is used most in the large company size is Inventory Counting System (52.4%). The theory used most in the medium company size is JIT/TPS (36.5%). The theory used most in the small company size is Inventory Control System (41.6%).
### Table 4: The Application of Inventory Management Theories to Auto-Parts Manufacturing Companies Classified by Investment Sources

<table>
<thead>
<tr>
<th>Inventory Management Theories</th>
<th>Investment Sources</th>
<th>No. of companies</th>
<th>% of all companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 BIN</td>
<td>100% Thai</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>12</td>
<td>4.6</td>
</tr>
<tr>
<td>MRP</td>
<td>100% Thai</td>
<td>20</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>55</td>
<td>21.0</td>
</tr>
<tr>
<td>EOQ</td>
<td>100% Thai</td>
<td>22</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>46</td>
<td>17.6</td>
</tr>
<tr>
<td>ROP</td>
<td>100% Thai</td>
<td>14</td>
<td>17.5</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>18</td>
<td>6.9</td>
</tr>
<tr>
<td>JIT/TPS</td>
<td>100% Thai</td>
<td>22</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>87</td>
<td>33.2</td>
</tr>
<tr>
<td>Inventory Control System</td>
<td>100% Thai</td>
<td>28</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>96</td>
<td>36.6</td>
</tr>
<tr>
<td>Inventory Counting System</td>
<td>100% Thai</td>
<td>34</td>
<td>42.5</td>
</tr>
<tr>
<td></td>
<td>Some investment from foreigners</td>
<td>97</td>
<td>37.0</td>
</tr>
</tbody>
</table>

When classified by the investment sources, the inventory management theory used most in companies with 100% Thai investment and some investment from foreigners is Inventory Counting System (42.5% and 37%). The theory used the least with 100% Thai investment and some investment from foreigners is 2 BIN (12.5% and 4.6%).
Table 5: The Application of Inventory Management Theories to Auto-Parts Manufacturing Companies Classified by Authorized Capital

<table>
<thead>
<tr>
<th>Inventory Management Theories</th>
<th>Authorized Capital</th>
<th>No. of companies</th>
<th>% of all companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 BIN</td>
<td>Less than 30 million baht</td>
<td>3</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>7</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>3</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>4</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>3</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>MRP</td>
<td>Less than 30 million baht</td>
<td>5</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>17</td>
<td>30.4</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>10</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>10</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>8</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>25</td>
<td>29.8</td>
</tr>
<tr>
<td>EOQ</td>
<td>Less than 30 million baht</td>
<td>12</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>14</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>13</td>
<td>20.3</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>9</td>
<td>20.9</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>7</td>
<td>17.1</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>13</td>
<td>15.5</td>
</tr>
<tr>
<td>ROP</td>
<td>Less than 30 million baht</td>
<td>4</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>5</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>4</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>4</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>9</td>
<td>22.0</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>6</td>
<td>7.1</td>
</tr>
<tr>
<td>JIT/TPS</td>
<td>Less than 30 million baht</td>
<td>8</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>15</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>29</td>
<td>45.3</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>17</td>
<td>39.5</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>10</td>
<td>24.4</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>30</td>
<td>55.7</td>
</tr>
<tr>
<td>Inventory Control System</td>
<td>Less than 30 million baht</td>
<td>20</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>21</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>20</td>
<td>31.2</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>13</td>
<td>30.2</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>13</td>
<td>31.7</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>37</td>
<td>44.4</td>
</tr>
<tr>
<td>Inventory Counting System</td>
<td>Less than 30 million baht</td>
<td>23</td>
<td>42.6</td>
</tr>
<tr>
<td></td>
<td>31-50 million baht</td>
<td>25</td>
<td>44.6</td>
</tr>
<tr>
<td></td>
<td>51-100 million baht</td>
<td>25</td>
<td>39.1</td>
</tr>
<tr>
<td></td>
<td>101-150 million baht</td>
<td>15</td>
<td>34.9</td>
</tr>
<tr>
<td></td>
<td>151-200 million baht</td>
<td>8</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>201 million baht or over</td>
<td>35</td>
<td>41.7</td>
</tr>
</tbody>
</table>

Table 5 reveals that the companies with authorized capital of less than 30 million baht and 31-50 million baht mostly use Inventory Counting System (42.6% and 44.6%). The companies with authorized capital of 51-100 million baht and 101-150 million baht use JIT/TPS (45.3% and 39.5%). The company with authorized capital of 151-200 million baht and 201 million baht or over uses Inventory Control System (31.7% and 44.4%).
From the data analysis showing in all tables, it could be assumed that Inventory Control System, Inventory Counting System, and JIT/TPS seem to be the theories that most companies apply to their inventory management. On the other hand, 2 BIN seems to be the least use in all types of auto-parts manufacturing companies.

To the research objective, the aim is to investigate factors affecting the application of theories to inventory management of auto-part manufacturing companies. The result shows that all seven factors affect the application of inventory management theories at a high level (mean = 3.51-4.50). The descriptive statistics related to the factors affecting the application of inventory management theories reported from the questionnaire was summarized in the Table 6.

<table>
<thead>
<tr>
<th>Factors</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working systems</td>
<td>342</td>
<td>4.2018</td>
<td>.62000</td>
</tr>
<tr>
<td>Workers’ qualification</td>
<td>342</td>
<td>4.1316</td>
<td>.64775</td>
</tr>
<tr>
<td>Organization culture</td>
<td>342</td>
<td>4.1930</td>
<td>.66161</td>
</tr>
<tr>
<td>Worker supporting policy</td>
<td>342</td>
<td>4.1988</td>
<td>.62350</td>
</tr>
<tr>
<td>Technology and quality</td>
<td>342</td>
<td>4.1930</td>
<td>.72099</td>
</tr>
<tr>
<td>Executives’ supports</td>
<td>342</td>
<td>3.9766</td>
<td>.79922</td>
</tr>
<tr>
<td>Team work and flexibility</td>
<td>342</td>
<td>4.1784</td>
<td>.69796</td>
</tr>
</tbody>
</table>

From Tables 6, the mean scores show that all factors have an effect on the application of inventory management theories at a high level. The working systems have the most effect (mean=4.2018) and worker support policy comes to the second most (4.1988). Executive’s supports are the least effect among all.

The result from the data collection was analyzed again using KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) and Bartlett’s test of sphericity. The result indicated that Factor Analysis could be useful with the data.

In order to use factor analysis, firstly, the factors were extracted using PCA (Principle Component Analysis). The eigenvalues, variance, and cumulative variance are described in Table 7. The result revealed that instead of 7 factors, it became 10 factors including organization awareness, organizations’ internal cooperation, supports from their organization and colleagues, knowledge management system, organization culture, importance of workers, organization’s quality and management, workers’ skills, knowledge application, and receiving skills. These 10 factors had the eigenvalues of 1.00 or higher. The sum of cumulative variance was 61.284%.
VARIMAX was used as a rotation method to find the association factors and variables. All variables were associated with the factors. Table 8 – Table 17 demonstrate each factor and its variables.

### Table 7: Numbers of Factors, Eigenvalues, Variance, and Cumulative Variance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Eigenvalues</th>
<th>% of Variance</th>
<th>% of Cumulative Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.877</td>
<td>9.231</td>
<td>9.231</td>
</tr>
<tr>
<td>2</td>
<td>3.360</td>
<td>8.000</td>
<td>17.232</td>
</tr>
<tr>
<td>3</td>
<td>3.313</td>
<td>7.888</td>
<td>25.120</td>
</tr>
<tr>
<td>4</td>
<td>2.833</td>
<td>6.745</td>
<td>31.864</td>
</tr>
<tr>
<td>5</td>
<td>2.678</td>
<td>6.376</td>
<td>38.241</td>
</tr>
<tr>
<td>6</td>
<td>2.385</td>
<td>5.678</td>
<td>43.919</td>
</tr>
<tr>
<td>7</td>
<td>2.196</td>
<td>5.229</td>
<td>49.147</td>
</tr>
<tr>
<td>8</td>
<td>2.008</td>
<td>4.781</td>
<td>53.928</td>
</tr>
<tr>
<td>9</td>
<td>1.608</td>
<td>3.828</td>
<td>57.756</td>
</tr>
<tr>
<td>10</td>
<td>1.481</td>
<td>3.527</td>
<td>61.284</td>
</tr>
</tbody>
</table>

The first factor is organization awareness consisting of seven variables. The factor loading is between .450 - .658. The eigenvalue is 3.877. All variables are important. In order to gain organization awareness, a company needs to pay attention to all variables and makes them happen. From the factor loading, the most important variable that a company needs to achieve first is the first one “The organization and workers are sharing the same aims.” Then other variables could be done after.

### Table 8: Factor 1: Organization Awareness

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>The organization and workers are sharing the same aims.</td>
<td>.658</td>
</tr>
<tr>
<td>18</td>
<td>Working as a team.</td>
<td>.637</td>
</tr>
<tr>
<td>24</td>
<td>Workers understand clearly what organizations want to be in the future</td>
<td>.594</td>
</tr>
<tr>
<td>21</td>
<td>Working together with creative thinking</td>
<td>.568</td>
</tr>
<tr>
<td>19</td>
<td>Leaders have holistic concepts that help to see the whole picture of operation systematically.</td>
<td>.551</td>
</tr>
<tr>
<td>38</td>
<td>The organization is aware of the importance of team working.</td>
<td>.510</td>
</tr>
<tr>
<td>32</td>
<td>The organization gives workers opportunities to improve themselves.</td>
<td>.450</td>
</tr>
</tbody>
</table>

Eigenvalue = 3.877, % of Variance = 9.231
## Table 9: Factor 2: Organizations’ Internal Cooperation

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>The organization can adapt to all changes.</td>
<td>.640</td>
</tr>
<tr>
<td>42</td>
<td>Workers can adapt to all changes.</td>
<td>.632</td>
</tr>
<tr>
<td>40</td>
<td>Members of organizations share ideas to support the organization in coping with any future situations in order to achieve the organizations’ goal.</td>
<td>.558</td>
</tr>
<tr>
<td>33</td>
<td>All members can connect to each other through different kinds of technology.</td>
<td>.536</td>
</tr>
<tr>
<td>39</td>
<td>The organization is aware of the cooperation in working network.</td>
<td>.510</td>
</tr>
<tr>
<td>34</td>
<td>There is a suitable use of technology for all kinds of work.</td>
<td>.491</td>
</tr>
<tr>
<td>15</td>
<td>The organization builds and transfers knowledge that is useful to the work to its workers.</td>
<td>.463</td>
</tr>
</tbody>
</table>

Eigenvalue = 3.360, % of Variance = 8.000

Organizations’ internal cooperation is the second factor including seven variables. The variables have factor loading between .463 - .640. The eigenvalue is 3.360. Considering the factor loading, the most important factor is item no. 41 “The organization can adapt to all changes” which is needed to be done first.

## Table 10: Factor 3: Supports from Organization and Colleagues

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Working systems are correlated with your knowledge.</td>
<td>.727</td>
</tr>
<tr>
<td>2</td>
<td>Leaders support you in applying your knowledge to your works.</td>
<td>.679</td>
</tr>
<tr>
<td>4</td>
<td>To develop the organization, your organization has financial support for applying workers’ knowledge to actual work.</td>
<td>.647</td>
</tr>
<tr>
<td>5</td>
<td>The organization provides technology that is able to support your knowledge.</td>
<td>.601</td>
</tr>
<tr>
<td>3</td>
<td>Your colleagues cooperate with you when you apply your knowledge to works.</td>
<td>.567</td>
</tr>
<tr>
<td>6</td>
<td>Your position supports the use of your knowledge.</td>
<td>.405</td>
</tr>
</tbody>
</table>

Eigen Value = 3.313, % of Variance = 7.888

Supports from their organization and colleagues are the third factor that contains six variables. The factor loading of all variables is between .405 - .727. The eigenvalue is 3.313. The most important variable is “Working systems are correlated with your knowledge,” and following by “Leaders support you in applying your knowledge to your works.”
The fourth factor is knowledge management system. The eigenvalue is 3.313. The variables in this factor include 4 variables. The variables have factor loading between .515 - .661. The most important one is “The organization is willing to build its own knowledge.”

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>The organization is willing to build its own knowledge.</td>
<td>.661</td>
</tr>
<tr>
<td>25</td>
<td>The organization provides clearly solutions to deal with different problems</td>
<td>.655</td>
</tr>
<tr>
<td>20</td>
<td>Workers support each other by transferring knowledge to each other.</td>
<td>.577</td>
</tr>
<tr>
<td>28</td>
<td>The organization offers opportunities to workers to participate in setting the policies.</td>
<td>.515</td>
</tr>
</tbody>
</table>

Eigenvalue =3.313, % of Variance = 7.888

The fifth factor is organization culture including 4 variables. The variables have factor loading between .493 - .686. The eigenvalue is 2.678. The most important one is “The organization culture supports the application of theories to the work.”

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>The organization culture supports the application of theories to the work.</td>
<td>.686</td>
</tr>
<tr>
<td>16</td>
<td>The organization and employees are sharing the same mission.</td>
<td>.579</td>
</tr>
<tr>
<td>12</td>
<td>The organization’s atmosphere supports the application of theories to the works.</td>
<td>.512</td>
</tr>
<tr>
<td>13</td>
<td>The organization has a structure that supports the application of theories to the works.</td>
<td>.493</td>
</tr>
</tbody>
</table>

Eigen Value = 2.678, % of Variance = 6.376

The sixth factor is the importance of workers. The eigenvalue is 2.385. The most important one is “The organization builds a strong viewpoint of cooperation among the whole organization employees.”

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Employees’ responsibility is flexible.</td>
<td>.612</td>
</tr>
<tr>
<td>31</td>
<td>The organization gives employees opportunities to be able to learn.</td>
<td>.565</td>
</tr>
<tr>
<td>27</td>
<td>The organization gives workers opportunities to learn new technology.</td>
<td>.471</td>
</tr>
<tr>
<td>17</td>
<td>The organization builds a strong viewpoint of cooperation among the whole organization employees.</td>
<td>.441</td>
</tr>
</tbody>
</table>

Eigen Value = 2.385, % of Variance = 5.678
The sixth factor is importance of workers including 4 variables. The variables have factor loading between .441 - .612. The eigenvalue is 2.385. The most important one is “Employees need flexibility in their responsibility.”

Table 14: Factor 7: Organization’s Quality Management

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>The organization is consistently aware of the importance of quality management.</td>
<td>.649</td>
</tr>
<tr>
<td>37</td>
<td>The organization’s atmosphere supports the development of working life quality.</td>
<td>.573</td>
</tr>
<tr>
<td>36</td>
<td>Executives give employees supports more than giving orders.</td>
<td>.506</td>
</tr>
</tbody>
</table>

Eigen Value = 2.196, % of Variance = 5.229

The seventh factor is Organization’s Quality Management including 3 variables. The variables have factor loading between .506 - .649. The eigenvalue is 2.196. The most important one the needs to be done first is “The organization needs to be consistently aware of the importance of quality management.”

Table 15: Factor 8: Workers’ Skills

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>The years of working experience supports the application of your knowledge to your work.</td>
<td>.814</td>
</tr>
<tr>
<td>8</td>
<td>Your special profession supports the application of your knowledge to your work.</td>
<td>.715</td>
</tr>
<tr>
<td>10</td>
<td>The job security supports the application of your knowledge to your work.</td>
<td>.509</td>
</tr>
</tbody>
</table>

Eigen Value = 2.008, % of Variance = 4.781

The eighth factor is workers’ skills with the eigenvalue at 2.008. This factor contains 3 variables. The variables have factor loading between .509 - .814. The most important one is “the years of working experiences that help them to apply their knowledge.”

Table 16: Factor 9: Knowledge Application

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Your education level supports the application of your knowledge to your work.</td>
<td>.572</td>
</tr>
<tr>
<td>29</td>
<td>The organization gives workers opportunities to solve their own problems</td>
<td>.569</td>
</tr>
</tbody>
</table>

Eigen Value = 1.608, % of Variance = 3.828

The ninth factor is Knowledge Application including 2 variables. The variables have factor loading between .569 - .572. The eigenvalue is 1.608. The factor loading of
these 2 variables are quite close to each other; however, it would be better if workers have suitable level of education so that they can apply their knowledge to their work. Then a company can give them opportunity to solve problems in order to help them learn more and experience more.

Table 17: Factor 10: Receiving Skills

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Variables</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Your communication skill is an important obstacle in transferring knowledge to you work.</td>
<td>.572</td>
</tr>
<tr>
<td>22</td>
<td>You clearly understand about your own business.</td>
<td>.569</td>
</tr>
</tbody>
</table>

The last factor is receiving skills. The eigenvalue is 1.481. The factor has 2 variables with factor loading at .569 and .572, respectively. It is clearly that workers need to have effective communication skills first and so they can better understand what they need to do.

**Conclusion and Future Directions**

From the framework of seven factors that affected the application of inventory management theories of auto-parts manufacturing companies, all factors have high effect on the application. The most important one was “working systems” and “worker support policies” came to second. The least effect one was “executives’ support.”

After the data were analyzed for the factor analysis, the result revealed 10 factors instead of 7 factors. From the Eigen Value, it demonstrated which factor that needs to be considered as the most important and immediately done first. That was organization awareness, organizations’ internal cooperation, supports from their organization and colleagues, knowledge management system, organization culture, importance of workers, organization’s quality and management, workers’ skills, knowledge application, and receiving skills. If a company aims to achieve the application of inventory management theories effectively as well as create an organization of learning, this study suggests that these ten affective factors needs to done orderly. Then it would help a company to save both time and costs.

Piromrean (2008) studied the internal factors that influenced the organization of learning of Metropolitan Electricity Authority of Thailand. She found that organization culture and organization environment had the most direct effect while leadership of organization executives had the most indirect effect on the workers. She also found that the application of technology seemed to be the least effect factor; however, it was still in the moderate level.

In order to motivate the application of inventory management theories in an organization and create the organization of learning, an organization should be aware of all affective factors, none of them could be ignored. Importantly, all factors should be considered as one single system as they are related and support each other.
Therefore, an organization needs to operate them at the same time, and if it is possible, they should be done orderly as mentioned even though the result might not be effective.

For the future research, the study could be done in other kinds of industry such as, electronic and electric as they are the second large industry in Thailand. Other industries that need to be studies could be computer, plastic, and food since there is still very few studies about theory application for these kinds of industry.
References


Taiwanese EFL learners’ perceived use of online reading strategies

Wen Chun Chen, National Taiwan Normal University, Taiwan

Abstract

Reading strategies are beneficial to learners’ reading comprehension. The strategies can be divided into different categories, such as global reading strategies, problem solving strategies and support strategies. Most previous studies investigated the importance of reading strategies in the paper-based reading. However, relatively few studies examined online reading strategies and their effects on reading comprehension. Online reading materials are important sources for EFL students since an increasing number of learners read texts and learn through the Internet. EFL learners in Taiwan, unfortunately, are reported to be overwhelmed with English online materials on the Internet. Therefore, this study intends to examine EFL learners’ perceived use of online reading strategies and whether their perceived strategy uses are different in terms of proficiency levels and gender. There are 94 Taiwanese EFL learners (43% of them are males, n=40 and 57% of them are females, n=54), who received the Online Survey of Reading Strategies (OSORS) adapted from Anderson (2003) in the study. The result showed that EFL online readers tend to use more global strategies, such as using contextual clues and observing tables, figures, and pictures in the on-line text to increase understanding. High level learners used more global and problem solving strategies than low level learners, which corresponds to previous studies. Additionally, there is no difference of strategy use between males and females. Several pedagogical implications, such as the need to raise students’ awareness of strategy use, are addressed in the present study.

Keywords: online reading; L2 reading strategies; reading comprehension; gender differences; proficiency-level differences
1. Introduction

Reading strategies are beneficial to learners’ reading comprehension (Huang et al., 2009). The strategies can be divided into different categories, such as global reading strategies, problem solving strategies and support strategies. According to Sheorey and Mokhtari (2001), global reading strategies refer to intentional techniques by which learners monitor their reading, such as previewing the text for its organization. Problem solving strategies are localized techniques that readers use when problems form in understanding textual information, such as guessing the meaning of unknown words. Additionally, support strategies are seemed as using some supportive mechanisms, such as consulting an online dictionary. These reading strategies are commonly discussed in previous research. Readers utilize these strategies to help them improve their reading comprehension. Most previous studies investigated the importance of reading strategies in the paper-based reading (Bereiter and Bird, 1985; Singhal, 1999; Sporer et al., 2009; Mokhtari and Reichard, 2004; Sheorey and Mokhtari, 2001; Ikeda and Takeuchi, 2006; Spörer, Brunstein and Kieschke, 2009; Huang, 1999). However, relatively few studies examined online reading strategies and their effects on reading comprehension (Anderson, 2003; Foltz, 1993; Huang et al., 2009; Singhal, 1999). Online reading materials are important sources for EFL students since an increasing number of learners read texts and learn through the Internet. EFL learners in Taiwan, unfortunately, are reported to be overwhelmed with English online materials on the Internet (Chen, 2003). Online materials are usually composed of hypertext which is non-linear information, differing from traditional reading and resulting in difficulties for learners. The different feature of online materials compared to paper-based reading may also lead to different online reading strategy uses, which suggest that there is a need to conduct more research to further explore this issue. Moreover, most of previous studies discussed EFL learners’ strategy use between learners in different levels but relatively little research investigates gender differences in online reading strategy use. This study intends to examine EFL learners’ perceived use of online reading strategies and whether their perceived strategy uses are different in terms of proficiency levels and gender.

2. Literature Review

In this section, previous studies of reading strategy use will be discussed in terms of electronic literacies, paper-based second language reading strategies and online second language reading strategies.

2.1 Electronic literacies

As technologies have evolved, the nature of literacy is changing rapidly. The definition of literacy has expanded from traditional reading and writing to the ability of learning, comprehending and interaction with technology meaningfully in online reading (Pianfetti, 2001). Electronic literacies referring to screen-based literacies include understanding hypertext and multimedia information as well as evaluating online resources by using computers (Park and Kim, 2011). Online reading materials are usually composed of text information, hypertext or hypermedia. Hypertext and hypermedia can provide annotations for readers to know more related information about the online text. Hypertext refers to text with links which can provide additional information and also make readers read between different sections or pages.
These links, or annotations, can allow readers to leave the primary material temporarily and then return after finishing the annotation (Nielsen, 1995). Additionally, the term hypermedia is hypertext with multiple forms of media, which can provide extra information in the form of pictures or videos. The most prominent feature of hypertext is its nonlinear organization of presenting the text (Akyel and Ercetin, 2009). Readers can choose their own pace when reading this online text either sequentially or non-sequentially, that is, learners’ reading orders are unpredictable and unstable. (Patterson, 2000) Therefore, readers should know how to integrate the text information and non-text information in online reading (Coiro, 2005; Schmar-Dobler, 2003), which is more complex and also differs from the traditional reading process. The different reading process may result in different reading strategies in online reading environments, which will be discussed in the review of studies about online reading strategies.

2.2 Paper-based second language reading strategies

Most of the previous studies exploring reading strategies have focused on readers’ use of pen-paper reading strategies rather than online reading strategies in reading comprehension. These studies discussed the effects of teaching reading strategies and the different use of reading strategies between EFL learners and native speakers when they read texts. Some research has suggested that when teachers conduct the training of reading strategies for learners in EFL classrooms, it can be effective to enhance learners’ reading comprehension. For instance, according to Bereiter and Bird (1985), they found that the group who received the explicit instruction of reading strategies showed a significant gain in reading comprehension than the group without explicit instruction. In addition, Singhal (1999) observed that metacognitive strategy training is effective in enhancing second language reading and the effectiveness of strategy training depends upon the way reading is measured. Similarly, the students who received the intervention of training reading strategies gained higher scores on an experimenter-developed task of reading comprehension and strategy use than the control group (Sporer, Brunstein and Kieschke, 2009).

Other studies have investigated the similarities and differences of reading strategy use between native speakers and EFL learners or discussed EFL learners’ individual differences towards reading strategy use. A few researchers indicated that EFL learners may use certain reading strategies more than native speakers. Mokhtari and Reichard (2004) stated that Moroccan students reported using certain types of strategies more often than their American counterparts did while Sheorey and Mokhtari (2001) found that both native and nonnative groups applied a similar number of reading strategies. In terms of learners’ individual differences in reading strategies, many studies revealed the different use of strategies among learners from various proficiency levels. Ikeda and Takeuchi (2006) noticed that the differences between students in the high and low proficiency level are attributed to: (1) understanding the purpose of strategies; (2) effectively using strategies; and (3) knowing how to combine strategies. Additionally, high proficient readers tend to use global strategies while low proficient readers appeal to local strategies (Huang, 1999).
2.3 Online second language reading strategies

Although many studies discussed paper-based reading strategies, relatively few studies discussed online reading strategies. Readers have different mental processes when reading printed texts and online texts since readers need to integrate text, visual and non-textual information, including pictures, footnotes and links in online reading. In this way, they have more active engagement of reading in online texts, which leads to deeper processing of information (Patterson, 2000). When readers are involved in online reading, they not only interpret the writers’ stances and viewpoints, but also integrate abundant materials by utilizing online strategies (Coiro, 2005; Schmar-Dobler, 2003), which indicates the important role of online reading strategies to help readers understand online texts.

Previous research explored online reading strategies in terms of different perspectives, such as comparing paper and online reading strategies, examining the relationship of online reading strategies and web-based learning and discussing the individual differences in strategy use. In terms of comparing online and paper-based reading strategies, readers may transfer their print-based reading strategies to hypertext reading but they will also need to use additional strategies in hypertext reading (Shapiro and Niederhauser, 2004; Schmar-Dobler, 2003). Similar results are also found in other studies. Foltz (1993), for example, compared the strategy use by learners when they read the text in the form of linear text and hypertext. He proved that readers use the similar numbers of strategies when reading these two types of texts but when they read the hypertext, they not only got involved in a reading process but also developed problem solving strategies when dealing with unfamiliar texts. Additionally, Park and Kim (2011) investigated ESL learners’ use of online reading strategies from a sociocultural perspective and they observed that learners adopted their paper-based reading strategies in online reading, such as setting up reading purposes and previewing. At the same time, they also adjust their strategies and use new strategies for online reading materials, such as using hypermedia. Akyel and Ercetin (2009), similarly, indicated that hypertext readers applied similar reading strategies as paper-based reading but they used some other strategies, such as using navigation strategies or referring to annotations in their hypertext reading.

As for the relationship of online reading strategies and web-based learning, Singhal (1999) showed that online reading strategies have a positive effect on Web-based learning and reading comprehension. He investigated hypertext reading strategies among university students in a Web-based reading class and discovered that after Web-based reading instruction, students’ reading comprehension made progress and their use of reading strategies increased as well. In Coiro’s (2007) study, the finding also revealed that successful Internet reading experiences appeared to require complex applications of inferential reasoning strategies. Both studies suggested that online reading strategies play an important role in the success of web-based learning.

Some research discussed EFL learners’ use of online reading strategies and whether individual differences will influence learners’ strategy use. Amer, Barwani and Ibrahim (2010) examined whether there is a difference of online reading strategy use between Omani EFL university students in a high proficiency level and those in a low proficiency level. The result found that high proficient readers used more global strategies than low-proficient readers did, corresponding to Huang’s study (1999). In addition, a few studies discussed the role of prior knowledge in learners’ online
strategy use. Coiro and Dobler (2007) suggested that skilled readers usually referred to their prior knowledge of the topic and printed informational text structures to guide their online reading. Moreover, previous research asserted that low knowledge participants benefited more by following a high coherent reading order, whereas highknowledge participants tended to read the hypertext in a low coherent order and read based on their interests (Salmerón, Cañas, Kintsch and Fajardo, 2005; Akyel and Ercetin, 2009). These studies revealed the important role of students’ prior knowledge in exploring online reading strategies.

Some research discussed EFL learners’ use of online reading strategies and whether individual differences will influence learners’ strategy use. Amer, Barwani and Ibrahim (2010) examined whether there is a difference of online reading strategy use between Omani EFL university students in a high proficiency level and those in a low proficiency level. The result found that high proficient readers used more global strategies than low-proficient readers did, corresponding to Huang’s study (1999). In addition, a few studies discussed the role of prior knowledge in learners’ online strategy use. Coiro and Dobler (2007) suggested that skilled readers usually referred to their prior knowledge of the topic and printed informational text structures to guide their online reading. Moreover, previous research asserted that low knowledge participants benefited more by following a high coherent reading order, whereas highknowledge participants tended to read the hypertext in a low coherent order and read based on their interests (Salmerón, Cañas, Kintsch and Fajardo, 2005; Akyel and Ercetin, 2009). These studies revealed the important role of students’ prior knowledge in exploring online reading strategies.

Although previous studies discussed online reading strategies broadly from different perspectives, relatively few studies investigated Taiwanese EFL learners’ perceived online reading strategies. Since EFL learners are reported to be overwhelmed with English online materials on the Internet (Chen, 2003) so their online reading strategy use would be our interest to further analyze. Additionally, a lot of previous research explored the different uses of online reading strategies between different proficiency levels but the factor of gender was seldom mentioned as well. Due to these issues, there is a need for us to further discuss EFL learners’ perceived online reading strategies and the differences of strategy use between learners in different levels and genders. The following are the three research questions addressed in the present study:

1. What is the pattern of online reading strategy use by EFL learners?
2. Are there any differences of online reading strategy use between learners in the high proficiency level and low proficiency level?
3. Are there any differences of online reading strategy use between males and females?

3. Methodology

3.1 Participants

The subjects consisted of 94 EFL learners (43% of them are males, n=40 and 57 % of them are females, n=54) in the study. The average age was 22 years old, ranging from 19 to 26. Over half of them were undergraduate or graduate students (n=58) and the rest of them just graduated from universities (n=36). 72 learners have participated
TOEIC test before and their data were analyzed to see whether there was a difference of strategy use between learners in different proficiency levels.

3.2 Instrument

The Online Survey of Reading Strategies (OSORS) adapted from Anderson’s (2003) study was used in the study. The OSORS measured three dimensions of reading strategies, including global strategies, problem solving strategies and support strategies. One support strategy, which refers to whether learners click on annotations when they read online English materials, was added in the present study because learners tend to use additional strategies when reading online materials and clicking on hyperlinks or annotations would be one of these additional strategies. Anderson (2003) demonstrated the reliability of items in OSORS, proposing that the Cronbach’s alpha for the overall OSORS was .92. There were 37 items in the survey, containing 16 items as global strategies, 11 items as problem solving strategies and 10 items as support strategies. Each statement in OSORS could be responded by the 5-point Likert Scale, ranging from 1 (never or almost never use this strategy) to 5 (always or almost always use this strategy).

3.3 Procedure

The researcher collected data by online Google questionnaires. The link of questionnaire was posted on the college social networks and also sent through instant messages and emails. The data of participants above 26 years old would be eliminated since the focus of the participants in the present study were mainly college or graduate students. Then the mean scores of the items would be calculated and the paired t-test would be conducted to observe whether there is a significant difference of strategy use regarding proficiency differences and gender differences.

4. Results

4.1 The top ten and the bottom ten frequently used online reading strategies

Among the top ten most frequently used online reading strategies, half of them were global strategies, three of them were problem solving strategies and two of them were support strategies, as shown in Table 1. Although it seemed that learners seldom used support strategies compared to other two kinds of strategies, the most frequently used strategy was using an online dictionary to help readers understand online texts, which is a support strategy. It was not surprising that EFL learners most frequently looked up an online dictionary when they read online reading materials since previous L2 research showed that vocabulary is perceived to be the most difficult task among EFL learners (Cheng, 1998; Chi & Chern, 1988) so it was no wonder that EFL learners tended to look up new words when they encountered difficulties.
Table 1: *Mean scores of top ten frequently used online reading strategies*

<table>
<thead>
<tr>
<th>The top ten frequently used online reading strategies</th>
<th>Mean scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. I use reference materials (e.g. an on-line dictionary) to help me understand what I read on-line. <em>(Support strategy)</em></td>
<td>4.03</td>
</tr>
<tr>
<td>19. I use context clues to help me better understand what I am reading on-line. <em>(Global strategy)</em></td>
<td>3.99</td>
</tr>
<tr>
<td>10. I try to get back on track when I lose concentration. <em>(Problem solving strategy)</em></td>
<td>3.90</td>
</tr>
<tr>
<td>29. When I read on-line, I guess the meaning of unknown words or phrases. <em>(Problem solving strategy)</em></td>
<td>3.88</td>
</tr>
<tr>
<td>17. I use tables, figures, and pictures in the on-line text to increase my understanding. <em>(Global strategy)</em></td>
<td>3.80</td>
</tr>
<tr>
<td>25. I try to guess what the content of the on-line text is about when I read. <em>(Global strategy)</em></td>
<td>3.78</td>
</tr>
<tr>
<td>20. I paraphrase (restate ideas in my own words) to better understand what I read on-line. <em>(Support strategy)</em></td>
<td>3.78</td>
</tr>
<tr>
<td>26. When on-line text becomes difficult, I re-read it to increase my understanding. <em>(Problem solving strategy)</em></td>
<td>3.68</td>
</tr>
<tr>
<td>4. I think about what I know to help me understand what I read on-line. <em>(Global strategy)</em></td>
<td>3.66</td>
</tr>
<tr>
<td>31. I scan the on-line text to get a basic idea of whether it will serve my purposes before choosing to read it. <em>(Global strategy)</em></td>
<td>3.64</td>
</tr>
</tbody>
</table>

As for the bottom ten online reading strategies used by learners, three of them were global strategies, three of them were problem solving strategies and six of them were support strategies, as shown in Table 2. Most of the infrequently used online reading strategies were support strategies so EFL learners seldom used support strategies except for consulting an online dictionary as mentioned before. This corresponds to Anderson’s (2003) study which indicated that the least frequently used online reading strategies were support strategies. The least frequently used online reading strategy was participating in live chat with other learners of English, which is a global strategy. The reason why learners seldom live chatted with other learners may be because they tended to focus on the understanding of the online English materials instead of social interaction with other readers.
Table 2: Mean scores of bottom ten online reading strategies used by learners

<table>
<thead>
<tr>
<th>The bottom ten online reading strategies</th>
<th>Mean scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have a purpose in mind when I read on line. <em>(Global strategy)</em></td>
<td>3.16</td>
</tr>
<tr>
<td>21. I try to picture or visualize information to help remember what I read on-line. <em>(Problem solving strategy)</em></td>
<td>3.15</td>
</tr>
<tr>
<td>33. I critically evaluate the on-line text before choosing to use information I read on-line. <em>(Problem solving strategy)</em></td>
<td>3.05</td>
</tr>
<tr>
<td>22. I critically analyze and evaluate the information presented in the on-line text. <em>(Global strategy)</em></td>
<td>2.94</td>
</tr>
<tr>
<td>35. When reading on-line, I look for sites that cover both sides of an issue. <em>(Problem solving strategy)</em></td>
<td>2.67</td>
</tr>
<tr>
<td>27. I ask myself questions I like to have answered in the on-line text. <em>(Support strategy)</em></td>
<td>2.65</td>
</tr>
<tr>
<td>36. When reading on-line, I translate from English into my native language. <em>(Support strategy)</em></td>
<td>2.63</td>
</tr>
<tr>
<td>3. I take notes while reading on-line to help me understand what I read. <em>(Support strategy)</em></td>
<td>2.44</td>
</tr>
<tr>
<td>11. I print out a hard copy of the on-line text then underline or circle information to help me remember it. <em>(Support strategy)</em></td>
<td>2.37</td>
</tr>
<tr>
<td>2. I participate in live chat with other learners of English. <em>(Global strategy)</em></td>
<td>1.96</td>
</tr>
</tbody>
</table>

4.2 Online reading strategy use in terms of different proficiency levels

The responses of 72 EFL learners who have participated TOEIC test were analyzed in this section. They were divided into the high and low proficiency level based on their scores of TOEIC. Learners who got over 700 scores were considered as higher level learners and those who got scores below 700 were seemed as lower proficiency learners. In this way, 55 of them were learners of the high level and 17 of them were in the low level. The result is shown in Table 3.
Table 3: Differences between high level students and low level students

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level</td>
<td>55</td>
<td>3.66</td>
<td>.495</td>
<td>7.520</td>
<td>.000</td>
</tr>
<tr>
<td>Low level</td>
<td>17</td>
<td>3.11</td>
<td>.491</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem solving strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level</td>
<td>55</td>
<td>3.67</td>
<td>.418</td>
<td>5.479</td>
<td>.000</td>
</tr>
<tr>
<td>Low level</td>
<td>17</td>
<td>3.11</td>
<td>.345</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level</td>
<td>55</td>
<td>3.28</td>
<td>.666</td>
<td>2.010</td>
<td>.075</td>
</tr>
<tr>
<td>Low level</td>
<td>17</td>
<td>3.07</td>
<td>.659</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level</td>
<td>55</td>
<td>3.56</td>
<td>.54</td>
<td>8.132</td>
<td>.000</td>
</tr>
<tr>
<td>Low level</td>
<td>17</td>
<td>3.10</td>
<td>.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As presented in Table 3, there was a significant difference of total strategy use between high level students and low level students (p=.000). High level students tended to use more online reading strategies than low level students, which can be expected. Also, the high proficiency group employed more global strategies than the low proficiency group and there was a significant difference between their mean scores of global strategies (p=.000). This finding was also found in the previous L2 research indicating that high proficiency learners conducted more global strategies than low proficiency learners (Huang, 1999; Mokhtari & Reichard, 2002; Shen, 2003). As for problem solving strategies, the similar result as global strategies was found. The high proficiency group used more problem solving strategies than the low proficiency group and there was also a significant difference between their means of problem solving strategies (p=.000). However, there was no significant difference of support strategies between the means of support strategies in high level learners and low level learners (p=.075). Both groups used relatively fewer support strategies than global and problem solving strategies.

4.3 Online reading strategy use in terms of gender difference

There were 40 males and 54 females in the present study. The result indicated that there was no significant difference of total strategy use between the male and female group. In addition, there was no significant difference of each category of strategy use (global, problem solving and support strategies) between the male group and female group as well. This suggested that males and females used the similar online reading strategies when they read online materials. The finding corresponds to previous studies, such as Amer, Barwani & Ibrahim’s (2010) study which investigated student teachers online reading strategy use and found that there was no significant difference in terms of gender.
Table 4: Differences between males and females

<table>
<thead>
<tr>
<th>Group</th>
<th>Male</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global strategy</td>
<td>male</td>
<td>40</td>
<td>3.36</td>
<td>.456</td>
<td>1.823</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>54</td>
<td>3.44</td>
<td>.487</td>
<td>-</td>
</tr>
<tr>
<td>Problem solving</td>
<td>male</td>
<td>40</td>
<td>3.43</td>
<td>.360</td>
<td>-1.82</td>
</tr>
<tr>
<td>strategy</td>
<td>female</td>
<td>54</td>
<td>3.45</td>
<td>.404</td>
<td>-</td>
</tr>
<tr>
<td>Support strategy</td>
<td>male</td>
<td>40</td>
<td>3.16</td>
<td>.538</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>54</td>
<td>3.17</td>
<td>.645</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>male</td>
<td>40</td>
<td>3.33</td>
<td>.454</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>54</td>
<td>3.37</td>
<td>.513</td>
<td>1</td>
</tr>
</tbody>
</table>

However, if we look at the individual strategy use in detail, it is suggested that females are more active strategy user than males because more strategies used by females reached high frequency. As shown in Table 5, the strategies with high frequency in females were more than those in males. For example, the mean scores of top three frequently used strategies for females reached 4 points, which means “I usually use this strategy” in the Likert scale. This indicated that females usually used references, contextual cues and the strategy of guessing unknown words when they read English online reading materials. Nevertheless, in terms of males’ strategy use, none of the strategies’ mean scores reached 4 points.

Table 5: Top ten frequently used strategies by males and females

<table>
<thead>
<tr>
<th>Male</th>
<th>Mean</th>
<th>Female</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. I try to get back on track when I lose concentration. (Problem solving strategy)</td>
<td>3.93</td>
<td>14. I use reference materials (e.g. an on-line dictionary) to help me understand what I read on-line. (Support strategy)</td>
<td>4.11</td>
</tr>
<tr>
<td>14. I use reference materials (e.g. an on-line dictionary) to help me understand what I read on-line. (Support strategy)</td>
<td>3.93</td>
<td>19. I use context clues to help me better understand what I am reading on-line. (Global strategy)</td>
<td>4.09</td>
</tr>
<tr>
<td>19. I use context clues to help me better understand what I am reading on-line. (Global strategy)</td>
<td>3.85</td>
<td>29. When I read on-line, I guess the meaning of unknown words or phrases. (Problem solving strategy)</td>
<td>4.04</td>
</tr>
<tr>
<td>25. I try to guess what the content of the on-line text is about when I read. (Global strategy)</td>
<td>3.78</td>
<td>10. I try to get back on track when I lose concentration. (Problem solving strategy)</td>
<td>3.89</td>
</tr>
<tr>
<td>8. I read slowly and carefully to make sure I understand what I am reading on-line. (Problem solving strategy)</td>
<td>3.73</td>
<td>17. I use tables, figures, and pictures in the on-line text to increase my understanding. (Global strategy)</td>
<td>3.87</td>
</tr>
</tbody>
</table>
5. Discussion

The present study shows that EFL online readers tend to use more global strategies when they read online texts, which is different from previous studies showing that EFL learners use more problem solving strategies (Amer, Barwani & Ibrahim’s, 2010; Anderson, 2003). The possible explanation is that there are more high proficiency learners in this study and high level students tended to use more global strategies than low level students (Huang, 1999), which may lead to more global strategy use in the present study. Additionally, the result shows that there is a significant difference between high and low level learners, which is also found in previous research (Huang, 1999; Mokhtari & Reichard, 2002; Shen, 2003). High level learners used more global and problem solving strategies than low level learners but both groups employ the similar numbers of support strategies. The possible interpretation of why the two group using similar support strategies is that many support strategies are related to EFL learners’ first language, including looking up an online English-Chinese dictionary and using L1 paraphrases. Most EFL learners are accustomed to resort to their L1 as a meaning making process when they are reading or writing (Freedman et al., 1983; Kobayashi and Rinnert, 1992), which might explain the uses of support strategies between high and low level groups do not differ. The other finding is that there is no significant difference between males and females but females seem to use certain strategies with high frequency, which is also presented in Amer, Barwani & Ibrahim’s (2010) research. This study demonstrates several findings which confirm the results in previous research and also increase our understanding of Taiwanese EFL learners’ online reading strategy use.

6. Pedagogical Implications and Future Studies

The present study raises some implications for reading instruction. First, since the result of the present study indicates that high proficiency learners tend to use more
global strategies to increase their reading comprehension, it seems that global strategies are more efficient than the other two strategies. (Akyel, A., & Erçetin, G., 2009). Teachers should therefore explicitly teach students global strategies in their reading processes in EFL classrooms, such as using context clues, predicting the content of the text, reading purposefully. For instance, teachers can design some activities to ask students to predict what will happen in the content of the text, ask them to skim the text to grasp the main idea of the text or ask them some questions before they begin to read so that they can scan the answers for the questions when they are reading. Additionally, teachers should pay attention to how to help students spontaneously utilize those reading strategies when they read online English materials by raising their awareness of reading strategy use through training before they are immersed in online reading materials.

However, there are some limitations of the present study. First, the numbers of high proficiency learners and low proficiency learners are not equal so future studies should have equal participants of learners in different levels so that the result will be more valid. In addition, this study only investigates learners’ perceived strategies, which may differ from their actual use of online reading strategies so future researchers can compare whether there is a difference between learners’ perceived strategy use and actual strategy use in order to provide more insight of EFL learners’ strategy use.
References


Gamification of Web Based Learning Environment for Physics Problem Solving

Zeeshan Rasool, University of Malaya, Malaysia
Nurul F. Mohd Noor, University of Malaya, Malaysia
Mohd Nizam Ayub, University of Malaya, Malaysia
Hannyzzura Affal, University of Malaya, Malaysia
Nornazlita Husin, University of Malaya, Malaysia

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Abstract
In today’s digital generation, gamification has become a popular tactic to encourage specific behaviors, and increase motivation and engagement. While having this idea successfully used mostly in business and commercial contexts, it’s suggested that application of game mechanics can be used in web based education to ease the common pain points in education. Some common pain points in education such as focus, motivation, pride, physical-mental and emotional factors.

This paper addresses our work on gamifying the web based learning environment system for problem solving. The system’s instructional design is based on Polya’s problem solving model which consists of four stages: a) Understand the problem b) Devise a plan c) Execute the plan d) Review the solution. Both the social and self-elements of gamification are covered in gamification process of the system. Social elements include Leaderboards, Virtual Goods; whereas self-elements includes Points, Levels, Trophies and time restrictions. The gamification elements in the system are assume to help student to get more involved and engage with the system, eventually helping student to get most out of an e-learning system. This paper focuses on the design and application of gamification elements in the system.

Keywords: Gamification, education, engagement, visualization, e-learning, physics
Introduction

Gamification refers to use of game mechanics in non-game environment to influence behavior and increase engagement [6]. Gamification has been incorporated with commercial success into platforms, i.e. badgeville, especially social ones, as a way to create narrow relationships between the platform and the users, and to drive viral behaviors on them to increase platform popularity. This success has made some researchers theorize that it also could be used in education as a tool to increase student engagement and to drive desirable learning behaviors on them [1] [6]. The main objective behind gamification in education is to apply some of these ideas in designing educative initiatives and their contents in an attempt to make them more motivating [6]. Gamification indirectly can increase the skill of students since it encourages them to perform an action. When students are motivated enough to act and practice their exercises it can increase their knowledge [3]. Lee and Hammer [1] believes that gamification, in coming years, will be a part of students’ lives. It can play important part in making students to perform better in academic as well as real life if motivation and potential of gamification is directed towards education and learning. [1].

In this study, we focus on gamifying an adaptive learning environment for physics problem solving known as ALEPS. We have developed a web based learning system incorporating a set of gamification mechanics. Next section describe the ALEPS system (non-gamified) followed by Gamified system that include design functionalities and architecture. The last section presents conclusions and direction of our future work.

ALEPS System

ALEPS, an Adaptive Learning Environment for Problem Solving is based on Polya’s problem solving strategies which include, understanding, planning, implementing and checking [13]. This system uses visualization to highlight and explicit the schemata.

Figure 1: Understanding Stage. Figure 2: Planning Stage.

In the first stage which is understanding module (Figure 1), students have been provided a platform to acquire basic understanding of physics problem by pointing
out known/Unknown variables and domain in which problem falls in. The next stage is planning module (Figure 2) where student further proceed towards the solution by selecting principle involved and appropriate equation to solve the problem.

![Figure 2](image)

Figure 2: Planning module.

In planning stage, student have access to simulation environment specific to the problem where students can change the values of variables (i.e. mass, velocity, acceleration etc.) of an object to observe the effect of the change and to have some visual picture and understanding of real world scenario. After completing the planning stage, student can execute the plan to create visualization (Figure 4), where the objects are simulated as per student’s selected principles and equations. Student will be notified of the result of the visualization. For checking and reviewing process, correct simulation of the specific problem is also provided in same stage as well.

**Gamification of ALEPS**

Lee and Hammer [1] [6], suggested that the gamification in education should concentrate on cognitive, emotional and social areas of user. Games are motivating because of focusing on these three areas. Game mechanics are the mechanisms used to gamify an activity [12]. Most common game mechanics are shown in Table 1. As game mechanics are the rules and rewards of the game, intended to evoke determined emotions on the player, game dynamics are the desires and motivations leading to those emotions (Table 1).

Table 1. Common Game Elements

<table>
<thead>
<tr>
<th>Game Mechanics/Elements</th>
<th>Game Dynamics/Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>Reward</td>
</tr>
<tr>
<td>Levels</td>
<td>Status</td>
</tr>
<tr>
<td>Trophies, Badges</td>
<td>Achievement</td>
</tr>
</tbody>
</table>
Virtual goods | Self-expression
---|---
Leaderboards | Competition
Virtual gifts | Altruism

The proposed gamified ALEPS system includes some of the most usual game elements (Table 1) as follows.

1. Dashboard  2. Coins
3. Badges  4. Levels
5. Experience  6. Progress meter
7. Trophies  8. Leaderboard

**System Design**

As explained in last section, in ALEPS system the cycle starts from first stage of problem solving which is understanding the problem, followed by second stage of planning the solution and executing, finally the Visualization stage for reviewing and checking. However, student can go back to planning stage in case of unsuccessful attempt. In order to implement the gamification mechanics, we upgraded the system by not only including the game mechanics but also few additional controls. Nevertheless, the main flow of problem solving in three stages remains same as shown in Figure 4, 5 & 6. The gamification mechanics adapted to ALEPS systems such as:

**The dashboard:** This control comes directly after the successful login of student, showing the current progress and status of the achievements in terms of badges and trophies won. The leaderboard is students ranking which also shown in the dashboard. The link for full leaderboard is provided as a reference.

**Problem Solving – How To?**: This comes just before student starts to solve any problem and briefs explanation about the problem solving cycle to the student in descriptive as well as in pictorial form.

**Progress Meter:** During the process of problem solving using ALEPS, we have included the progress meter which updates its status after student successfully complete each stage. The intention to use this element is to make student aware of progress, helping him not to feel lost among multiple stages as well as keeping him motivated to finish the task of solving the Physics problem.

**Score:** ALEPS system originally calculates the score of every exercise done by student. The calculation of the score depends upon multiple factors such as: time taken to solve each question; number of wrong attempts in choosing known variable, unknown variable and domain of the problem. In this system, we have retained the score feature and its calculation formula.

**Coins:** Coins element is also implemented in this system. Some amount of coins is by default provided to the student upon the registration of the system. The student can
earn more coins by each successful action on choosing correct variable or principle or upon completion of each stage. Previously in ALEPS, the multiple level hints feature was given to students which started from basic hint to finally giving them correct choice. It was noticed in pilot study that students were using the hint feature in excessive manner without reading and understanding it properly. In this system the student uses coins to buy hint(s), which makes students to use hint feature cautiously, forcing them to read and understand. Student loses some coins too when he uses hit and trial method while selecting the correct variable.

**Levels:** In this system, the student will achieve higher level upon completion of successful attempts in solving each problem. The purpose of this element of gamification is to retain the student engaging with the system in long term.

**Experience:** Unlike the level element, the student gains experience value for each activity regardless level of activity or success of the activity. This element enabling students to remain motivated emotionally even if they make any wrong attempts which cost those coins or score.

![Figure 4. Understanding Stage](image)

**Badges and trophies:** Students win badges and trophies as a reward for doing their exercises. There are varieties of badges and trophies have been introduced in this system to keep student motivated. Trophies and badges both highlight different achievements of the student. Three different levels of trophies such as Gold, Silver & Bronze are used for number of successful exercises. Whereas, different types of badges can be won by student on his different activities such as Beginner badge for completing first exercise, Regular Visitor badge by visiting online portal at least once a week.

**Leaderboard:** This element satisfies the social aspect by promoting competition among students. In this system the Leaderboard element shows the top students based on the results of various game elements used in this system such as: Score, Levels, Experience, Number of Badges and highest trophies.
**System Features**

The web application features are divided based on the roles of user.

1. **Student:**
   a. Profile Avatar – Update personal profile avatar or picture.
   b. Problem solving exercises
   c. Dashboard, Leaderboard and achievement
   d. Account settings – Update password or bio-data
   e. Help – General help about the entire web application features

2. **Administrator:**
   a. Manage user accounts i.e. Change password if user forgets the password
   b. Reports of the System

**System Architecture**

The gamified system is designed and developed as a web application hosted on educational institute’s own server. The chosen implementation technology makes the web application accessible through internet on any web browsers regardless of type of the operating system.

![Architecture of Web Application](image)

Figure 7. Architecture of Web Application
The web application architecture is not complex and it is mainly divided into two main parts i.e. front-end and back-end separated by the Internet cloud as shown in the Figure 7. The back-end consists of The Database & the web server. The SQL Server is used as a database server to store the user data as well as the exercises data. The webserver is used to host the web application which is responsible for handling all the interaction with the user and with the database. ASP.NET is used as a server side technology coupled with MS SQL Server. The front-end consists of the HTML, CSS, JavaScript & other libraries i.e. JQuery, for handling client side validation and user feedback enabling immediate and swift interaction between the system and the user.

Conclusion

The propose system uses latest technique of gamification applied to ALEPS (an adaptive learning environment for physics problem solving). This gamified system aims to improve student’s engagement and motivation. Gamification indirectly prompts to get more knowledge and skills with its direct effect on engagement and motivation [3] and it will eventually be helpful for improving problem solving skills which the ALEPS system is designed for. The system covers three basic areas which are addressed by games i.e. Cognitive, Social and Emotional, where leaderboard element is used to address social satisfaction; Coins and Levels covering the motivational and cognitive aspects respectively. Our next step would be to test this system with the students in order to measure the effectiveness and the impact of the gamification. After the experimental study and based on its results we would reflect towards incorporating more gamification elements to enhance gamification experience such as forum for group discussions and real time chat component and social media that will cover social aspect in better manner and can lead to collaborative learning among students. We are also considering about including mini games focused on basic knowledge of physics such as equations, formulas, symbols and units.
References


Contact email: {fazmidar,nizam,nazlita,hannyz}@um.edu.my, zeeshan@siswa.um.edu.my
Design of Accessible Digital Picture Books for People with Print Disabilities

Hanae Ikeshita-Yamazoe, Ritsumeikan University, Japan
Chihoko Aoki, Ritsumeikan University, Japan

Abstract
This research examined the design of accessible digital picture books (e-books) for people with print disabilities. Accessible e-books can be presented in a simplified layout, with suitable fonts, or audio synchronized with word highlighting. Previous studies have established that children show curiosity about recordings of unfamiliar natural voices that are different than their mother’s voice when reading an e-book on a tablet PC, but reactions to text-to-voice synthesized speech have not yet been tested. We investigated the effects of natural versus synthesized voices on ease of listening. Eight adults (2 males and 6 females) took part in this study. Five versions of a digital picture book were created, with different voice conditions (natural voice of girl and an adult, synthesized voice of a girl and an adult, animated voice of a boy). The study was set up on a tablet computer (iPad). First, participants listened to the picture books being read in each of the voices. Then, they were asked to rate the ease of listening for each reading voice using 4 items evaluated on a five-point Likert scale. In addition, the participants were interviewed and asked to comment on the digital picture books. The results showed that participants preferred digital picture books with speech synthesis rather than natural voices. The synthesized child’s voice was suitable for the digital picture book in which a girl was a character, suggesting that speech synthesis might be suitable for character voices in picture books.

Keywords: Accessibility, digital picture book, print disability, text-to-speech
Introduction

A picture book is designed so that illustrations are as important as text when telling a story. Reading picture books to young children is seen as beneficial for fostering language abilities (Aram, 2006). Technological innovations have led to inherent changes in how individuals read; several book publishers and periodicals have abandoned print in favor of digital media. Numerous digital picture books are versions of classic children’s stories that were once published in a traditional printed form. In most cases, text and illustrations are presented in a similar format as the printed version, but multimedia features, such as word pronunciation, narration, sound effects, and animations, are incorporated. Multimedia formats for picture storybooks offer various ways for supporting story comprehension and other aspects of literacy (Smith, 2001). Grimshaw et al. (2008) reported that the main benefit digitized storybooks have for children’s reading abilities, compared to printed versions, are narration provisions that are accompanied by animated pictures and sound effects that relate directly to the storyline. Reading electronic picture books might facilitate children’s cognitive development, as well as their picture book reading ability. In accordance with these changes, e-readers with advanced accessibility options are now available to aid people with print disabilities.

People with print disabilities are unable to read standard printed material because of a visual, physical, perceptual, developmental, cognitive, or learning disability. Individuals with poor vision as a result of advanced age are also included within this category. Print disabilities prevent a person from gaining information from printed material in a standard way, requiring them to utilize alternative methods, such as technological or personal aids, to access that information (Learning Ally, n.d.).

Digital picture books are widely available and can be accessed with a portable electronic device. However, while several digital picture books are available for individuals with normal reading acumen, availability is limited for individuals with print disabilities. Moreover, little is known regarding the impact of artificial or natural voice text-to-speech functions in the context of reading digital picture books.

Previous studies have established that children show curiosity regarding unfamiliar natural voice recordings (that differ from their mother’s voice) when reading an e-book on a tablet PC (Ikeshita-Yamazoe et al., 2012). However, reactions toward text-to-voice synthesized speech have not yet been tested. To fill this gap, the present study examined the design of accessible digital picture books (e-books) for people with print disabilities. The goal was to develop universally accessible e-books. As a first step, we evaluated the effects of natural versus synthesized voices on the ease of listening e-books in a sample of individuals without print disabilities.

Methods

Participants

Eight adults (2 males and 6 females) between 20 and 50 years of age took part in this study. All participants were native Japanese speakers; and all participants except one had never read e-books before. Written informed consent was obtained.
Materials

The study used a picture book (Kore wa Mahou kana; Sakura Maeda, 2013) intended for both children and adults. The book tells the fantasy story of a girl and a magical store. None of the participants had ever read this book before. To create the e-book, illustrations were scanned (but not the text). All text was converted into text data. The digital picture book was created in EPUB 3.0 format. The digital picture book was presented in a simplified layout, with suitable fonts or audio synchronized with highlighted words. Illustrations that are central to comprehending the story include a text alternative using a text-to-speech synthesized voice. The digital picture book was created in several formats, with and without the embedded reading voice (see Table 1). Five versions of the digital picture book were created, with different voice conditions. Two versions used natural voices (either a female adult or a girl) and two used synthesized speech (either a girl or a boy anime character). These voices were created using text-to-speech software (AITalk Plus, AI Inc.). This software enabled us to provide the listener with more natural, higher-quality human-like voices than a conventional machine sound. The final version of the digital picture book did not have the embedded reading voice. Instead, the reading voice was a voiceover (female adult) recorded through the iPad’s (Apple) accessibility functions. The e-books were read using the Apple reader application iBooks on a 9.7-inch Apple iPad.

Table 1. Characteristics of each of the five versions of the digital picture book.

<table>
<thead>
<tr>
<th>Digital picture book</th>
<th>Reading voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book 1</td>
<td>Natural voice Female adult</td>
</tr>
<tr>
<td>Book 2</td>
<td>Natural voice Girl</td>
</tr>
<tr>
<td>Book 3</td>
<td>Speech synthesis Female adult</td>
</tr>
<tr>
<td>Book 4</td>
<td>Speech synthesis Girl</td>
</tr>
<tr>
<td>Book 5</td>
<td>Speech synthesis Boy anime character</td>
</tr>
</tbody>
</table>

Procedure

The study was set up on a tablet computer (iPad). First, participants listened to the picture books read in each of the voices. Then, participants were asked to rate the ease of listening for each voice using 4 items evaluated on a 5-point Likert scale (see Table 2): 1 = “strongly disagree,” 2 = “disagree,” 3 = “neutral,” 4 = “agree,” and 5 = “strongly agree.” In addition, participants were interviewed and asked to comment on the digital picture books.

Table 2. Questionnaire Items.

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Have you ever read digital picture books?</td>
</tr>
<tr>
<td>2  Which voice of the five digital picture books did you find most easy</td>
</tr>
<tr>
<td>to listen to?</td>
</tr>
<tr>
<td>3  What do you think are the differences in readers’ story comprehension</td>
</tr>
<tr>
<td>when different voices are used?</td>
</tr>
<tr>
<td>4  Do you think digital picture books will be used in the future?</td>
</tr>
</tbody>
</table>
Results

None of the participants had previously read a digital picture book (Q1). When asked which picture book was the easiest to listen to (Q2), 5 respondents chose Book 4 (synthesized voice of a girl), one respondent chose Book 1 (natural voice of a female adult) and one respondent chose Book 2 (natural voice of a girl) (see Figure 1). Non-responses were eliminated.

The average evaluation provided for Q3 and Q4 were 4.3 ± 0.7 and 3.4 ± 0.5 (see Figure 2). Participants made several comments regarding the digital picture books. The comments included “I thought about it, and I wonder if this is something that the world will like since a lot of people can share in the new book because it’s digital.” “I think this is a new form of entertainment for people who like to hear the story and the representation of the sounds.” “I think digital picture books will definitely change our worldview.” “Voiceovers and synthetic speech are difficult to listen to.”

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![Figure 1. Results of evaluation for Q2.](image1)
![Figure 2. Average response for comprehension of the different digital picture book forms (Q3) and the desire to use these picture books in the future (Q4). Error bars represent standard deviations.](image2)
Discussion

The current study showed that adult readers prefer digital picture books with synthesized speech rather than natural voices. The synthesized child’s voice was suitable for the digital picture book in which a girl was the main character (see Table 1). Otsuka and Toyama (2014) reported that speech synthesis might influence human emotional reactions. Our results suggest that appropriate speech synthesis of natural, high quality human-like voices might affect reader comprehension and story enjoyment. Accessible digital picture books hold the possibility for substantially increasing access to material among people with print disabilities.

A slight advantage was identified for synthesized speech compared to a natural voice using the tablet computer. This suggests that appropriate synthesized speech might help people with print disabilities read picture books. Since the sample size in this study was rather small, future studies will include a larger sample size to better understand how reading with electronic media affects text recognition among people with print disabilities. This will help determine the optimum display method and settings for maximizing visual information processing. Developing a picture book that anyone can enjoy is difficult, but our research will help provide equal access to this form of information.
References


Gender Effect on Student Teachers' Attitudes toward Peer Feedback in a Wiki Learning Environment

Yehuda Peled, Western Galilee College, Israel
Rakefet Sharon, Ohalo College, Israel

The focus of this research is pre-teachers’ attitudes toward peer feedback in a wiki learning environment and its relation to their self-esteem. Results indicate that women find it harder to give and receive feedback. Men agree more with statements that represent high self-esteem. Women agree more with statements which represent lower self-esteem and learning from others. A correlation exists between self-esteem and readiness to give and receive feedback. Self-esteem has a gender-related influence on the willingness to give and receive feedback. Gender influences the tendency to pass the responsibility for feedback to the lecturer. This paper discusses the implication of these findings, as they relate to the education system with its majority of female teachers. We discuss the influence of these findings on the preparedness of the system to embrace meaningful learning based on critical thinking and constructive feedback, which are based on self-confident teachers and willingness to give and receive feedback, both from students and teachers. In conclusion, we discuss the following issues:

How well do colleges prepare teachers for the task of building evaluation processes that include critical thinking and feedback both from peers and students? Does teacher training stress women's empowerment, taking into consideration their tendency of lower self-efficacy and its influence on the readiness to give and receive feedback? Is it right to take these aspects into consideration while testing suitability for a teaching career?

Keywords: cooperative/collaborative learning, gender Studies, interactive learning environments
1 INTRODUCTION

In a two-year study, academic writing in a wiki learning environment based on a peer feedback process was used to determine the added value to meaningful learning, ownership of the learning process, the improvement of academic skills and information literacy of pre-service teachers in Israel. The assignment was to create a course Wikipedia in three courses and a Wikibook in one course. During the courses each student was invited to (1) participate in an introductory exercise; (2) write four wiki entries; (3) give feedback to four of his or her peers' entries; and (4) update his or her own entries, according to peers' feedback. The teacher monitored the wiki activity in order to evaluate its effect on achieving the objectives set by the course’s teacher. The characterization of the attitude to feedback in a wiki-environment framework indicated a gender effect (see Peled, Bar-Shalom, & Sharon, 2012). Other evidence pointed out that there’s a gender difference in wiki posts. For instance, the 2010 UNU-MERIT survey found evidence of a significant gender skew: fewer than 13% of Wikipedia contributors are women (Antin, Yee, Cheshire, & Nov, 2011), a study on the pedagogical value of wikis (PVW) found gender differences and the PVW score being higher for males, which is consistent with previous research (Eachus & Cassidy, 2006) that found that males spend more time on the Internet than females, and therefore may be more comfortable with the technological aspects of Internet use (Sunil, North, & Moreland, 2009). Similar findings in related fields on videoconferencing have previously indicated that women react less favorably to videoconferencing in certain contexts (Armstrong-Stassen, Landstrom, & Lumpkin, 1998). In light of this evidence and Peled et al.’s (2012) findings, additional investigation was carried out in order to explain the effect of gender on the attitudes of pre-service teachers to feedback in a wiki learning environment provided by their peers and its relationship to their levels of self-esteem.

1.1 Gender related inequality, stereotypes and self-esteem

Gender is a sociological term used to define social differences between men and women and from which the differences between them can be inferred (Raz, 2005). Gender related inequality in working environments is equated with the differences between men and women on a number of levels: women are employed in “female” positions as opposed to men who are employed in “male” positions, salary levels, the number of women holding key positions and more (Raz, 2005; Yizraeli, 1999).

Apart from social definitions, gender stereotypes also exist which are defined as common, rigid and generalized patterns of thought that ascribe to men and women characteristics, personal qualities and behaviors which are attributed to their biological gender and which do not take into account any individual reality (Bobbitt-Zeher, 2011; Malach-Penas, 1998). Stereotypes cause the individual to attribute to men the characteristics and functions that match the male stereotype and to women those characteristics associated with the female stereotype (Archer, 1989; Koenig, Eagly, Mitchell & Ristikari, 2011). Perceptions, based on stereotypes, can also affect functionality. Research that examined 10 indexes relating to self-esteem (Gentile, Grabe, Dolan-Pascoe, Twenge, Wells, & Maitino, 2009) showed that low self-esteem amongst women adversely affects their academic performance and achievements.
1.2 Inequality within the educational system

During their initial socialization process both at home and at school, women are encouraged to study those subjects and professions considered to be “feminine” professions such as teaching, education and office work. Within these professions the employment environment provides fewer possibilities and rewards (Hanik, 1998). Today, numerous research questions why STEM is male dominant with no clear answer (see, e.g., English, Hudson & Dawes, 2011; Legewie & DiPrete, 2012; Sassler, Glass, Levitte, & Michelmore, 2011). This state is equivalent to that existing when choosing study tracks at school. For example, the few female students engaged in computer studies in schools report feelings of discomfort when they are amongst men (Drygulski, 1990). These conceptions and attitudes are strengthened as the age range rises (Shotick & Stephens, 2006).

Gender related research shows unequal opportunities between the sexes and existing imparities within the educational system. The creation of an equal opportunity culture within school requires that all educators, and especially pre-service teachers, to examine their positions and opinions before they instill values of equality into their students (Gilad, 2012). One of the tools for evaluating positions is reflection through feedback.

1.3 The role of feedback in teaching

Feedback plays an important role in teaching (Mory, 2004; Topping, 1998) and is vital to the learning process (Driscoll, 2000). Significant, qualitative and up to date feedback help students better understand the material being studied (Higgins, Hartley & Skelton, 2002). Feedback is also an important resource for improving performance and self-management that can lead, not only to achievements in task performance but also to increased feelings of capability (Miller & Karakowsky, 2005). Feedback can also function to shape and develop evaluation due to its ability to spur and improve the learning process (Nicol & Macfarlane-Dick, 2006), and assist in the development of self-esteem and reflection abilities. It encourages a dialogue relating to the learning process between teachers and their colleagues and encourages motivation and positive self-evaluation. Peled et al., (2012) identified three types of peer feedback in a wiki environment:

Constructive feedback – relevant and clear, defines both weak and strong points, clearly presents the characteristics of the problem and suggestions for improvement while referring to additional materials, examples and sources.

Mollifying feedback – sycophantic or flattering feedback with no relevant basis that does not refer to weak points or present suggestions for improvement. For example: “Very nice work”; “I enjoyed reading your work”; “I learned a lot from your writing.”

Meaningless/neutral feedback – non relevant, unclear definitions and non-relevant suggestions for improvement lacking concrete direction or examples.

Peled’s (2008) previous research found that student teachers have difficulty in providing their peers with meaningful/constructive feedback. Since the feedback/reflection tool is one of the central tools used in teacher training, there is great importance attached to identifying those factors that create difficulty in the giving of constructive criticism. Difficulty in giving feedback could be influenced by gender when the feedback is seen as being criticism. Previous research (Gentile et al.,
2009) shows that men with higher self-esteem show better performance results and less in terms of social behavior while women see greater importance in being able to get along with others and are, therefore, less concerned with what they perceive as criticism (Josephs, Markus, & Tafarodi, 1992).

Two hypotheses arise from the aforementioned: (1) since women and men relate differently to providing criticism and since feedback is, essentially, constructive criticism, the assumption is that gender has an impact on the willingness of student teachers to give and receive constructive criticism and (2) the giving and receiving of feedback requires self-confidence or high self-esteem. The assumption is that student teachers’ levels of self-esteem are gender dependent and influence their readiness to give and receive feedback.

2 METHODS

2.1 Research population
The research was carried out amongst 52 student teachers studying in courses within a wiki environment. Students were asked to state their gender.

2.2 Research tools
The study used an anonymous questionnaire in which students were asked to grade on a scale of 1 = totally disagree to 5 = totally agree 63 statements. The statements were concentrated into six categories: (1) feedback is the lecturer’s responsibility; (2) the difficulty in giving feedback; (3) the difficulty in receiving feedback; (4) readiness to provide feedback; (5) readiness to receive feedback; and (6) self-esteem (this was divided into two sub-categories: high and low).

A one directional T-test and variable analysis (ANOVA) followed by Tukey’s HSD analysis were used to compare findings. Symmetry and Pearson regression were used to analyze correlation.

3 FINDINGS

3.1 Gender influence on the attitude of student teachers to peer feedback
Differences were found between male and female students in their readiness to give and receive feedback (see Figures 1 and 2). At the category level (see Figure 1) it would appear that women find it more difficult than men to accept feedback and clearly find it more difficult to give feedback (T-test: t=2.39; p=0.017). Men are significantly more prepared to accept feedback than women (T-test: t=-2.01; p=0.045). When the categories are split into distinctive statements (see Figure 2) it was found that men are clearly seen to agree with statements expressing willingness to give and accept feedback. Thus, “I find it easy to give feedback” (T-test: t=2.07; p=0.044), “It’s not hard giving feedback” (T-test: t=-2.65; p=0.011), “Feedback helps both the giver and the receiver” (T-test: t=2.54; p=0.015), and “I was happy to get feedback” (T-test: t=2.03; p=0.049).
3.2 Gender effect on levels of self-esteem

Self-esteem of both men and women was evaluated by their attitudes in relation to various statements. These statements were compiled into categories that represent high and low self-esteem and also statements representing the willingness to learn from others as an indirect index of self-confidence (see Figure 3). It was found that men were clearly more in agreement with statements appearing in categories representing high self-esteem (T-test: t=-4.59; p<0.0001), while women are clearly
more in agreement with statements appearing in categories relating to low self-esteem (T-test: t=3.37; p=0.0009) and learning from others (T-test: t=8.16; p=0.0001).

When examining specific statements from all categories (Figure 4) it was found that men gave a higher score to the statement “I feel that I have merit” (T-test: t=3.41; p=0.0014), “I have positive characteristics” (T-test: t=2.93; p=0.0053), and “I function well” (T-test: t=1.92; p=0.06). Women, on the other hand, gave higher scores to statements that indicate lower self-esteem such as “I don’t have much to be proud of” (T-test: t=2.13; p=0.039) and “I would like to have more self-esteem” (T-test: t=1.9; p=0.064).

Figure 3: Levels of agreement with statements in categories representing high self-esteem, low self-esteem and statements representing a willingness to learn from others (average ± standard error for all statements in a category). Asterisk indicates significant differences.

Figure 4: Levels of agreement with specific statements in categories representing high self-esteem and categories representing low self-esteem (average ± standard error for each statement). Asterisk indicates significant differences.
3.3 The relationship between the willingness to receive and to give feedback as an indication of levels of self-esteem and the transfer of responsibility to the lecturer

The influence of self-esteem on willingness to give and receive feedback was also examined as expressed in the correlation between representative statements in the high self-esteem category and representative statements in the willingness to give feedback category (Figure 5A) and the willingness to accept feedback (Figure 5B).

It was found that a correlation exists both amongst men and women. However, it can be seen that there is a shift of the trend line on the x-axis that represents levels of self-esteem. Amongst women, points of convergence were found to be lower than amongst men. From this we can state that high levels of self-esteem have a gender dependent effect on the readiness to give and receive feedback. A similar phenomenon can be seen when examining the effect of low self-esteem on the difficulty of giving feedback (Figure 6A) and on the transfer of responsibility for the provision of feedback to the lecturer (Figure 6B). Therefore, low self-esteem has a gender dependent influence on the ability to provide feedback and on agreement that the responsibility for providing feedback is that of the lecturer.

![Figure 5: The relationship between high self-esteem and the readiness to give (A) and receive (B) feedback (average for each statement; 5 statements in each category).](imageURL)
Figure 6: The relationship between low self-esteem and readiness to give feedback (A) and the responsibility of the lecturer to provide feedback (B) (Average for each statement; 5 statements in the low self-esteem category and 4 statements in the lecturer’s responsibility category).

4 DISCUSSION AND CONCLUSIONS

This article focuses on the effects of gender upon the attitudes of student teachers to peer feedback and the link to their levels of self-esteem.

From the present research, it appears that men find it easier to give and receive peer feedback while for women this is more difficult. This finding is strengthened by previous research in which it was found that women are less interested in dealing with what they perceive as criticism (Josephs et al., 1992). The gender composition of those teaching in the educational system is primarily female with, in the Jewish educational sector, 86% of teachers in primary education, 80% in junior high, and 76% in high school being women. In the Arab educational sector, 77% of primary teachers, 66% of junior high teachers and in high schools 50% of teachers are female and the other 50% male. (Israel Central Bureau of Statistics, 2013). This composition further exacerbates the problem shown by the present research findings that if women find it more difficult than men to accept feedback and clearly find it more difficult to give feedback, and raises the question if this state effects their functioning as teachers? This finding also raises questions regarding the ability of the educational system to expand assessment through grades by combining formative assessment and the provision of constructive feedback when teacher reserves, the majority of whom are women, find it difficult to give and to provide constructive feedback. One possible way of achieving this is by increasing the use, within teacher training institutions, of Web 2.0 tools such as wikis, Twitter and Facebook, and any other social framework that sharpen the need to provide constructive feedback under the teacher’s guidance during the process of constructing the feedback (Peled et al., 2012).

In addition to the dominant female presence within the educational system, stereotypes in course materials, books and children’s books that describe the male as being the hero, as being brave, smart, successful, persevering and charismatic, also have a clear impact. This as opposed to the female figure that is described as weak, dependent, submissive, maudlin, yielding and unstable (Avrahami-Einat, 1989).
From the present research it is apparent that female student teachers value themselves less than the male student teachers. This finding is compatible with an analysis of 115 research studies (meta-analysis) carried out by Gentile et al. (2009) that found that men exhibit higher levels of self-esteem than women. When the majority of female student teachers and the educational system’s teacher reserves are shown, as this research has discovered, as having low levels of self-esteem, then there is a danger that female stereotypes within the system will be perpetuated.

An additional problem shown by this research is the relationship that was found between the low self-esteem of women and the resulting difficulties of giving and receiving feedback and the transfer of responsibility for feedback to the lecturer. This is especially a concern during a period when teaching is undergoing a change and developing meaningful learning processes in which responsibility for learning is transferred from the lecturer to the student. Meaningful learning is based on critical thinking and encourages the student to ask questions and, as part of this process, self-confidence founded on the teacher’s self-esteem and the feedback process play a central role. As Gilad (2012) mentioned that when referring to changes in personal positions and perceptions regarding stereotypes, the process of change is difficult, slow and complex. The difficulty in dealing with the issue of equality opportunity within the educational system results, first and foremost, from the fact that this is clearly an ideological issue that is seen firstly from an emotional point of view and only then from a rational point of view.

Lack of confidence and the inability to give and to receive constructive feedback, combined with traditional thinking that feedback is the teacher’s responsibility will make it even more difficult to make changes in the educational system.

Applied questions raised by the research: To what extent do teacher training colleges train student teachers to build an assessment process that includes critical thinking and the giving and receiving of feedback from their peers and students? Is female empowerment emphasized as part of the teaching process and are the issue of lower self-esteem amongst women and the results of their willingness to give and accept feedback addressed? Also, should suitability for teaching also be examined from these points of view?
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Developing ESP Multimedia Courseware for East Rift Valley National Scenic Area

Hsin-Pei Wang, National Kaohsiung University of Applied Sciences, Taiwan
Shu-Chiao Tsai, National Kaohsiung University of Applied Sciences, Taiwan

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Abstract
The government of Taiwan has carried out various policies to promote the tourism industry. To meet the needs of the industry, several related programs, departments and colleges in higher technical education have been established in Taiwan to cultivate high quality manpower by increasing English communication skills and related professional knowledge. With the rapid development of information technology, it is important to implement digital materials or courseware for students in higher technical education to help them acquire professional knowledge and English language abilities for their future jobs. Thus, the aim of this study is to develop bilingual (English and Chinese) multimedia courseware for East Rift Valley National Scenic Area, one of the most popular tourist sites in Taiwan.

The development of the courseware is mainly based on Mayer’s multimedia learning cognitive theory. The courseware includes three sections: introductory English texts about the rift valley, scenic spots and festival activities, combined with corresponding English audio, Chinese translation support and integrative language exercises for English learning (listening, speaking, reading, writing and translation). An evaluation system with an instant feedback function is developed as well. The online evaluation system includes five language tests of various types such as cloze, sentence restructuring, dictation, and bilingual translation at various degrees of difficulty. Through the courseware, learners are expected to expand their language skills and obtain relevant content knowledge for a better understanding about the target subject. The multimedia courseware will be integrated into instruction for EFL students to investigate their learning effectiveness and their conception.

Keyword: ESP, English Learning, Multimedia, Courseware
Introduction

Tourism plays an important role in Taiwan’s economy so that various policies related to tourism have been implemented by the government of Taiwan. In addition, since Taiwan has become one of members of the WTO, World Trade Organization, Taiwan has greatly increased opportunities to connect with foreign countries. Meanwhile, many foreign films and variety and reality shows are shot in Taiwan, such as Lucy, Grandpa over Flowers and Running Man, bringing growth to the economy and tourism. Natural landscape is not only a valuable treasure of mankind but also the source of attraction for foreign visitors. English as an international language is a significant component for global communication; hence, manpower with professional knowledge and English ability will be needed in order to facilitate the continuing growth of tourism industry. Therefore, English for specific purposes (ESP) instruction is increasingly emphasized at technical universities in Taiwan.

ESP is well-known as a learner-centered and content-based approach to teaching or learning English as a foreign language and is designed to meet the needs of learners who want to learn English for use in their specific field, such as technology, leisure and academic learning (Johns & Dudley-Evans, 1991; Dudley-Evans & St John, 1998). Hence, ESP instruction can narrow the gap between skills acquired in higher educational institutions and the skill sets needed in industry.

However, some problems are found in ESP curriculum development in Taiwan. After investigating the correlation of English proficiency of students at four technical universities, Lai (2005) indicated that first, there is a lack of sufficiently qualified teachers, authentic materials and specific knowledge of certain areas; second, students’ needs for improving integrated language skills should be met in areas such as listening, speaking, reading; writing and third, a higher level of English skills is required to perform well in learning in ESP courses. These findings were echoed in Tsou (2009).

Courseware or multimedia integration into instruction has become an effective tool for learning (Roblyer, 2003). Courseware, also called instructional or educational software, is widely used in higher education as an integral part of the courses (Riley, 1995). Interactive multimedia can easily integrate language skills, including listening, speaking, reading and writing with authentic learning experiments, learners’ control over their learning and a focus on the content (Warschauer, 1996). The development of ESP courseware can play the role of tutor, a tool, or a tutee and provide a kind of
team-teaching to help Chinese EFL students repeatedly practice their English skills with L1 audio through the courseware, while learning professional content (Tsai, 2009).

Therefore, the purpose of the study is to develop bilingual (English and Chinese) multimedia courseware about the East Rift Valley National Scenic Area, one of the most famous scenic spots. A variety of multimedia elements are incorporated in the courseware, for example, English texts with corresponding audio, Chinese translation support, images and an online evaluation system with instant feedback which includes five linguistic and content-based tests of various types such as cloze, sentence restructuring, dictation, and bilingual translation at various degrees of difficulty.

**Literature Review**

With recent progress in information technologies, computer-assisted language learning (CALL) can provide numerous advantages in the fields of contextual (Shamsudin & Nesi, 2006; Tsai, 2009), self-paced, autonomous and individualized learning (Fischer, 2007), motivation (Chang, 2005), feedback and evaluation (Dickinson, Eom, Kang, Lee & Sachs, 2008). Besides, E-learning is known as a learner-centered educational system. Learners can learn what they want anytime and any places on their own needs and at their speed (Rosenberg, 2001). These advantages and values meet the requirements of ESP curriculums, in which content and method are related to the needs of learners. Among innovative information technologies approach, integrating multimedia courseware into instruction is regarded as an efficient instrument for learning (Roblyer, 2003; Tsai, 2009). Courseware development and its application in classroom instruction are much more stressed. However, both of its layout and application have been greatly concentrated on courses of technology and sciences (Li, 2004; Shamsudin & Nesi, 2006), probably due to teachers in these areas, who have more skills and competence in use of multimedia software and programming. Thus, teachers can more easily transform lecture notes into interactive multimedia. The effectiveness of these instructional instruments has not been completely investigated with regard to developing ESP courseware in Taiwan because it is an interdisciplinary mission, addressing to coordinate and integrate subject language, language learning and technologies of multimedia and information.

Generally, six characteristics of multimedia digital materials are included. First is integration, incorporating characteristics of several media, such as audio, video, image
and text to communicate learning information. Second, it is interaction, offering mutual communication between learners and the computer so that learners’ motivation and participation are enhanced. Third is familiarity which offers users with a user-friendly environment. Fourth is non-linearity which offers learners more resources and information through hypermedia. Fifth is simultaneity which offers learners the latest development or information through internet. Final is virtuality which offers a virtual world that nearly seems like the real one through computers, which will promote learning interest and efficiency (Tsai, 2005).

Most digitalized learning materials can be linked to the internet. Through browser hypermedia, information is searched and acquired so that learners can access to abundant and various learning resources. Even though digital materials incorporate these advantages, it is also very important to consider the user’s ability. If all the information or knowledge cannot be appropriately acquired by the learner, the information, therefore, won’t be effectively used. Hence, several factors should be considered in the production of digital material, such as content of the material, the style of the media and the layout of the interface.

The materials play an important role for the learner to explore and study. Appropriate teaching methods combined with strategy in digital material production should be also considered for conducting an effectively English learning. In order to increase the learner’s motivation and interest in learning persistently, five components should be incorporated. First, it is necessary to enlarge cognitive ability, cultivate better attitude and characteristics and develop frequent and practical usage of multimedia materials in order to reduce the stress of learning. Second, the tendency of the new generation to use technology should be considered to establish an interactive and various learning environment so that user’s attention or interest should not be distracted and lost by multimedia usage and layout. Third, topic of materials should be based on daily life in which learner’s prior experience can be incorporated to facilitate the acquisition of new knowledge. Next, computer games can be designed to allow learners studying in an interesting and challenging environment while enjoying the system. Finally, in order to assess the learner’s independent thinking and problem solving ability, learners can take part in the online evaluation with instant feedback for learners to self-examine and understand their learning progress (Tsai, 2005).

Methodology

In this study the procedure used to develop the multimedia courseware incorporates
background analysis, mining and selection of data, structure design of content and its production, digitalization of content, multimedia design, integration of content system, testing and modification and courseware completion, as shown in Figure 1.

Figure 1: The procedure of multimedia courseware development

The software used in the courseware development includes Microsoft, Audacity, Photoshop and Hypermedia to integrate a variety of resources such as text, audio, pictures and movies. For the multimedia courseware design, it is important to effectively use the multimedia and educational technology so that in the learning process, the interaction between the meaning and media will be executed. The multimedia courseware was based on Mayer’s learning cognitive theory (2001; 2005) in this study. The bilingual content of the courseware were excerpted from the official website East Rift Valley National Scenic Area (http://www.erv-nsa.gov.tw/user/main.aspx?Lang=2&SN0=00000000). The Figure 2 shows the structure of the multimedia courseware. The courseware for East Rift Valley separates into three parts: About Rift Valley, Scenic Spots and Festival Activities. Each part includes many topics and every topic contains many learning units.
Figure 2: The development of multimedia courseware materials

A variety of learning items will be presented in each unit, including authentic English texts with its audio and Chinese translation, narration, practices of language skills, on-line tests with an immediate self-checking function and graphical images. Mayer’s temporal and spatial principles were considered in this study, as shown in Figure 3, suggesting that students learn better when corresponding words and pictures are presented near or simultaneously rather than far from each other on the page or screen. Besides, the navigation and interface design will be carried out in learner-paced sections by button clicking so that students can control their learning pace and educational experience for repetition, deliberate practice and self-evaluation with the multimedia courseware. This feature is in accordance with the pacing principle which means the pace of presentation is controlled by the learner rather than by the program (Moreno & Mayer, 2000).
Results and Discussion

Mayer's multimedia learning cognitive theory (2001, 2005) was adopted in the courseware design. The main page of East Rift Valley National Scenic Area courseware incorporates three sections, as shown in Figure 4. Teachers and learners can click “Text Print” button on the bottom right of the screen to print all material of the courseware.
By clicking one of three section buttons on the main page, learners can go through the topic of the chosen section, shown in Figure 5. By further clicking any section button, learners can access the related learning content and activities of the section shown in Figure 6, including several buttons for studying subject content and practicing language skills. Five kinds of online language tests are embedded such as pronunciation practice, listening test, cloze test, sentence reconstruction, and translation writing. To get more additional materials and resources, learners can click the photo on the bottom left side of the screen which is hyperlinked to the official website. The courseware was designed based on a logical layout with a clear guidance and interface to meet the principles of Guided-discovery in the Advanced Principles of multimedia learning (Mayer, 2005). Thus, learners can have the freedom to study any learning topic at their own pace.
The operational mode of language learning of the multimedia courseware is explained as follows: while any sentence of English text in each learning unit is touched by the mouse, the color of the clicked sentence turns into blue, shown in Figure 3. The sentence is being spoken with English audio when clicking the left button of the mouse, which enables learners to practice English reading skills, pronunciation and listening skills. The multimedia message with words presented with spoken language is in accordance with the modality and multimedia principle proposed by Mayer (2001). It facilitates learners to establish verbal and visual cognitive representations and integrate them. In addition, when clicking the right button of the mouse, the Chinese translation and explanation will be presented in a pop-up window near the clicked sentence, shown in Figure 3. This design corresponds to Mayer’s temporal and spatial contiguity principles (2001). Such a bilingual version (English and Chinese) will facilitate EFL learners’ text comprehension.

As for language practice such as listening, speaking, reading, writing and translation, learners can select one of five different levels language tests in the online evaluation system provided by the courseware. While learners choose one of these five tests, then, the program randomly selects questions of the test for them to practice. Since all these learning tests are accompanied by an instant self-checking system, learners can examine themselves instantly and understand their learning progress. If learners don’t know the answer of the question, they can click the button of bell shown at the end of question. Then, the English audio of the reference answer will be played to help learners to answer the question, shown in Figure 7. Such a learner-centered cue layout can decrease cognitive load and learning difficulty. This design is in accordance with Mayer’s prior knowledge principle in multimedia learning advanced principles.
The wrong part of learner’s answer is presented in red and its reference answer is in green. Meanwhile, the courseware design in this study also corresponds to Chapelle’s suggestions for multimedia CALL (1998). For instance, the features of color, English audio and Chinese translation provided by the courseware are in accordance with Chappelle’s first suggestion, indicating that important linguistic traits notable through emphasizing them in a different color, in aural input and translation of sentences involving linguistic components.

The multimedia courseware provides learners to repeatedly practice integrative language skills with written English texts and its English audio. This design corresponds to Chapelle’s second suggestion related to linguistic input offered by either aural or written language and modified in many ways, such as repetition, simplification through reduced speed, reference material and change of input mode. Moreover, a variety of language tests, for example, pronunciation, cloze test and sentence reconstruction are incorporated in the online evaluation system, allowing learners to practice integrative English skills and increase comprehensible output. This feature corresponds to Chapelle’s third suggestion. Furthermore, learners can analyze, recheck, identify and correct their mistakes through the online evaluation system, which corresponds to Chapelle’s fourth and fifth suggestion, mentioning the opportunity for learners to notice their mistakes and correct the linguistic output. Hypertext links and learning activities in language and in subject content embedded in the courseware can provides modified interaction between the learner and computer.
through mouse clicking. It corresponds to Chapelle’s sixth suggestions

**Conclusion**

The purpose of the study was to develop multimedia courseware for East Rift Valley. Mayer’s multimedia learning cognitive theory was adopted in the courseware layout of the study. The language learning of the courseware corresponded to Chapelle’s suggested criteria to develop multimedia CALL. The multimedia courseware included authentic texts with English audio and Chinese translation support, narration and practice with integrative language skills. In addition, the online evaluation system provided learners with a variety of language tests with instant feedback.

A model of networked ESP courseware development for East Rift Valley national scenic area provides learners with opportunities both to interact with content knowledge or integrative language practices at their own pace and need. Therefore, through a great amount of authentic materials for real life and meaningful communication, learners can explore and interact in the target language. In order to further investigate learners’ effectiveness and perception, the multimedia courseware will be integrate into classroom.

**Acknowledgment**

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**Contact email:** hebe1918@gmail.com
Algorithm for Innovative Educational E-System on Strategic Management for Technology New Ventures

Sia Tsolova, Sofia University “St. Kliment Ohridski”, Bulgaria

Abstract
The goal of this article is to present the results from a research on strategy modeling for technology new ventures and the creation of an educational e-system used for education on strategy management and strategy modeling for students on entrepreneurship and entrepreneurs in technological sphere. The presented algorithm is based on research including: adaptation of the classical process of strategic management for technology new ventures; development of an innovative detailed process for strategic modeling for technology new ventures with development of all included sub steps and tools; development of strategic identifying and analyzing modeling canvas; modification of balanced scorecard model; application of 3-dimensional classification model of the basic typological strategies for technology new ventures and defining of the corresponding key factors of success, strategic threads, etc., based on research amongst 121 entrepreneurs in the technological sphere (107 from Bulgaria and 14 from other countries). The implemented educational e-system is designed specifically for education on strategic management in technology entrepreneurship. The algorithm of the e-system gives students and entrepreneurs the possibility to check their skills in strategy modeling by automated comparing of their results with the elaborated through the current research results for the different typological strategies for technology new ventures. The system also teaches students in the sequence of steps in the process of strategic management for technology new ventures. This article is describing the developed and implemented in the system algorithm, underlining processes, tools and interconnections, as well as the automation principles of work of the system and its applications.

Keywords: algorithm, innovation, process, education, strategy, management, modeling, technology, entrepreneurship, e-system.
1. Introduction

The education on strategic management is connected with various tools during all stages of strategic management – strategic analysis, strategic modeling, strategic implementation, strategic execution and strategic control and evaluation stages. The tools used in the educational process are connected with the basic theoretical tools and processes in strategic management and education on the usage of the most widely spread software platforms for strategic management - BSC Designed, QPR Scorecard, etc. Strategic management also has specific differences in the application of strategy management for developed companies and strategic management for startup companies.

![Figure 1: General Strategic management process structure](image)

This article is proposing an algorithm for strategic management educational e-system, which can be used as a tool during the process of education for traditional learning (face to face), blended e-learning and distance e-learning. The system is offering simulation learning environment, which is supporting students in the process of learning strategic management, its processes, tools, interconnections and models. The educational e-system is intended for education of students and entrepreneurs on strategic management for technology startup companies (technology new ventures).

2. Problem formulation

The education on strategic management for technology new ventures is slightly different from the education on strategic management for developed companies in terms of strategy modeling and tools for strategic analysis, as well as strategic implementation, execution and control and evaluation, in terms of the lack of complex hierarchical structures in the technology new ventures. The problems of strategic management education are connected with: (1) high complexity of the taught material, processes, tools, interconnections and non-trivial tasks in the strategic management modeling process and overall strategic management; (2) need of e-system supporting the educational process with virtual learning environment; (3) current strategic management software programs for studying the strategic management processes, tools and methods of strategy modeling are not enough for studying strategic management; (4) specifics of strategic modeling process and its process of work, which cannot be learned by learning to use the strategy management systems only; (5) lack of systems guiding students in strategic management specifically for technology startup companies with corresponding developed strategic tools, etc. All these problems, together with the need of simulated learning environment for education on
this complex discipline – strategic management – lead to the need of research and development of an e-system, supporting and specifically designed for strategic management education.


The upper mentioned challenges in strategic management education can be successfully met by a combination of the following elements: (1) theoretical tools, methodologies, processes and best practices education; (2) learning of the functioning of classical strategic management systems; (3) usage of simulating learning environment for the overall process of strategic management with elements of gamification, simulation and creativity components. Algorithm for such e-system simulating learning environment for strategic management education, designed specifically for strategic management for technology new ventures is presented in this article.

An e-system for strategic management needs to include all basic stages in the strategic management process (see Figure 1.) and also it needs to provide opportunities for: (1) knowledge building, (2) knowledge checking and (3) knowledge applying. All these elements are included in the presented in this article e-system.
3.1 Entire process overview.

The system for education will start its operation with the students with an overview on the entire process of strategic management and the entire process of functioning of the system. The system covers the following processes: (1) strategic analysis processes – classical strategic analysis tools and innovative analysis tools for technology new ventures; (2) strategy modeling process – typological classification process, defining of typological strategy and defining of company-specific typological strategy; (3) strategic implementation (preparation for strategic execution) – necessary resources, responsibilities for strategic actions execution, projections (target values, deadlines, etc.) and partners and collaboration; (4) strategic execution process – model of prioritization of tasks by urgency and importance and link to skills and knowledge from disciplines Project Management and Operational Management; (5) strategic control and evaluation processes – periodical overview on target values, overview on current deviations in target values, evaluation and correcting activities. While following these processes, students will have access to: (1) knowledge building on strategic tools, processes, methodologies, models and interconnections; (2) knowledge checking by using simulated learning environment and (3) knowledge applying, while working on the different projects and processes of the strategic management educational e-system for technology new ventures.

![Figure 4: Educational E-System for Strategic Management Processes.](image)

3.1.1. Initial steps in strategic management – Mission and Vision of the Company

The strategic management for each company starts with defining Mission and Vision for the company. There will be two steps in this initial part of the system: (1) gamification on Mission and Vision statements for popular companies and (2) defining of Mission and Vision of the company they will be working on, following several rules and guidelines.
The gamification process includes theoretical basics and definitions on the Mission and Vision statements (knowledge building) and a gamification based on quiz for Mission and Vision statements for popular companies in the technology sphere, according the focus and examples in the developed educational e-system. The system proposes different Mission and Vision statements and students have to guess the popular technology company to which the statements belong (knowledge testing) with evaluating from one to five the quality of the statements, according their opinion. The method has been tested amongst a course on Strategic management at master degree students in master degree program Technology Entrepreneurship at Sofia University “St. Kliment Ohridski” and proved to be very successful and very positively accepted amongst students.

The second process is connected with knowledge applying in developing through creativity process in groups of 3 a Mission and Vision statement for the technology startup company, which will be their model for simulation during the educational process on strategic management for technology new ventures.

![Diagram showing the strategic analysis education e-system components.](image)

**3.2. Strategic analysis process.**

Strategic analysis process in the educational system consists of two steps: (1) introduction of the classical strategic analysis tools, which are most appropriate for the technology new ventures sphere (identified by research of the author) and (2) presentation of innovative tool specifically developed for strategic analysis for technology new ventures, consisting of all most important elements for the next stage of strategic management - strategic modeling stage.
3.2.1. Classical Strategic analysis tools

The research on the level of usage of strategic analysis tools, implemented amongst 121 entrepreneurs in the technology sphere (107 from Bulgaria and 14 from other countries) proved the low level of usage of classical strategic analysis tools from entrepreneurs in the technology sphere. The results below are showing the levels of usage of four of the most popular strategic analysis tools.

Table 1: Usage of Strategic analysis tools (research by author).

<table>
<thead>
<tr>
<th>No</th>
<th>Research on Usage of Classical Strategic Analysis Tools Amongst 121 Entrepreneurs in the Technology Sphere</th>
<th>Yes, I use it.</th>
<th>No, I don’t use it.</th>
<th>I am not acquainted with it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SWOT analysis</td>
<td>70%</td>
<td>7%</td>
<td>22%</td>
</tr>
<tr>
<td>2</td>
<td>PEST (PESTLE/PESTEL) analysis</td>
<td>30%</td>
<td>10%</td>
<td>60%</td>
</tr>
<tr>
<td>3</td>
<td>GAP analysis</td>
<td>32%</td>
<td>12%</td>
<td>55%</td>
</tr>
<tr>
<td>4</td>
<td>USP (Unique Selling Proposition) analysis</td>
<td>26%</td>
<td>9%</td>
<td>64%</td>
</tr>
</tbody>
</table>

The results from the research are quite low, despite the high level of education on entrepreneurship and management of the participants in the research, shown on the next table, high level of usage of methods for strategic management and early level of technology startup companies’ development, shown on the next tables.

Table 2: Level of education of participants (research by author).

<table>
<thead>
<tr>
<th>Have you been studying entrepreneurship and management?</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, I have</td>
<td>65%</td>
</tr>
<tr>
<td>No, I haven’t.</td>
<td>20%</td>
</tr>
<tr>
<td>Self-learning</td>
<td>15%</td>
</tr>
</tbody>
</table>
The results from the implemented research confirm the need of suitable strategic analysis tools, supporting the strategic management process and the need of further training, guidelines and development of innovative tools, meeting the needs and specifics of technology new ventures in a higher degree. The classical strategic analysis tools, which were defined to be most important for the strategic management of technology new ventures in the current research are:

- SWOT analysis
- PEST (PESTEL/PESTLE) analysis
- 5 Porter’s Forces analysis
- Unique Selling Proposition analysis
- Core Competences analysis
- Niche/Gap analysis
- GAP analysis

The system contains the following three stages: (1) theoretical information and practical guidelines for practical work with the tools, as well as usable templates for the tools; (2) gamification on knowledge checking – for each tool there are some pre-developed strategic analysis with the different tools for famous companies, which are given in mixed group. Students have to order statements to the correct position (box) in the tools developed; (3) creativity process on using strategic analysis tools for creating strategy analysis for the technology startup company, with which they are working during the course of education. In this way all three steps in the educational process are covered by the system.
3.2.2. Innovative SIAMC tool for technology new ventures

The second part of the system aims introducing work with innovative tool for strategic analysis, which is specifically designed by the author for technology new ventures, being verified amongst 121 entrepreneurs in technology sphere and additional research and development of processes for its application.

During the development of the tool by the author, the research amongst 121 technology entrepreneurs on the level of importance of the included in the developed instrument categories has given the following results:
Table 5: Level of importance of the categories in Strategy identifying and analysing modeling canvas (SIAMC), according research.

<table>
<thead>
<tr>
<th>Categories in the developed instrument</th>
<th>High importance</th>
<th>Average importance</th>
<th>Total and High Importance</th>
<th>Low importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clients</td>
<td>93%</td>
<td>7%</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Product</td>
<td>88%</td>
<td>11%</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Strategic goals</td>
<td>80%</td>
<td>19%</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Mission</td>
<td>63%</td>
<td>30%</td>
<td>93%</td>
<td>7%</td>
</tr>
<tr>
<td>Competitors</td>
<td>61%</td>
<td>36%</td>
<td>98%</td>
<td>2%</td>
</tr>
<tr>
<td>Key resources</td>
<td>60%</td>
<td>33%</td>
<td>93%</td>
<td>7%</td>
</tr>
<tr>
<td>Market scope</td>
<td>60%</td>
<td>37%</td>
<td>98%</td>
<td>2%</td>
</tr>
<tr>
<td>Pricing and revenue streams</td>
<td>60%</td>
<td>37%</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>Key competence/skills</td>
<td>50%</td>
<td>45%</td>
<td>95%</td>
<td>5%</td>
</tr>
<tr>
<td>Key partners</td>
<td>48%</td>
<td>43%</td>
<td>91%</td>
<td>9%</td>
</tr>
<tr>
<td>Channels</td>
<td>46%</td>
<td>47%</td>
<td>93%</td>
<td>7%</td>
</tr>
</tbody>
</table>

These results can be applied also as a proof for the importance of the categories groups and their suitability for participation in the unified tool. The tool is structured in the form of canvas, which has proven its applicability in the sphere of technology entrepreneurship and management. The tool aims providing the most essential information at one unified tool, providing the necessary information after analysis for the next stage of strategic management – strategic modeling for technology new ventures. The tool is presented at Figure 9.

Figure 9: Strategic identifying and analyzing modeling canvas (Strategy modeling canvas SIAMC)
The tool has 11 categories and set of guiding questions, developed for each of the categories. The tool also has developed, by the author, a process of usage, presented at Figure 10. The process consists of three steps: Step (A), which is defining of the scope of competition, includes work on the categories in sequence as follows: 1) Mission; 2) Goals; 3) Market scope; 4) Clients. Step (B), which is defining of competitive advantage, includes work on the following categories: 5) Key competences; 6) Product; 7) Key competitors; 8) Key partners; 9) Pricing and revenue streams. Step (C) - defining of key elements from the strategic plan of actions, includes the following categories: 10) Key resources; 11) Channels of distribution (incl. advertising activity).

![Figure 10: 3-step (A-B-C) process of work with the developed Strategic identifying and analyzing modeling canvas (SIAMC).](image)

The process is forming the sequence of usage of the strategic identifying and analyzing modeling canvas (SIAMC), developed by the author, which can be used by technology new ventures as a transition step between the stages of strategic analysis and the stage of strategic modeling.

![Figure 11: Sequence of work with the developed Strategy analyzing and identifying modeling canvas](image)
The process of education consists of the three steps, described for the classical strategic analysis tools in the previous part of this chapter, since the role, usage and applying of the tools is the same.

### 3.3. Strategic modeling process

The stage of strategic modeling is the most difficult part in the process of strategic management. It is often connected with words such as talent, gift, art, visionary, etc., due to the lack of clear guidelines for its development process. The developed by the author process of strategic modeling for technology new ventures, however, is solving this problem and offers access to the classical tools for strategic classification, as well as to an innovative three-dimensional classification model for strategy modeling for technology new ventures, which also has full developed for each of its models – typological strategy, table of strategic choices and process of work with the tool.

The presented in the system basic theoretical tools are Porter’s Generic Strategies and Ansoff’s Product-Market Matrix and the innovative tool, combining the two strategic modeling tools, providing an innovative tools for strategy modeling, specifically designed for technology new ventures.

The process of education with the system has the following steps: (1) theoretical basics on the tools; (2) gamification on working with typological strategy’s quizzes and (3) creativity process on specifying company-specific strategy for their technology startup companies.

![Figure 12: Strategic modeling education e-system components.](image)

The general steps in the process of education on strategic modeling for technology new ventures, which are part of the proposed algorithm are: (1) Learning the entire process of strategic modeling steps (theoretical preparation); (2) Working on step 1: analyzing and applying results from the strategic analysis, implemented with strategic analysis tools during for strategic classification process; (3) Working on step 2: defining of typological strategy’s characteristics; (4) Working on step 3: defining of company specific strategy. (see Figure 13)
The process of strategy modeling has the following stages in its process:

![Strategy Modeling Process](image)

**Figure 13: Strategic modeling process steps**

### 3.3.1. Strategic classification process.

The classification process uses the innovative strategic modeling classification matrix, which consists of the following axes: (1) level of innovative capacity of the company; (2) market scope; (3) market maturity.

The typological classification model has the following presentation:

\[
NVTS = f(IC, MS, MM) \quad (1)
\]

where NVTS is the new venture typological strategy, IC is the company’s innovation capabilities, MS is the market scope and MM is the market maturity. Each of these variables (1) has two values, which defines a total of 8 typological strategies, described further in the chapter. The values, which IC has are: “innovator” and “follower”. The values of MS are: “local market” and “global market”. The values of MM are: “new or emerging market” and “existing market”. Each of the groups of values for the variables is forming a full set in the described field and thus eight typological strategies in total are formed.

- \( IC \in \{0;1\} \), where “0” when “follower” and “1” when “innovator”;
- \( MS \in \{0;1\} \), where “0” when “local market” and “1” when “global market”;
- \( MM \in \{0;1\} \), where “0” when “existing market” and “1” when “new/emerging market”; NVTS is a set of all eight combinations.

Table 6: Typological strategies for technology new ventures – classification model.

<table>
<thead>
<tr>
<th>Typological strategies - Global Market – Level Second</th>
<th>High innovation capabilities</th>
<th>Low innovation capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>New / Emerging Market</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Existing Market</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typological strategies - Local Market – Level First</th>
<th>High innovation capabilities</th>
<th>Low innovation capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>New / Emerging Market</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Existing Market</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
The general steps in the process of education on Strategy Classification Process include defining of company’s position at one of the typological strategies from the strategy classification model, following the steps at Figure 14.

![Figure 14: Strategic modeling process steps.](image)

Application of strategic analysis with SIAMC tools is needed at this stage of strategy’s modeling. After defining of company’s typological strategies, an overview on all typological strategies definitions is made, as a correcting step for students to confirm the correctness of their choice, or correct it by choosing the right category.

### 3.3.2. Typological strategy formulation process.

The defining of typological strategy is following the step of choosing typological strategy type. The process of defining of typological strategy in the education system has the following steps (see Figure 15)

![Figure 15: Strategy formulation process basic steps.](image)

At each of these steps in the educational system’s process, a defining of part of the typological strategy for the educational company is implemented. The process consists of two steps: (1) Choosing most appropriate typological strategy definition (key success factor, strategic goals, key performance indicators, typological strategic actions); (2) Overview on the entire typological strategy classification and their correct typological strategy’s definitions (correcting step).
Key success factors process of education in the typological strategy stage consists of the following steps: (1) students select key success factors from list of all strategies' key success factors; (2) overview of correct key success factors for the chosen typological strategy (correcting step).

For each Key success factor, one or more strategic goals are defined: (see Figure 18)
Defining of typological strategic goals, follows the gamification character of key success factors: (1) students select key success factors from list of all strategies' key success factors; (2) overview of correct key success factors for the chosen typological strategy (correcting step).

Figure 19: Defining of typological strategic goals by students.

Next step in the process is defining of Key performance indicators for measuring the progress towards achieving typological strategic goals. The key performance indicators defining for typological strategies has the following structure: (1) students select key performance indicators from list of all strategies' key performance indicators; (2) overview of correct key performance indicators for the chosen typological strategy (correcting step).

Figure 20: Defining of key performance indicators steps

The next step, defining of Typological strategic actions, is the final step from this stage of the process. For each typological strategic goal, one or more typological strategic actions are defined. The process of work is following the processes for all previous steps in this stage: (1) students select typological strategic actions from list of all strategies' typological strategic actions; (2) overview of correct typological strategic actions for the chosen typological strategy (correcting step).
After implementing all these steps, a table of strategic choices for the chosen typological strategy can be formed.

3.3.3. Typological strategies table of strategic choices.

The table of strategic choices is containing all information for the developed typological strategy in the previous step and will be used further as a basis for the final company’s specific strategy formulation.

The table of strategic choices consists of the upper mentioned categories: key success factors, strategic goals, key performance indicators and strategic actions, but also it applies an innovative Balanced scorecard model, also developed by the author. The model is specifically developed for technology new ventures strategic management, based on research and previous experience of the author with the model.

The research amongst 121 technology entrepreneurs showed the following level of usage of strategy modeling tools and models.

Table 7: Levels of usage of Business Model Canvas and classical Balanced Scorecard model.

<table>
<thead>
<tr>
<th>No</th>
<th>Strategic Analysis Tool</th>
<th>Research on Usage of Strategic Modeling Tools Amongst Entrepreneurs in the Technology Sphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Business Model Canvas</td>
<td>Yes, I use it. 54%</td>
</tr>
<tr>
<td>6</td>
<td>Balanced Scorecard</td>
<td>Yes, I use it. 23%</td>
</tr>
</tbody>
</table>

The low levels of usage of the classical Balanced Scorecard model, together with the Product-Market Fit focus of technology startup companies, Customer Development Model and wide spreading of Business Model Canvas, supporting the business model and Product-Market Fit development, and also the “search” mode of functioning of
the technology startup companies lead to the development of the modified Balanced Scorecard model used in the educational system (see Figure 22).

Figure 22: Modified Balanced scorecard model developed by the author.

The model was presented to the 121 technology entrepreneurs, participating in the research. The results are confirming the suitability of the model.

Table 8: Modified Balanced Scorecard Preference from entrepreneurs in technology sphere (research).

<table>
<thead>
<tr>
<th>No</th>
<th>Research on Preference of Type of Balanced Scorecard Model Amongst Entrepreneurs in the Technology Sphere</th>
<th>Preference results</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>BSC without Product perspective</td>
<td>15%</td>
</tr>
<tr>
<td>8</td>
<td>Balanced Scorecard with Product perspective</td>
<td>85%</td>
</tr>
</tbody>
</table>

Using the modified Balanced Scorecard model, a presentation on the table of strategic choices can be made. Categories in the table are: (1) key performance indicators; (2) typological strategic goals; (3) key performance indicators; (4) typological strategic actions. The Perspectives from the modified Balanced Scorecard model are: (1) Financial perspective; (2) Clients perspective; (3) Product perspective; (4) Perspective Internal processes and (5) Perspective Learning and Growth.

Table 9: Table of strategic choices – typological strategy (categories).

<table>
<thead>
<tr>
<th>Structure of the table of strategic choices for typological strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key success factors</td>
</tr>
<tr>
<td>Data*</td>
</tr>
</tbody>
</table>

* Data is ordered according the Balanced Scorecard Model
3.3.2. Defining of Company-Specific Strategy process

The process of defining of company-specific strategy consists of the following five steps (see Figure 23).

![Figure 23: Company-specific strategy modeling steps.](image)

The students follow again the steps of strategic modeling process for the typological strategy, but this time they create content, not only choose. They add or modify specific key success factors, key performance indicators and specify more detailed and corresponding to the company they are using in the process of education - strategic goals, specific actions for reaching the specific strategic goals of the company, as well as, they prepare for specifying of target values at the next step of the process – transition to strategic implementation stage.

As a results from this creative process, a table of strategic choices for the company-specific strategy is created. It consists of the following categories (see Table 11).
Table 11: Table of strategic choices – company-specific strategy (categories).

<p>| Research on Type of Balanced Scorecard Model Amongst Entrepreneurs in the Technology Sphere |</p>
<table>
<thead>
<tr>
<th>Key success factors</th>
<th>Strategic Goals</th>
<th>Key performance Indicators</th>
<th>Target values</th>
<th>Specific Strategic Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data*</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
</tr>
</tbody>
</table>

* Data is ordered according the modified Balanced Scorecard Model.

Table 12: Table of strategic choices – company-specific strategy (categories and modified BSC model).

<table>
<thead>
<tr>
<th>Key success factors</th>
<th>Strategic goals</th>
<th>KPIs</th>
<th>Target values</th>
<th>General typological actions</th>
<th>Specific strategic actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial perspective</td>
<td></td>
<td></td>
<td>data</td>
<td>data</td>
<td>data</td>
</tr>
<tr>
<td>Clients perspective</td>
<td></td>
<td></td>
<td>data</td>
<td>data</td>
<td>data</td>
</tr>
<tr>
<td>Product perspective</td>
<td></td>
<td></td>
<td>data</td>
<td>data</td>
<td>data</td>
</tr>
<tr>
<td>Perspective Internal processes</td>
<td></td>
<td></td>
<td>data</td>
<td>data</td>
<td>data</td>
</tr>
<tr>
<td>Perspective Learning and Growth</td>
<td></td>
<td></td>
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<td>data</td>
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<td>data</td>
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</tr>
</tbody>
</table>

After specifying the strategy of the educational company, a smooth transition can be made to the next step of strategic implementation, by continuing the development of the presented table of strategic choices.

3.4. Strategic implementation process

The strategic implementation process is divided by the author in two stages. The first stage is initial preparation for the work distribution from the second stage of the strategic implementation process.

The first stage, consists of the following three steps (see Figure 23).

(1) defining person responsible for each of the strategic actions
(2) defining level of importance of key success factors and strategic actions
(3) defining of overall level of importance of strategic actions

Figure 24: Company-specific strategy transition to strategy implementations steps – stage 1.
After defining one person from students’ team responsible per strategic action, a distribution of the responsibilities in the team is easily implemented. The next stage is defining level of importance for key success factors and strategic actions. These levels of importance are defined by the strategic team. A check on the levels of importance for key success factors is possible for the defined key success factors, only in the process of typological strategy creation.

The ranking categories which are used in the system are: (1) low importance = 1 point; (2) average importance = 2 points; (3) above average importance = 3 points; (4) high importance = 4 points; (5) very high importance = 5 points.

After defining levels of importance for the two categories, an overall ranking by importance is implemented by multiplying the digital expressions of levels of importance of the key success factors and strategic actions. This ranking allows easier prioritization of tasks during strategy execution stages.

The second stage in the process of strategic implementation consists of the following four steps (see Figure 25).

![Figure 25: Strategy implementation process – stage 2.](image)

Working on the steps in stage 2 of the process by the team aims preparation for the next stage of strategic execution. By following these processes, an easier transition from strategic modeling to strategic execution is implemented. Students learn team working basics, responsibility and prioritization techniques, as well as the general steps in preparing for strategy execution process.

The information, connected with organization on the strategic implementation process is also included in the table of strategic choices.
Table 13: Table of company-specific strategic choices in strategy implementation.

<table>
<thead>
<tr>
<th>Key success factors</th>
<th>Strategic goals</th>
<th>KPIs</th>
<th>Target values</th>
<th>General typological actions</th>
<th>Specific strategic actions</th>
<th>Overall level of importance</th>
<th>Responsible person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial perspective</td>
<td>data</td>
<td>data</td>
<td>data</td>
<td>data</td>
<td>data</td>
<td>data</td>
<td>data</td>
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<tr>
<td>Clients perspective</td>
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<td>data</td>
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<tr>
<td>Product perspective</td>
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<td>data</td>
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<tr>
<td>Perspective Internal processes</td>
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<td>data</td>
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<tr>
<td>Perspective Learning and Growth</td>
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</tbody>
</table>

After finishing both stages of the strategic implementation process, students are ready for the next stage of strategic execution process.

3.5. Strategic execution process

Strategic execution is connected with various skills, learned from subjects Project Management and Operational Management, which are not subject of this research and for this reason the system will make a link to these subjects and their systems, but since educational process may also be only simulative in the strategic execution stage, not only these subjects are included, but also skills on strategic prioritization according overall level of importance of the strategic actions, defined in the previous stage and the urgency of the strategic actions, defined on the time available to the deadline of the strategic action. The prioritization matrix, which is included in the system, as a tool with theoretical explanation and guidelines for practical exercises is described on Table 14.

Table 14: Prioritization of Strategic actions during strategy execution process
(Research) – scale: 1-highest priority; 4-lowest priority.

<table>
<thead>
<tr>
<th>Strategic actions prioritization modeling during strategy execution stage</th>
<th>Tasks with High level of strategic importance</th>
<th>Tasks with Low level of strategic importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks with High level of urgency</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Tasks with Low level of urgency</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The educational management strategic e-system includes gathering of performance data on day to day basis and allows strategic execution control and evaluation processes during the execution stage (see Table 15).

Table 15: Table of company-specific strategic choices in strategy implementation.

<table>
<thead>
<tr>
<th>Key success factors</th>
<th>Strategic goals</th>
<th>KPIs</th>
<th>Target values</th>
<th>Current values</th>
<th>General typologic al actions</th>
<th>Specific strategic actions</th>
<th>Overall level of importance</th>
<th>Responsible person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial perspective</td>
<td>data</td>
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<td>Clients perspective</td>
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<tr>
<td>Product perspective</td>
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<tr>
<td>Perspective Internal processes</td>
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<tr>
<td>Perspective Learning and Growth</td>
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</tr>
</tbody>
</table>

The next stage in the educational e-system for strategic management is Strategic control and evaluation.

3.6. Strategic control and evaluation processes

The control and evaluation process shows to what degree the current results and actions are corresponding to planned results and chosen goals. It aims noticing at the earliest possible stage any existing deviations and their correction as quickly as possible. For this reason, it will use as a basis the deviations between target and current values and the prioritization model from strategic execution stage.

The process of strategic control and evaluation processes in the system are shown on Figure 27.

![Figure 26: Strategy control and evaluation process.](image)

The educational strategic management e-system at this stage is offering a supportive tool in a simulation environment on strategic control and evaluation processes and is providing a field for different scenarios games, led by an lecturer, teacher or assistant.

With this stage the strategic management process is complete and the system is covering all strategic management stages.
4. Conclusion

The presented algorithm of work of an innovative educational strategic management e-system includes all stages from strategic management process and is developed based on research amongst 121 entrepreneurs in the technological sphere. The developed system is aimed towards education on strategic management, specifically for technology new ventures and is designed using the tools of: theoretical preparation (knowledge gathering), gamification principles (knowledge checking) and creativity application of the knowledge (knowledge applying). The presented system can be applied in all types of education: traditional education (face to face learning), blended e-learning and distance e-learning. The presented system can be used as a basis for further development for strategic management systems for other types of companies and education and training applications.
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Chesbrough, W. V. (2006), *Open innovation: researching a new paradigm*.


Contact email: s.valentinova@gmail.com
Using Flipped Classroom Ideology to Explore Deep Learning in Large Classrooms

Brenda Danker, Sunway University, Malaysia

Abstract
This project used the Flipped Classroom approach to stimulate deep learning in large classrooms during the film module of a Diploma in Performing Arts course at Sunway University, Malaysia. In the flipped class, students first watched online lectures as homework, and then completed their assignments and practical work in class where the lecturers were present to help the students, in addition to the advantage of students being able to help one another. Apart from the blended learning approach, the in-class learning activities included inquiry-based learning, active learning, and peer-learning. Data was gathered from questionnaires filled out by the students and from short interviews with the students, as well as from the teacher’s reflective journals. The findings verified that the flipped classrooms were able to remodel large lecture classes into active-learning classes. The possibility of individualised learning for the students was high as a result of the teacher’s ability to have one-on-one tutoring through technology-infused lessons. It is imperative that the in-class learning activities needs to be especially purposeful in design to increase the students’ curiosity and to engage them to develop higher-order thinking skills and, ultimately, to become life-long learners. This project also concluded that flipped classrooms had promising impact for student learning and achievement in a Performing Arts course in Malaysia.

Keywords: flipped classroom, curriculum design, technology: lifelong, online lecture, blended learning
Introduction

In recent decades, the student-centred learning approach has shown significant learning gains and has reformed teaching styles in many higher educational institutions globally. However, on the other end of the spectrum, in many developing countries, including Malaysia, the teacher-centred learning approach is still widely used and preferred. The teacher-centred learning approach uses lecture-based instruction which is economical and viable for teaching a large number of students at a time. Lecture-based instruction is where the teacher takes the active role of dispensing knowledge in a classroom. The propagation of information is in a one-way direction. In such an environment, the students are passive learners, where they rely on learning by listening, memorising, and on the repetition of the taught knowledge. The major shortcoming in passive learning is that students only have a basic recollection of knowledge - which means they have merely achieved a low level of thinking skill. To attain a higher and conceptual level of thinking, the students need to take responsibility for their own learning and become active knowledge seekers. The student-centred learning approach emphasises engaging learners to structure their learning to include applying their current classwork or experience when they collaborate to solve problems, and make sense of their learning. With this approach, students become active learners and the teacher’s role now moves to that of being a facilitator by initiating classroom discussions to ensure that all the students achieve understanding for meaningful and effective learning (Goh, 2012). The student-centred approach should be at the heart of our educational system and this calls for a paradigm shift in higher educational institutions in Malaysia - to move from the teacher-centred approach to the student-centred approach.

In addition, technology in education is a step in the right direction as we move forward in the 21st century. When teachers effectively integrate communication technologies in their teaching, they create engaging learning environments, especially as students have already adopted technology in their lives and use it increasingly for learning. Higher educational institutions cannot ignore technology in fulfilling their strategic mission and in responding to the expectations of a diverse student body (Donelly, 2009) as technology-rich classrooms have shown an effect on the students’ achievement.

In moving away from the lecture model to an instructional design involving interactive pedagogy and technology, many educators are paying attention to the Flipped Classroom ideology. YouTube Teacher’s Studio educator, Ramsey Musallam, (2011) suggests using teacher produced videos to shift the form of instruction from the classroom to the homework setting in the Flipped Classroom approach. Students watch recorded lectures for homework and complete their assignments, lab work and tests in class (Hertz, 2012). This allows the lecturers to work with the students during class on what was formerly given as homework. In this way, the lecturers are present to help the students and the students can also help each other (Pink, 2012). Flipped classrooms draw on concepts such as active learning, student engagement, hybrid course design, and course podcasting (Educause, 2012). It overlaps other instructional tools, such as Reverse Instruction, Inquiry Learning, Blended Learning, and Online Instruction, through the use of podcasting or screencasting, Web 2.0 resources, and inquiry activities (Bennett, et al. 2011).

In this study, the student-centred learning approach with an instructional design using
technology was drawn up to encourage active learning and higher-order thinking skills within a large class size. The major research questions in this study were:

1. How will using Flipped Classroom ideology engage the students in deep learning despite being in a large class?

2. Using the Flipped Classroom ideology, what in-class instructional design for a large class size can be practised to increase the interaction between the teacher and the student and between the student and another student, with the intention of engaging them to deep learning?

**Student Learning and the Flipped Classroom**

The flipped classroom promotes an environment which increases the interaction between the students and teachers and engages the students in learning through application and practice. In this aspect, flipped classrooms use a student-centred approach as it focuses on student learning and it places the responsibility for learning more on the shoulders of students than teachers while giving them a greater impetus to experiment (Sams, 2011). This can be seen from the early pioneers of the Flipped Classroom model - Bergmann and Sams’ instructional design - where students explore and make sense of their learning through active learning activities like inquiry learning, problem-based learning and peer collaboration (Sams, 2011). This creates the face-to-face time to have a “much deeper interaction” between the teacher and student as they engage and interact on case studies, and discuss particular problems (Leckhart & Cheshire, 2012; Gerstein, 2012). The learners are able to demonstrate what they have learned and to apply the material in a way that makes sense to them. As learners make sense of their learning, they create something that is individualized, and with application to the learners’ everyday lives, it extends beyond the lesson. This is the highest level of learning under Bloom’s Revised Taxonomy of Learning (Gerstein, 2012).

The Flipped Classroom promotes personalised learning as students can pause, re-wind and re-watch the online video at their own pace - one of the major, evidence-based advantages of the use of video is that learners have control over the media with the ability to review parts that are misunderstood, which need further reinforcement, and/or those parts that are of particular interest (Gerstein, 2012). This has a positive effect on student learning and achievement. For example, in 2009, after they flipped their classrooms, Clintondale High School in Michigan, U.S, had a dramatic decrease in the failure rate in critical subjects, such as English Language Arts – which was from 52% to 19% (Álvarez, 2011).

**Flipped Classroom in a Large Class Size**

Large classrooms are the norm in higher educational institutions in Malaysia. In a study on large group teaching in a Malaysian private university, researcher Susan Thomas assumes that an average class in Malaysia has more than 80 students (Thomas, 2011). The maximum class size for writing classes should be 20 or less, as recommended by The Conference on College Composition and Communication, a professional organisation within the National Council of Teachers of English that focuses specifically on college writing (Horning, 2007). In large classrooms, engaging the students all at once is a challenge even more so when using traditional approaches.
to teaching - which research has demonstrated to be less effective than more interactive methodologies (Schell, 2012). Implementing a flipped classroom for a large class size may boost the students’ academic attainment as it generally enables more focused teaching and learning to take place in the classroom despite the class size (Kachka, 2012). The flipped classroom’s online material enables teachers to coach large classes: one-on-one tutoring, scaled by the web (Leckhart & Cheshire, 2012). As for its in-class teaching approach, small group discussions, peer-learning and inquiry-learning have been used to engage students in their learning, even for a large class size. In a large classroom of 209 students, Rick Sellens, a professor at Queens University in Canada, uses the Flipped Classroom with Peer Instruction. Despite the large enrolment, Sellens says: “I was able to get students engaged and talking to each other about the subject matter using Peer Instruction” (Schell, 2012).

**Concerns in using the Flipped Classroom Model**

An effective flipped classroom requires careful preparation and there is concern regarding the amount of time and effort the instructor has to put in. Recording lectures requires skill and time on the part of the faculty. Moreover, out-of-class and in-class elements must be carefully integrated for students to understand the model and be motivated to prepare for the class. A teacher, Roshan, admits that the process is time-consuming – about one hour and 15 minutes to record and edit a 30-minute lecture. But then, instead of lecturing in class, Roshan spends the class time “just walking around seeing what [students] need help with... they’re able to work at their own pace” (Houston & Lin, 2012). As such, introducing a flip can mean additional work and may require new skills for the instructor, although this learning curve can be mitigated by approaching the model slowly (Educause, 2012). It takes effort, but planning, implementing and revising are all doable tasks and each effort builds a block upon which the next can be built. The important component of this process is to develop high-level, engaging questions that serve to deepen students’ thinking and to address misconceptions in the lesson (November & Mull, 2012).

Hertz (2012) raises the issue of students’ access to the Internet. A common concern in the flipped classroom process is regarding students who have poor or no Internet access outside of class since the activities outside of class rely on technology. To mitigate this, lecture videos should be converted into a format that can be accessed by students through various means - laptops, tablet computers, smartphones and DVD players. The school faculty can also ensure that the computers in the library and labs are available for students to preview the videos before class.

Another concern, which pertains to education in general, is when the student does not do the homework, in this case, to watch the online material before class. A flipped class requires students to be willing to take responsibility for their learning. While the focus of the Flipped Classroom is no longer the faculty as the “sage on the stage” but rather the “guide on the side”, it provides a setting where students receive personal attention still held accountable for actions and academic performance (Hawks, 2014). Students who do not watch the online material before class will not be able to participate in the in-class activities fully and proceed to the application tasks. To ensure greater compliance, instructors can track the knowledge gained from the homework or they can adjust the class activities for unprepared students, if they are in fact unprepared (Kachka, 2012). This might be achieved by insisting that the
unprepared students watch the video during class time (the preparatory work that is required so as to be able to proceed to the application tasks) while the rest of the class deepens their knowledge through other activities, i.e. the unprepared student misses out on the class interaction.

Implementing the Flipped Classroom

The process of just flipping a classroom will not transform students’ learning. According to a study by Houston and Lin (2012), a successful implementation of a flipped classroom would need the videos to be relatively short (no longer than 20 minutes) and teachers should briefly review the course content before in-class activities to answer any questions and to make sure that the majority of the students have sufficient understanding of the material. Kachka (2012) recommends that during the in-class activities, the teacher must be deliberate to guide and increase the interaction with the students. In addition, the instructional design using technology needs to be carefully planned to ensure the students’ learning experience is enhanced, where students identify learning as their goal. Ramsey Musallam, who began flipping his classroom in 2006, stressed this, saying, “(a) flipped classroom is a thing you do in the context of an overarching pedagogy [and is] not the pedagogy itself” (Ash, 2012). The Flipped Classroom has a comprehensive instructional model that includes direct instruction, inquiry, practice, formative and summative assessment and many more elements (Bennett, et al. 2011). These instructional techniques give a focus to the process of learning. It is aimed to enable students to be more actively engaged with the course material and, ultimately, empower them to construct knowledge through their understanding.

Methodology

This study uses an action research approach, in line with the research query - which is to investigate what in-class instructional design for a large class sizes can be used to increase the interaction between the teacher and the student and between the student and another student, with the intention of engaging the students to deep learning. The instructional design using a flipped classroom strategy can be improved progressively in later flipped classes to achieve its impact of deep learning among the students.

Procedure

The study was done in two cycles, involving two cohorts of the Diploma in Performing Arts students from the Department of Performance and Media, Sunway University. The first cycle was conducted in the Scriptwriting course in the August 2012 semester. With 32 students from the second year cohort of the programme, two flipped classes were held. The second cycle was conducted in the Video Tools course in the April 2013 semester. With 33 students from the first year cohort of the programme, two flipped classes were held.

In the first cycle of the flipped classroom, the students’ learning cycle consisted of two stages, as outlined in Figure 1. The first stage involved the students viewing an online lecture as homework before class. The second stage involved the students engaging in active learning in class where they worked out real-world projects to
grasp the context of the taught topic. In-class learning activities included peer
instruction, problem-based learning and collaborative work.

![Figure 1: Students’ learning cycle in Flipped Classroom Cycle 1](image1)

The model of instruction for the second cycle of the flipped classroom was improved
after continual reading of literature on achieving deep learning among students and
personal reflection on the researcher’s observation notes and questionnaires from the
first cycle of the flipped classes. The in-class instruction now merged aspects of
blended learning with an inquiry-based learning cycle. According to Flipped
Classroom instructor Ramsay Musallam, when flipping his classrooms to achieve
meaningful student learning, he would include the “Explore” phase, where students
would work through guided inquiry exercises. This is based on the Explore-Explain-
Apply inquiry learning cycle developed by Robert Karplus (Musallam, 2013).

The flipped classrooms for the second cycle consisted of three stages, as outlined in
Figure 2. The first stage involved in-class learning activities focusing on exploration
of concepts where students would perform hands-on activities designed to investigate
the concept, and included discussion on various probabilities with the intention to lead
to an understanding of the concept. The second and third stages were similar to the
students’ learning cycle in the Flipped Classroom Cycle 1, which was to preview an
online lecture, followed by concept application in class. In the case of students who
did not watch the online lecture before class, they were asked to watch it at the
beginning of the lesson and, after watching it, resume class to take part in the active
learning phase of the course.

![Figure 2: Students’ learning cycle in Flipped Classroom Cycle 2](image2)

**Research Method**

To investigate if students were engaged in deep learning in a flipped classroom, a
qualitative research method was used, with questionnaires, short interviews and
observations. The first source of data - questionnaires focusing on the online lecture -
were given to the students immediately after each flipped class. The second source of
data - short interviews with a small sample of the two cohort groups of the
programme - were semi-structured, with key questions asked on their experience or
behaviour in the flipped class, their knowledge of the topic taught, and their learning
in the flipped classrooms. The study sampling had 19 students (nine from the first year cohort and 10 from the second year cohort). The final source of data was from the researcher’s personal reflection, abstracted from observational logs written during the flipped classes and from reflection notes written soon after each class.

**Results and Discussion**

In analysing the qualitative data, a thematic analysis was carried out within the scope of the themes determined by the research question framework of the study - which is, how the Flipped Classroom ideology can engage students in deep learning despite being in a large class. Student’s characteristics of their approach to achieve deep learning were identified from The Higher Education Academy in the UK (compiled from Biggs (1999), Entwistle (1988), and Ramsden (1992)) and were used in the scope of the themes explored in this study. Students who want to achieve deep learning have the intention of understanding, engaging with, operating in, and valuing the subject. As such, the thematic analysis shows that deep learning occurs when students:

1. Look for meaning in their learning
2. Interact actively and
3. Relate new and previous knowledge (Higher Education Academy, 2011).

The results also indicated several common issues and themes.

**Students Look for Meaning in their Learning**

In analysing the theme of students looking for meaning in their learning, we first looked for any behaviour trends when the students accessed the lesson online, and also the level of understanding of the topics taught in the flipped classroom. After watching the online lecture, 50% of the Year 1 students reported in the questionnaire that they replayed and paused the online lecture to take notes and to understand the lesson. Relating to their understanding of the topics taught, respondents from both cohorts interviewed had a high understanding, with an average ranking of 4 out of 5 (highest) as outlined in Table 1. In the second flipped class for Year 1 students, 44% of the respondents felt they understood the topic well and ranked it at 5 (as outlined in Figure 3). These results show that most learners are engaged in their learning when using the technology to watch the online lecture. From the nine interview respondents with the Year 1 cohort, one student, after watching the online lecture, even looked for more information online and two students understood the topic well enough to apply it to the personal projects they took on.

When using the flipped classroom model, learning instructions, like inquiry-learning, were implemented in the Flipped Classroom Cycle 2 with the intention for students to make sense of their learning. The results from this study showed that more than half of the respondents (67%) from flipped class Cycle 2 (which taught camera shots size and angles and how to develop stories by using storyboards) found learning engaging and were excited by the ideas taught to try them out themselves. For example, Interview 5 (Year 1) had practiced framing different shots and angles with a camera before class to test the knowledge received. Interview 7 (Year 1) said: “I am a dancer and I wanted to start planning to shoot dance movements using the camera”. Three respondents from Cycle 2 began to think about the process for story development. Interview 7 (Year 1) said: “I looked at how stories are from script to visual. I was also...”
thinking of how to shoot stories”. Based on the researcher’s observation notes, respondents from Cycle 2 were prepared for the lesson and were capable of going straight into the activity. This is in accordance with the increased percentage (from 30% of the Cycle 1 respondents to 67% of Cycle 2 respondents) who reported they were engaged in their learning and were excited to try these ideas out on their own. A factor which may have led the students to be engaged and energised in their learning was when inquiry-learning (which is the explore phase) was incorporated in the flipped classes Cycle 2. The instructional design with the “Explore” stage in Cycle 2 could have sparked the students’ curiosity and zest for learning as inquiry-learning helps foster critical thinking.

Table 1: Students’ level of understanding of the topics taught and the average ranking in the flipped classes.

<table>
<thead>
<tr>
<th>Year 2 Students</th>
<th>Iv 1</th>
<th>Iv 2</th>
<th>Iv 3</th>
<th>Iv 4</th>
<th>Iv 5</th>
<th>Iv 6</th>
<th>Iv 7</th>
<th>Iv 8</th>
<th>Iv 9</th>
<th>Iv 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Lecture 1</td>
<td>4.5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2.5</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Online Lecture 2</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3.5</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 1 Students</th>
<th>Iv 1</th>
<th>Iv 2</th>
<th>Iv 3</th>
<th>Iv 4</th>
<th>Iv 5</th>
<th>Iv 6</th>
<th>Iv 7</th>
<th>Iv 8</th>
<th>Iv 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Lecture 3</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Online Lecture 4</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Average ranking of students’ level of understanding of the topic taught in the flipped classes 4

Iv Interviews were labelled numerically.

0-5 Level of students’ understanding of the topic taught with 5 ranked as the highest.

Figure 3: Students’ level of understanding of the topic taught in Online Lecture 2 in the Flipped Classroom Cycle 2.
The above results point to how this flipped classroom study helped students to be active learners despite the class size. This setting helped turn what was traditionally passive learning (sitting, listening, taking notes) into a more active, hands-on, student-centred process, by means of technology. The content of the lesson, now delivered to the students online, gives the students the opportunity to reflect and be prepared to be engaged further in class. With class time focused on meaningful learning activities, students also collaborated in small groups to solve problems and use deeper learning processes such as critical thinking. Students from this study showed that they actively sought to transform their own learning from understanding to a higher level of thinking when they engaged in applying and connecting the lesson to their own projects and interests. The flipped classroom model creatively helped these students to manage their own learning.

**Students’ Active Participation during In-Class Activities**

In assessing students’ participation in class activities, the interview results showed a high participation in all the flipped classes with a majority (more than 70%) saying they gave at least 80% of their attention to the activities. Nearly half of the respondents attributed their high level of participation to gaining new knowledge from the online lecture and in-class activities and finding it interesting.

In engaging diverse types of learners in the in-class activities, it is important to pay attention to students who are introverted or are more of reflective learners. In this study, these learners found it hard to participate as they would rather think through the work than voice their opinions during the in-class activities. 11% of the respondents felt they could have spoken up more during the group activities. Interview 9 (Year 1) said: “I could have done better at participation as I have feedback in my head”. The researcher had observed this and recognised these learners and decided, in future lesson plans, to provide discussion questions ahead of time and to include short reflective breaks during class for these learners to think through the lesson.

In a flipped classroom setup, there is increased interaction between the teacher and the student, and with the student and another student, despite the large class size. One evidence of this interaction is the increased time for feedback. This is seen from the Year 2 interview respondents where 50% of them had a consistent comment on feedback - they either felt they had provided feedback or received useful feedback from their peers and the teacher on the work they did in the in-class activities. Interview 6 (Year 2) said: “Through the activity, my group members gave good feedback on how to improve the conflict in my script”. In the researcher’s observation notes, it was noted that as the students performed the learning activities, the teacher could assess the students’ level of understanding and provide prompt guidance directly. These increased opportunities for feedback could improve student learning. According to Bloom (1984), “an average student who receives one-on-one attention is enabled by constant feedback and a corrective process, and can jump into the 98th percentile of the student population in the academic achievement realm” (Houston and Lin, 2012).

The in-class activities were all conducted in small groups varying from two to five members, depending on the type of activity. The researcher’s notes showed that
working in small groups helped students to feel less intimidated to ask questions and express their opinions. In addition to this, an interview respondent from the Year 1 cohort commented that questions were asked throughout the activities in the class, compared to a traditional classroom, where questions are only asked at the end of the class. This helped draw the students into the learning process.

Students in this study recognised the benefits of active participation in class. They participated as they found the activities interesting, were interested to gain new knowledge in the classroom, and to share knowledge with one another. The class itself was transformed into a bustling learning hub.

Students Connect New and Previous Knowledge

Deep learning involves being able to connect the taught topics to previous knowledge and to the real world. In the thematic analysis of relating the topics taught in their flipped classrooms to new and previous knowledge, 90% of the interview respondents from the Year 2 cohort agreed that it did occur and they were applying the topics taught to their work (The flipped class was about story structure and conflicts in a short film). Interview 2 (Year 2) said: “I can apply this knowledge of storytelling in books whereby I can understand its story structure”. In another flipped classroom, all Year 2 respondents could relate the topic taught to film, life, and their projects. Interview 7 (Year 2) said: “Yes, I can relate the topic taught to my life. I can relate characters to myself, especially in the choices the character made when in conflict”. Interview 2 (Year 2) said: “I apply the knowledge taught when I view films, where I analyse the film structure. Also, when I work on the edit for my project, I pay attention to story flow and I apply the build-up sequence to the end of the story”. As for Year 1 interview respondents, 78% of them could relate or/and apply the knowledge taught to films, books, music videos, and topics taught in other classes.

The above encouraging results showed that most students in the flipped class were able to relate new ideas to previous knowledge to build an understanding of the material taught.

Other Findings

There was a common thread among the respondents regarding the benefits of peer learning. 50% of the Year 2 interview respondents placed value on peer learning. Interview 10 (Year 2) said: “I feel more comfortable in small groups and this enables me to give opinions and ask questions. I find this way of learning effective”. Interview 5 (Year 2) said: “Discussions with my peers are stimulating and I can retain the information better”. Peer learning helped most of the students in this study to understand the topic better and engage in the learning process.

Another benefit from the in-class activities, based on the researcher’s observation notes, was that the students developed soft skills when they were in the small groups. They were seen facilitating the discussion, articulating ideas, encouraging one another to contribute to the discussion, helping one another to accomplish the task and practicing leadership skills. Interview 8 (Year 1) reinforced this observation, saying: “We learnt to communicate better, where we expressed our ideas and feelings and tried to be a good listener”.

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All the study respondents found the flipped classroom to be productive and useful for their learning: 37% of the interview respondents felt that it was because the online videos were accessible and could be viewed again when necessary; 26% of the respondents said that the knowledge they acquired was condensed into a short video and this saved time in their learning; and 37% of the respondents said the flipped classrooms were productive for their learning as they were provoked to think about the topic before class and were able to go beyond what was taught.

Summary and Conclusions

The classroom flip in this study has shown encouraging results especially in the area of student participation in the lesson. The students have shown that they were involved in their own learning, with some students even applying what they learned in their own projects, and in their everyday lives. Students in this study also showed how they were able to connect new ideas to previous knowledge and apply it to the real world.

The flipped classroom is able to redesign a large lecture class into an active-learning class made of small groups. Despite a larger class size, active learning in small groups lead students to be engaged in learning, where they can participate, receive feedback and develop higher-order thinking skills. The class is no longer a place where students are passively seated and only take notes, but now is bustling with students who are interacting and discovering the lesson together.

In this study, exploratory learning through guided inquiry-based activities in the flipped classes was a successful way to engage students on a deeper level. This learning strategy increased the interaction between the teacher and the student and between the student and another student, despite the large class size. Interactive learning strategies in the classroom have to be planned out and revised accordingly as the dynamics is different from class to class, more so in a large class, so as to develop higher-order thinking skills and, ultimately, for students to become life-long learners.

The Flipped Classroom strategy promoted individualised learning for students as some of the students used the opportunity to replay and pause the online lecture to absorb it better. Students could do this at their own pace. However, students will need to take the initiative and take responsibility for their own learning.

In carrying out this study, both learners and faculty members had a rewarding experience in using the flipped classroom model as it has empowered students to take charge of their learning and to become their own teachers. It enabled the teachers to have one-on-one tutoring through a technology-infused lesson despite the large class size. This study provides an insight into a flipped classroom experience in a Malaysia context specifically in a Performing Arts course and supports the view that the flipped classroom has much to offer to the process of learning in higher educational institutions.
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flipped


Modeling Student Affect in English Learning Achievement Using Association Rules

Fitra A. Bachtiar, Ritsumeikan University, Japan
Eric W. Cooper, Ritsumeikan University, Japan
Gunadi H. Sulistyo, State University of Malang, Indonesia
Katsuari Kamei, Ritsumeikan University, Japan

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Abstract
Educational studies have been conducted to search for methods of optimum learning. Student-teacher interaction is important in classroom settings for an environment conducive to learning. Most instructional practices thus far have explicitly included many more cognitive factors than affective ones. The affective factors are often neglected because they are considered private matters, far too long-term to be assessed, and poorly understood phenomena. As part of learning, emotion has been shown empirically to affect the quality of thinking and cognitive information processing. Some educators have suggested that certain teaching and learning activities are more likely to be successful when students are motivated by affective factors. An initial step to better understand student learning achievement based on the affective domain is to build profiles to infer student learning achievement. In this study, association rules are used to infer the relationship between student affective factors and performance in a learning setting. This study shows methods of revealing how student affective profiles are linked to their achievement in learning a second language. Factors influencing student learning are selected, classified, and used to form student affective profiles and to generate rules associating the factors with learning outcomes. The results show that both integrative motivation and intrinsic motivation show a positive and significant correlation with achievement. The resulting profiles are applicable as a basis to develop empirically-based teaching methods that explicitly include individual student affective aptitude.

Keywords: affective factors, student modeling, association rules, English learning
Introduction

In recent years, research in education has been focusing on comprehensive studies for quality learning (Felder and Brent, 2005). Previous studies have found that interaction between teachers and students plays an important role in classroom settings (Efklides & Volet, 2005; Sathik & Sofia, 2013). In addition, motivating students through the affective domain hierarchy is more successful in certain teaching and learning activities (Shephard, 2008). Teaching and assessment in higher education generally focuses on cognitive skills rather than the affective domain. The affective domain is often neglected because it is believed to be a private matter, too long to be assessed within a time scale of any particular learning activity, and involves poorly understood phenomena (Meredith, Fortner, & Mullins, 1998; Shephard, 2008). Teachers however should be conscious of student affective traits as these traits play a significant role in learning. Teachers should develop their ability to give positive signals and avoid negative signals that could prevent learning. They also should create conducive learning environments where student can take risks, develop self-confidence, and grow emotionally and academically for successful learning (Rosbach, 2003; Sathik & Sofia, 2013).

Emotion has been shown empirically to affect the quality of thinking and cognitive information processing (Meyer & Turner, 2002; Wolter & Pintrich, 1998). In English learning, emotion is a key factor for English as a Foreign Language (EFL) learning (Fen, Fan, & Yang, 2013; Obeidat, 2005), which includes vocabulary learning (Sadeghi, 2013). Students have different levels in their affective factors, motivation and attitude, as well as responses to specific teaching and learning practices (Felder & Brent, 2005). These differences have impacts on student performances in English learning, as has been shown in some studies, for example, Wei (2007) who used anxiety and motivation as these factors have been recognized as prominent factors in student performance. Al-Tamimi and Shuib (2009), paired up motivation and attitude as factors that cause low English proficiency in engineering students. Addressing and treating these factors incorrectly may impact on the learning outcome.

In this paper a data mining technique, association rule mining, is used to understand student emotional traits in learning. Association rules were developed by Agrawal, Mannila, Srinkat, Toivonen, and Verkamo (1996). Association rules are a method of representing acquired knowledge by identifying frequencies of adjacent relationships between items in a database (Garcia, Romero, Ventura, & de Castro, 2011). The goal of current study is to infer relationships between affective factors and performance in a learning setting, specifically to identify student affective profiles and to link them to the student general learning achievement in English. This paper is organized as follows: Section 2 presents a brief explanation about affective factors in learning and English learning. Section 3 describes questionnaire development and the subjects of this study. Section 4 explains the method proposed. In section 5, results and analyses of the proposed method are discussed. Section 6 concludes this paper by stating conclusions and future work.

Affective Factors

Affective factors in this present study are student emotions toward learning English as a foreign language. Affective factors in language learning are factors that deal with
student emotion and attitudes toward the target language (Bachtiar, Kamei, & Cooper 2012). The affective factors influencing students in language learning are various. According to Ellis (1995), an affective disposition character is influenced by individual factors, such as anxiety. Brown (2007) states motivation includes several affective factors that influence learning and divides motivation factors into intrinsic motivation and extrinsic motivation factors.

The proposed factors are factors commonly used in EFL research: motivation, attitude, personality, self-esteem, and anxiety (Al-Tamimi & Shuib, 2009; Bandura, 2006; Boekaerts and Boscolo, 2002; Dörnyei, 1998; Eysenck, 1968; Horwitz, 1999; John & Srivastava, 1999; Masgoret & Gardner, 2003; Myers & McCaulley, 1988; Obeidat, 2005; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pintrich, 2000; Wei, 2007; Zimmerman, 2000). Suitable factors from these studies are selected for the present study. Motivation factors identified in this study are Integrative Motivation, Instrumental Motivation, Resultative Motivation, Intrinsic Motivation, Global Motivation, and Task Motivation. Attitude factors are Attitude towards Community, Attitude towards Language, and Attitude towards Learning English. Personality factors consist of Introversion and Extroversion. Other factors, such as Anxiety and Self-Esteem, are independent variables that do not have sub factors. The proposed affective factors of interest are shown in Fig. 1.

![Fig 1. Proposed affective factors](image)

### Questionnaire Development and Subjects

#### Questionnaire Development

A questionnaire is developed to measure students’ affective responses as an input to the system, a Likert scale with five possible responses. The response values range from five for strong agreement, to one for strong disagreement. The classification factors include motivation, attitude, personality, anxiety, and self-esteem. The proposed factors are then broken down into several causal corresponding variables, as shown in Fig. 1. The questionnaire for each of the constructs is a modified version of the questionnaires developed by Al-Tamimi and Shuib (2009), Bandura (2006), Eysenck (1968), Horwitz (1999), John and Srivastava (1999), Myers and McCaulley (1988), Obeidat (2005), Pekrun et al., (2011), and Wei (2007). Cronbach Alpha analysis was performed on the preliminary data collected to examine the internal consistency of the psychometric attributes of the questionnaire before data collection. In general, the value of consistency of the items of each variable ranges from moderate to good. The alpha values for each factor are as follows: Integrative Motivation $\alpha = 0.720$, Instrumental Motivation $\alpha = 0.588$, Resultative Motivation $\alpha = 0.802$, Intrinsic Motivation $\alpha = 0.834$, Task Motivation $\alpha = 0.691$, Attitude to Community

...
α = .729, Attitude to English (language) α = .806, Attitude to (English) Learning α = .783, Introversion α = .531, Extroversion α = .654, Anxiety α = .838, and Self-Esteem α = .683. Students’ scores are collected from documents recording their accumulative learning achievement.

Subject

The subjects of this study were 188 second year undergraduate English majors of two state universities in Malang City, East Java, Indonesia. Three parallel classes were selected in the English Department at the State University of Malang, with 88 students; three parallel classes were selected randomly in the English Department, Brawijaya University, with 100 students.

Method

The collected data are pre-processed into categories using Norm-References Score Interpretation (NRI). NRI is used to convert the quantitative score into levels for further qualitative classifications. NRI provides rankings for individuals relative to others. Four types of factor combination are proposed as inputs to the system in the form of transactions. Each transaction has aggregated factors. The factor combination of the transactions is as follows:

- Transaction 1: M_{IntM, InsM, ResM, IntrM, TasM}, Anxiety
- Transaction 2: M_{IntM, InsM, ResM, IntrM, TasM}, \text{Attitude}_{(AttC, AttE, AttLE)}, \text{Personality}_{(IntP, ExtP, Anx, Sel)}
- Transaction 3: M_{IntM, InsM, ResM, IntrM, TasM}, \text{Attitude}_{(AttC, AttE, AttLE)}, \text{Personality}_{(IntP, ExtP)}, \text{Anxiety}, \text{Self-Esteem}

Association rules take transaction inputs and process them using the Apriori algorithm (Agrawal et al., 1996) using the pseudocode provided below:

\textit{Join Step}: C_{k} is generated by joining L_{k-1} with itself

\textit{Prune Step}: Any \((k - 1)\) itemset that is not frequent cannot be a subset of a frequent set

\textbf{Pseudocode}

\textit{C}_{k}: Candidate affective and learning achievement itemset of size \(k\)

\textit{L}_{k}: frequent affective and learning achievement itemset of size \(k\)

\(L_{1} = \{\text{frequent affective itemset}\}\)

\textbf{for} (\(k = 1; L_{k} ! = \emptyset; k + +) \textbf{do begin}

\hspace{1cm} C_{k+1} = \text{candidates generated from} L_{k}

\hspace{1cm} \textbf{for each} transaction in database \textbf{do}

\hspace{2cm} \text{increment the count of all candidates in} C_{k+1} \text{ contained in}

\hspace{2cm} L_{k+1} = \text{candidates in} C_{k+1} \text{ with min_support}

\hspace{1cm} \textbf{end}

\textbf{return} \bigcup_{k} L_{k}
There are three aspects that need to be considered in association rules: support, confidence, and lift. Support is the ratio of transaction supporting the association rule to the total number of transaction in the database. Confidence is percentage of transactions supporting the rule body and the lift is the amount by which the confidence exceeds the expected confidence.

For each of the models, parameters are set to a minimum support (MinSup) of {.10, .05, .01} and minimum confidence (MinConf) is fixed at the value of {.80}. In accordance with the objective of this study, the antecedents are affective factors and the consequent is English learning achievement as shown in Table 1. The overall process is shown in Fig 2.

Table 1. Antecedent-consequent rule representation

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Consequent</th>
</tr>
</thead>
<tbody>
<tr>
<td>{Student affective features}</td>
<td>=&gt; {Learning achievement}</td>
</tr>
</tbody>
</table>

Fig 2. Process of conducting apriori algorithm

Correlation analysis is conducted to better understand each of the factors that influence scores reflecting students’ achievement of English skills. To simplify the rules, the frequency of each affective factor in the ten rules with the highest lift is taken and the rule for each minimum support of {.05} and {.01} is then combined to describe the affective profile as one rule.

Result and Analysis

Result

The results of the Apriori algorithm are divided into four sections based on the transaction shown in Table 2. Transaction 1 only yields two rules of fair achievement of {.10} minimum support. The rules are {Anx=High} => {A=Fair} and {Mot=Mod, Anx=High} => {A=Fair}. Transaction 2 also yields in two rules of fair achievement of {.10} minimum support. The rules are {Mot=Low, Pers=Low} => {A=Fair} and {Mot=Low, Att=Mod, Pers=Low} => {A=Fair}. Transaction 3 yields 63 rules of Fair achievement of {.10} minimum support. In this transaction most of the rules generated are fair learning achievement {A=Fair}, only one rule of poor learning achievement {A=Poor}, and no rules of good learning achievement {A=Good}. Meanwhile, Transaction 4 yields most number of rules with 16 rules of fair achievement of {0.1} minimum support, in total 27 rules of good and fair rules of {.05} minimum support, and in total 26295 rules of poor, fair, and good of {.10} minimum support. The example of rules generated is shown in Table 3.
Table 2. Result generated from transaction 1-4

<table>
<thead>
<tr>
<th>Transaction</th>
<th>Minimum Support</th>
<th>Minimum Confidence</th>
<th>Rules Generated</th>
<th>Consequent Generated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.10</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.05</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.01</td>
<td>.80</td>
<td>2</td>
<td>Fair</td>
</tr>
<tr>
<td>2</td>
<td>.10</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.05</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.01</td>
<td>.80</td>
<td>2</td>
<td>Fair</td>
</tr>
<tr>
<td>3</td>
<td>.10</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.05</td>
<td>.80</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>.01</td>
<td>.80</td>
<td>63</td>
<td>Fair, Poor</td>
</tr>
<tr>
<td>4</td>
<td>.10</td>
<td>.80</td>
<td>16</td>
<td>Fair</td>
</tr>
<tr>
<td></td>
<td>.05</td>
<td>.80</td>
<td>270</td>
<td>Good, Fair</td>
</tr>
<tr>
<td></td>
<td>.01</td>
<td>.80</td>
<td>26295</td>
<td>Good, Fair, Poor</td>
</tr>
</tbody>
</table>

Table 3. Rule example of good achievement

<table>
<thead>
<tr>
<th>Rule No.</th>
<th>Rule</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>{ResM=Low, TasM=Mod} =&gt; {A=Good}</td>
<td>.0106</td>
<td>1</td>
<td>3.1864</td>
</tr>
<tr>
<td>2</td>
<td>{TasM=Mod, AttC=High} =&gt; {A=Good}</td>
<td>.0159</td>
<td>1</td>
<td>3.1864</td>
</tr>
</tbody>
</table>

Results of the correlation analysis for each transaction suggest that all factors used in Transaction 1 are significant to the English learning achievement. The motivation factor has the correlation of $r_{mot} = .252**$ ($p<.001$) while the anxiety factor has the correlation of $r_{anx} = -.192**$ ($p<.01$). In Transaction 2, only motivation factors correlate significantly with English learning achievement with $r_{mot} = .252**$ ($p<.001$) while the other two factors, attitude and personality, do not significantly correlate with English learning achievement. In Transaction 3, two factors are correlated significantly with student achievement, motivation and anxiety, with correlation values of $r_{mot} = .252**$ ($p<.001$) and $r_{anx} = -.192**$ ($p<.01$). Attitude, personality, and self-esteem in this transaction are not correlated with learning achievement with the values of $r_{att} = .095$, $r_{pers} = -.024$, $r_{sel} = .066$. Four factors are correlated significantly in Transaction 4, integrative motivation, intrinsic motivation, extrovert personality, and anxiety with values of $r_{intM} = .247**$ ($p<.01$), $r_{intrM} = .202**$ ($p<.01$), $r_{extP} = .214**$ ($p<.01$), $r_{anx} = -.192**$ ($p<.01$) respectively. The correlation value of each transaction is shown in Tables 4 – 7.

Table 4. Correlation between factors for transaction 1

<table>
<thead>
<tr>
<th>A</th>
<th>Mot</th>
<th>Anx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sig (2-tailed)</td>
<td>.252**</td>
<td>-.192**</td>
</tr>
</tbody>
</table>

** correlation is significant at the 0.01 level (2-tailed)

Table 5. Correlation between factors for transaction 2

<table>
<thead>
<tr>
<th>A</th>
<th>Mot</th>
<th>Att</th>
<th>Pers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sig (2-tailed)</td>
<td>.252**</td>
<td>.095</td>
<td>-.096</td>
</tr>
</tbody>
</table>

** correlation is significant at the .01 level (2-tailed)
Table 6. Correlation between factors for transaction 3

<table>
<thead>
<tr>
<th></th>
<th>Mot (A)</th>
<th>Att</th>
<th>Pers</th>
<th>Anx</th>
<th>Sel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sig</td>
<td>.252**</td>
<td>.095</td>
<td>-.024</td>
<td>-.192**</td>
<td>.066</td>
</tr>
<tr>
<td>(2-tailed)</td>
<td>.000</td>
<td>.194</td>
<td>.747</td>
<td>.008</td>
<td>.369</td>
</tr>
</tbody>
</table>

** correlation is significant at the .01 level (2-tailed)

Table 7. Correlation between factors for transaction 4

<table>
<thead>
<tr>
<th></th>
<th>IntM</th>
<th>InsM</th>
<th>ResM</th>
<th>IntrM</th>
<th>TasM</th>
<th>AttC</th>
<th>AttE</th>
<th>AttLE</th>
<th>IntP</th>
<th>ExtP</th>
<th>Anx</th>
<th>Sel</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.247**</td>
<td>.154*</td>
<td>.110</td>
<td>.202**</td>
<td>.081</td>
<td>.125</td>
<td>-.005</td>
<td>.069</td>
<td>-.173*</td>
<td>.214**</td>
<td>-.192**</td>
<td>.066</td>
</tr>
<tr>
<td>Sig</td>
<td>.001</td>
<td>.034</td>
<td>.134</td>
<td>.005</td>
<td>.269</td>
<td>.089</td>
<td>.946</td>
<td>.343</td>
<td>.017</td>
<td>.003</td>
<td>.008</td>
<td>.369</td>
</tr>
</tbody>
</table>

** correlation is significant at the .01 level (2-tailed)

Analysis

Transaction 1 uses motivation and anxiety factors to explain student motivation and anxiety generally. Frequent patterns are revealed in transaction 1 in which ‘moderate motivation’ and ‘high anxiety’ are an evident result in a fair learning achievement as shown in Fig 3. A possible example of this rule may occur in the case where a student’s moderate motivation overcomes their anxiety. Referring to the Table 4, the motivation factor shows a positive correlation (.252**; p<.001) in accordance with work by Masgoret and Gardner (2003) who reveal a positive and significant relationship between motivation and learning English. The anxiety correlation (-.192; p<.01) in this study is supported by findings by Wei (2007), who states if the student is anxious then ineffective learning will occur. When associated with the correlation for each factor, students tend to have good learning achievement when they have more motivation. The higher anxiety a student has, the lower achievement the student gets in the class.

![Fig 3. Rule representation of fair achievement in transaction 1](image)

Transaction 2 generates the fair learning achievement \{A=Fair\}. Motivation, attitude, personality are used to infer student emotion profiles. The pattern shows that student with low motivation, moderate attitude, and low personality will get fair learning achievement. The association rules in Fig 4 shows that even when students are low in motivation and low in positive personality traits, but they have moderate attitude, they are likely to get a fair learning achievement. A possible explanation for this comes from empirical evidence showing that attitude itself relates with integrative motivation (Masgoret & Gardner, 2003). Integrative orientation in an individual who learns English is an expression of interest in learning the language to interact, socialize, make friends, etc. with members of English speaking community. Thus,
although students’ affective factors like motivation and positive personality traits are low, they still can obtain fair achievement when they have moderate attitude.

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<tr>
<th>TRANSACTION 2</th>
<th>Affective Profile</th>
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<td>Mot</td>
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Fig 4. Rule representation of fair achievement in transaction 2

Fig 5 suggests that students will have a fair learning achievement under conditions represented as follows: when students are moderately motivated, and have moderate attitude, but their personality, anxiety, and self-esteem are low. An average score is achieved in the condition of moderate motivation and low anxiety but with low personality and low self-esteem. Brown (Brown, 2007) stated that students with low self-esteem are incapable of carrying out given tasks due to lack of confidence. Fig 6 suggests that even when students have high attitude, if they have introverted personalities, they will not have effective learning outcome.

<table>
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<tr>
<th>TRANSACTION 3</th>
<th>Affective Profile</th>
<th>Achievement</th>
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<td>Mot</td>
<td>Att</td>
<td>Pers</td>
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<td>High</td>
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<tr>
<td>Fair</td>
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Fig 5. Rule representation of fair achievement in transaction 3

Fig 6. Rule representation of poor achievement in transaction 3

Transaction 4 uses all affective sub factors. All of the learning achievement types in the consequent are obtained with different transaction parameters. The assumption that arises is that good achievers’ affective profile are students who feel that studying English is important for themselves and who value the learning, as shown in Fig 7. Another noteworthy profile is a profile is in which students with high instrumental motivation, high attitude to community, high extroversion but low intrinsic motivation, low attitude in learning English will also get a good learning achievement. There are two affective profiles for fair achievers in transaction 4 as shown in Fig 8. The first one is the students who take the learning as it is, who have a moderate level in their affective profile such as integrative motivation, instrumental motivation,
attitude to community, and who have a high attitude toward learning English. The second profile of fair achievers is students who are more likely to use English as a means to achieve a further goal, who are intrinsically motivated toward learning, who use English as a means to do other tasks, who are not active, and have high anxiety in learning. Meanwhile, for poor achievers, their affective profile is in low categories for task motivation and extroversion, as can be seen in Fig 9. One explanation for this is that the students do not use English to perform another task such as understanding literature written in English. In addition to this, the students are also less active as shown by low extroverted personality in the rules. Furthermore, these students do not have a clear orientation in the use of English as means to achieve something (e.g. to get a job that requires English).

Fig 7. Rule representation of good achievement in transaction 4.

Fig 8. Rule representation of fair achievement in transaction 4.

Fig 9. Rule representation of poor achievement in transaction 4.

**Conclusion and Future Work**

A preliminary study to understand students’ emotion in English learning achievement through association rules is described. There are several points that are offered for further studies. Firstly, further studies should consider the general factors influencing students’ learning in a variety of subjects. Secondly, to study in depth about factors influencing student learning, the factors should focus on specific aspects. Studies by Pekrun et al. (2011) differentiated the affective factors based on several aspects such as classroom environment, tests, and exams. Third, the rules generated still need to be enhanced to be easily understood by teachers as practitioners or others. Formulation of the rules needs to be validated to experts in English teaching and learning to give a better understanding of the student emotion in the learning context with the comprehension outcome. Fourth, the results obtained in this study were based on the
frequent item set. As a result, the rare item sets that would be useful are not yet included in an effective manner.

An attempt to model student affective profiles is described in this study. Methods of selecting affective factors are described to model student learning achievement based on their affective factor profile. The selected affective factors are then preprocessed in the form of qualitative values and decoded into transaction data. Each of the transaction data sets is used to explain the student affective profile in general and in detail. Mining rules in each of the transactions are performed to generate affective profile rules using different parameters. All types of student learning achievement of English in respect with affective profiles are obtained using different parameters. Rules obtained are then simplified in the form of if-then rules and are presented in a graphical format to be more easily interpreted than in the antecedent-consequent form. Finally, rules obtained are interpreted to illustrate latent patterns in student affective profiles.

The preliminary analyses may be used as a basis to understand more about students’ emotion in learning in general subjects. This allows teachers to analyze cases of student learning problems associated with their affective factors, to overcome them, and to improve their performance in learning or for curriculum development to include emotion as an explicit part of program development.
References


Derivations of the Factors Influencing Imagination Capabilities of Students Major in Computer Graphics

Shin Liao, National Taiwan Normal University, Taiwan
Yi-Hsuan Chiang, Shih Hsin University, Taiwan
Chui-Chu Yang, National Taiwan Normal University, Taiwan
Yi-Chen Pan, National Taiwan Normal University, Taiwan

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Abstract
Computer graphics is an efficient mean for exchanging information through graphical communication. Imagination capabilities are essential for computer graphics majored students in creative graphics design. However, very few researches tried to uncover the factors influencing the imagination capabilities of students major in computer graphics. To derive the factors, the focus group method was introduced. Based on the focus group research results, sixteen factors influencing the imagination capabilities of students major in computer graphics were derived and can be divided into three categories: idea, behavior and personality. The factors can serve as a basis for evaluations of computer graphics majored students’ imagination capabilities as well as designs of imagination capability development curriculum.

Keyword: imagination, creative concept, computer graphics, professional capability
Introduction

Education should help nurture constructive imagination in students so as to help unleash their creativity (McMillan, 1995). There had been much research done on creativity both in Taiwan and abroad and it is accepted that imagination is one of the major factors in boosting creativity. Csikszentmihalyi (1996) based on nearly 30 years of research has presented ten main characteristics of the creative people and one of them is to have a rich imagination which shows the important influence of imagination on creativity.

In tandem with the government’s aggressive promotion of the cultural industries, many domestic universities and colleges have subsequently introduced many courses aimed to increase creativity amongst students. As a result, this research would discuss the correlation between imagination of science students and their ability to draw computer graphics. The study would track the correlation between the two variables by following the changes in the imagination process of the students. The study would include the following areas:

1. Analyze the development of the creative imagination process of design students
2. Analyze the factors influencing the imagination of the design-related students.
3. Analyze the correlation between the imagination of the design related students and their computer graphic drawing ability.

Literature Review

Imagination: Its definition and classification

American educationist Dewey (1980) has said that imagination is the ability to see what is possible. He said: When the reality is integrated into one thing, imagination is ability to feel the way the world and the ability to turn the familiar into new experiences. When the human mind intersects with the universe, there is always a certain degree of risk; this adventure is the imagination, because imagination lets a single concept to produce a rich meaning.

Image is reflection in the memory to feel an experience while imagery is a trace left of that process in the mind, and finally the imagination is a mental process when a new imagery is formed as a result of mixture of memory and imagery (Chang, 2003). Literally speaking, imagination is an image which is seen by the mind’s eye, for example, when we seen an object we would have an imagery in the mind. However, if it is not present in the front of our eyes, we could still be able to recall its shape, which is related to memory. It is also called “reproductive imagination.” However, in design and art, we still need “creative imagination” because it is not just about recalling old experience but also involves creating new things.

Based on the definition of imagination put forward by many aforesaid scholars, imagination is a form of abstract thought process of humans. In total it includes knowledge, lived experience, and the ability to reconstruct thinking and image. This type of mental activity is not limited by any regulations and also not obstructed by the
existing thinking. Imagination would enrich existing conditions, raise knowledge and increase sensory experience.

Imagination is natural ability of the human being, and we can separate it into three categories (McMillan, 1995):

1. Natural reaction of imagination
   It is the basic imaginary reaction. For instance, when humans think of picked plum, we would involuntarily salivate; when we hear of old songs in the radio, we would naturally sing. Such activities could be seen as a primary form of imagination and the lowest form of imagination.

2. Free Imagery
   For example, when we are eating picked plum, we could think of a ripe plum, and can also think of a farmer who pickles the plum. As a result, this form of imagination is a reproductive imagination based on old experience and is not productive imagination. It is a slightly higher form of imagination.

3. Personal Mental Imagery
   This is a higher form of imagination. For instance the dream in our sleep in which the world appears as if real, but the same with our daydream in which the mental imagery such as castles in the sky and monstrous floods. The highest form of imagination is when the thinker arranges his or her mental imageries and creates or designs new connections. This is a productive imagination. Be it industrial invention, artistic creativity or scientific discoveries, they all belong this form of imagination.

With regards to the “objective” of the imagination, it includes “involuntary imagination” and “voluntary imagination”. Involuntary imagination is an unintended imagination and it changes the main theme and the objective of the imagination. Much of the imagination before childhood belongs to involuntary imagination. Voluntary imagination is a kind of stable imagination and it has a stable topic and objective (Lee, 1996). Chen (1995) has classified the nature of imagination into creative imagination and re-creative imagination and fantasy.

1. Creative imagination:
   If one can imagine without depending on things that can be seen with one’s eyes, then it can be categorized as “creative imagination”. Chang (1991) suggests that creative imagination is a process of reorganizing one’s past experience in our consciousness and thus creating something new by overcoming our experience. It is a new idea to an old problem, and it is also known as “constructive imagination.” Creative imagination needs three other conditions: original impulse, active thinking and inspiration. Therefore creative imagination can be born without the help of things before our eyes. Therefore, it also needs a medium which triggers the imagination, which would lead the creator remember certain images or events. However, the catalyst and image of constructive imagination are different because it can exceed that which is visible to the eye, and enter into certain explore and discover (Arnheim, 1997).
2. Reproductive Imagination:

“Reproductive Imagination” is an imagination, which is normally based on words and graphics and is many variations of imagination, which is triggered through the process of reading. Therefore, normally it requires one to have certain degree of knowledge with regards to literary products as well as rich memory (Li, 1996).

As for the latter two parts, Spencer (2003) has also pointed out that human imagination has creative and reproductive functions.

**Development of Imagination**

The process of creation is varied and normally comes in two types, which is its ability to imagine internally and also observe externally and translate the external observation into internal imagery and finally expressing their views through creative products. It is a way of transforming form into thought and then further translating it into products (Chen, 2000). Social psychologist Wallas (1926) has established a four stages of creative process: (1) Preparation Stage: Collecting information about the problem concerned and combining experience with new knowledge; (2) Fermentation Stage: Jettisoning the problems which could not be understood and subconsciously think of the problems that can be solved; (3) High-spirited Stage: Epiphany about the key issues to be addressed to solve the problem; (4) Experimentation Stage: It is a time to implement and see if the ideas are feasible or not.

Patrick (1937) observed the work of poets, artists and scientists and realized that their creative process also follow the four-stage model. Chen (1995) also learned that that the creative process of the artists, which goes from the rise of the image to its process of expression go from creation of internal idea to completion of an external creative product. This process includes observation, experience, imagination, selection, organization and expression (Figure 1).

![Figure 1: Creative Process, Chen (1995).](image)

Moreover, there are few places, which do not require imagination. In the process of imagination, it can be known that it is a process in which experience in our memory and our ideas are rearranged (Chang, 1991). Chen (1995) believes that imagination is “a process in which new image is formed as a result of processing, restructuring and
reorganizing memory which is already existent in human brain.” Wang, Ye, and Chiang (2012) argue the most important role in the process of imagination which consolidates individual experience and transformed into imagination is played by that of “association of ideas” and “divergent thinking.”

As expressed by scholars above, creation follows these processes to produce imagination and to create. The development of imagination has an implicit structure, while the internalization of experiences resembles the development process of creation. In other words, internationalization of individual experience results in association of ideas and divergent thinking which ultimately leads to imagination.

**The Evaluation of Imagination**

In the 1990s, the Test of Creative Imagination created by Kujawski is the most commonly used measurement of creative imagination to researchers. The test consists of four straight lines, four semicircles, four dots and four curved lines. The test taker is asked to use the 16 elements as many as possible to draw the objects that they imagine but not yet been seen. The objects drawn may be a new invention or tool. Finally, evaluation of the test taker’s reaction in fluency, originality and flexibility are given in order to assess the creative imagination of the individual (Karwowski & Soszynski, 2008).

Some researchers think that odor, taste, sound and words can all stimulates creativity, but the main method is still using visual stimuli (Baars, 1993). To make imagination easier to evaluate, Trotman (2006) listed the following ways that imagination can be expressed clearly: (1) Observe the student’s emotions, behaviors and reaction; (2) Record the conversation.; (3) Observe the interaction between students.; (4) Collect the essays and journal of the students.; (5) Photography records.; (6) Using pictures and images.; (7) Using animation, clips and stories.; (8) Dance.; (9) Music composition.; (10) Impromptu creation or speech.

Regarding to above, based on the difference level in individuality, novelty and creativity in the progress of imagination development, they can be categorized into four categories as follow: (1) Creation of imagination. (2) Recreation of imagination. (3) Expected imagination. (4) Perspective imagination. Also, imagination can be evaluated through teaching activities, imagination test and learning record.

The purpose of this study is to investigate the relation between the imagination and the abilities of computer illustrating of students in design related departments. Thus, the imagination mentioned in this research is an ability of analyzing and combing past experiences to reconstruct thoughts and images. Even in the absence of actual objects, past memories or similar experiences may be used.

**Research Design**

The research intended to understand the development of imagination and to further discuss about the relation between the imagination and computer illustrating abilities of students in design related departments. Focus group interview was conducted to understand the progress of the imagination development of the students, and
questionnaire to analyze the relation between the imagination and the abilities of computer illustration.

**Research Framework**

The research conceptual framework is as Figure 2:

![Figure 2: Conceptual Framework.](image)

**Data Collection and Instruments**

A total of 94 valid samples were collected from two universities. Participants had to satisfy two requirements: majoring in design department and having assignments of graphic design. In order to ensure richness of data and deeper insight, this study used two data-gathering instruments including questionnaire and interview questions.

The Two-Factor Imagination Scale (TFIS) designed by Jason Thompson (2009) were adopted and translated. The items were examined for comprehensiveness and clarity by research associates and three experts in psychology and design fields. This scale was pre-tested by 46 college students in the target pool and then verified by preliminary analyses. Removal of one item with low correlation led to an improvement in Cronbach's alpha. The 21-item scale was found to be reliable with Cronbach's alpha values of .65.

Based upon the literature review above, questions were developed to represent the issues identified in this study. The focus group interview questions were designed into three sections: (1) Analysis of creative imagination sources; (2) Thinking and creation process and experiences; (3) Ways of imagination break-through.
Data Analysis

Analysis of sources of creative imagination

Throughout the interview, we asked the interviewees’ sources of their imagination for creation. Starting from the interests of daily life, aiming to find the relation between creative imagination and interests. From the words of the interviewees, we found that most of the interviewees’ interests are listening to music and watching movies. For example:
I like to play guitar, listen to music and take photos. (S1)
My interests are listening to music, watching movies and reading novels. (S2)
My interests are listening to music, watching movies and reading novels. (S5)
I also like to read and paint, well, I also enjoying wandering on the street. (S6)
I like to watch movies a lot, I watch almost every types of movies, especially those you need to think to find out the killer, well, movies with suspension and mystery. I also enjoy watching cartoons, I can watch it for all day. (S9)

Some of the interests of the interviewees are sports, for example:
I like to watch television, listen to music and play volley ball. (S4)
I like to play ball games, most of the sports with balls like volley ball or basketball. I also like to paint and draw everywhere. (S7)

We found that most of the interviewees’ interests cline to literature and arts, only some of the interviewees’ interests are related to sports.

Interviewee S9 mentioned that, “I found that not to reject things is really helpful for the generation of imagination. When we confine ourselves to not watching or accepting specific things will lose a lot of imaginary power. Anything that happens in daily life is helpful for creative mind. Thus, if we limit the things that we approach will lose the power of imagination.” The experiences and perceptions of daily life are relatively important and influential to the creators.

Most of the interviewees enjoy interests of literature and arts like movies and music. Regarding to these interests, movies are with stories and properties of imagination and vitality; music concentrates on one’s spirit and may come out with creative thoughts with musical notes, which is very expendable to imagination.

The progress and experience of thinking and creation

Via the progress of creation, we investigate if there is a direct relation between the progress of production and imagination. By the way, we discovered that many imaginations come from the experiences and perceptions in the interview mentioned above. From the experiences of the interviewees, some of them start their creation in a relatively relaxed state, for example:
Things just come to my mind when I was listening to my friends chatting. (S2)
We need to create a poster for club performance, it’s more free to make club posters because I have less pressure that making those of school work. The idea of this poster comes to my mind when I was walking home. (S1)
Both of the interviewees sketched the rough images of their imagination in a relaxed state of life. S1 brought up that making a poster in the club is relatively free than making one as a homework due to the pressure. Regarding to the difference between club and homework, the inspiration of imagination is easier to generate in a relaxed condition for S1.

Some of the interviewees associate the topic of their mission with the expansion of their thoughts, in order to inspire their imagination to come up with ideas. Starting from the key words of the topic, associating related things to expand the thoughts and ideas is an organized way to construct a zone of expanded and diverse ideas. For example:

We are organizing a game project in a course, and one of the classmates brought up that we can make an “edible” character, but when I was watching the television, it came up to me that we can set that the special items obtained in the game is edible, and followed with more associations. (S8)

One assignment was to make a commercial clip, and our topic is Satay sauce. Our inspiration came from the “pop” sound when we open the lid. (S7)

It’s worth noting that via setting the topic and the accumulation of the experiences and observations of daily life, they could become a way of triggering inspiration. For example:

I think that I’m pretty good at observing, I don’t usually just see the appearance of things, I always observes longer and think deeper. Maybe things won’t be useful now, but I’m saving it for the power of future. Sometimes when you associate things with other incidences, many new ideas will come to mind. (S6)

More even, some of the interviewees develop their ideas and creation via discussing. For example: A brainstorm with a group of people is way better than doing alone, but I think that everyone should do some research in advance, and that will be more helpful. (S7)

In the progress of discussing and collecting data, exchanging ideas to create new ideas or associating collected information with life experiences and changing direction of gathering data will be other inspirations. For example:

I often read or notice things about graphic design, but not intentionally. I will keep some of the special or nice ones in my mind, but not record them with pen and paper. However, when I’m about to use them, they just came up together to my mind. (S1)

The teacher told us to decide our one topic of the homework this time, and we’re encouraged to draw whatever we like as long as it’s a whole series. I found a children’s book in the shelf of my home, and because I’ve read a lot of them when I was little, I decided to find one of the stories and draw them. Alice in wonderland is the one that I choose because of the variety and abundance of its characters. (S3)

The teacher told us to use “The Art Nouveau” as a topic, and most of my classmates chose the style of Mucha for creation, but I searched with the key word art nouveau and found out that Klimt’s artworks are great, so I decided to use them as references. (S5)
The inspiration phase of creation can be divided into three dimensions regarding to the interviewees experiences. I. Relaxed state of life and experiences. II. Motif observation and association. III. Discussion and data association. To the interviewees’ experiences, three of them are strongly connected, for example, the imagination of S3 comes from the combination of data collecting and life experiences; and S8 came up with ideas with discussion and association proceeding simultaneously.

If one wants to have a different ideas with others, reverse operation is needed. S5 decided not to use the information that most of the people know, and integrated life experiences to come out with different ideas.

We can speculate that the production of ideas owns a state that they just pop up to one’s mind via the results of the interviewees. The phenomenon may be contributed to the personal experiences or the internalization of read data. Imaginary may be influenced in an extent by the imagination of the information or the experiences and observation of daily life.

Ways of break-through of creation

The interviewees stated that they often encounter circumstances of no inspiration or thoughts in the progress of creation. We could found in the interview that many of the interviewees think that if the teacher can display some of the previous works or artist masterpieces, it will be very helpful for inspiring their creativity. Most of the interviewees are influenced by such acts.

The teacher inspired us with the display and analysis of many artworks from different epochs, along with masterpieces of modern art. (S4)

The teacher showed us many examples before the class starts, which inspires our imaginations. Nevertheless, a lot of classmates will follow what the teacher said, so if I made some differences, the teacher will find them creative. (S2)

Some of the interviewees inspires their imagination by walking outdoors and be in contact with daily life. For example: I’m quite restless and enjoy outdoor activities. I’ll be fine as long as I’m not staying at home. (S6)

A relatively less interviewees hold negative attitude, for example:

When I was thinking a story, I’ve been working on it for months but still without results and I’m not satisfied with the things that I’ve come out with. What I did was completely leave it alone, for three entire months. However, I found out a lot of ideas when I picked it up after three months. (S9)

It’s alright even though I have no inspiration, because the homework will be done before the deadline anyway. (S8)

Combing the perspectives of interviewees, most of the them resolve the problem of less inspiration by accepting information and artworks that the teacher gave, whilst some of them deal with them by ignoring them or using time pressure to force oneself to come up with ideas. However, stepping outdoors is one of the positive ways to inspire imagination when it comes to the dilemma of lacking ideas.
The imaginary performance of university students

To understand the self-rated score of student imagination that this research aimed at, we defined that who has a higher score than 73.5 as high imagination ability; score within 73~53 as medium imagination ability; and those with lower than 52.5 as low imagination ability. The analysis standards are as above.

There are 12 individuals scoring higher than 73.5, with a percentage of 14%; 67 individuals with scores within 73~53, contributing 82% of the population; and 4 with scores lower than 52.5, consisting 4% of the group. The result shows that the students sampled by our institute have an above average imagination performance, but most of them still belongs to the category of medium imagination ability, while the number of low imagination ability is the lowest.

The relation between imagination capability and artwork score

The research cross examined the self-rated score with their curriculum score of last semester, using Chi square analysis to process the contingency table of two variants ($X^2 = 542.246, p = 0.128 > 0.05$). Level of significance was not reached, meaning the two variants are independent and conspicuous relation is not detected.

Through Figure 3, the curve of artwork score and the imagination capability are not quite the same, so we can infer that the relation between the artwork score and imagination capability is relatively low in the sample students of this present study.

Figure 3: Relation between Artwork Score and Imagination Capability.

Research Results

The creation progress often starts from the task given by the school teacher. With different environment, past experiences and personality of each creator, different
emotion withdrawal progress develops. Imagination is an important phase of the students’ creation, happens in the middle phase of the creation progress. Associating the ideas obtained from imagination with the task given, create after having a specific clue and produce the artwork at last (Figure 4).

Figure 4: The progress of students’ creation and imagination.

Previous research indicated that the creative imagination progress of a sixth grade elementary school student can be separated into “The start of imagination,” “The correct of imagination,” and “The cease of imagination” (Wang et al, 2012). Their conclusions are identical with the results of this study, and we discovered via interviewing university students, as one’s age grows, the influence of “external environment,” “past experiences,” and “personality” becomes more predominant.

Imagination is one of the most important factors in designing problem resolving progress (Liang & Hsu, 2010). However, the factors influencing the development of imagination can be elaborated as Table 1.

Table 1: The interviewees’ Characteristics.

<table>
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<tr>
<th>Factors</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Belief</td>
<td>innovative, original, divergent thinking, alternative, integrative</td>
</tr>
<tr>
<td>Behavior</td>
<td>passionate, humorous, impatience, vigorous, confident, novel</td>
</tr>
<tr>
<td>Personality</td>
<td>observant, adventurous, agile, diverse, unpredictable</td>
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Also, we found in the interview that the student will have different imagination development regarding to the different creating tasks given by the teacher. Thus, when the teacher is conducting computer illustrating courses, there will be positive help towards the imagination development of students if the instructor can understand the students’ interests and give different sensational stimuli.

In addition, the sampled students’ imagination performances are above average, while most of them fall into the category of medium imagination ability, with the lowest ratio of low imagination ability. After cross examination of the self-rated imagination score and their score of computer graphic course, the result did not reach significance level, showing that the imagination ability is not conspicuously related to the computer illustrating ability. This might be affected by the students’
“ability to perform techniques”, which means that the students had abundant design imagination but their creation was limited by the ability to perform computer graphics techniques and therefore failed to convey their whole ideas.
References


**Contact email:** sliao@ntnu.edu.tw
Building a value network model for the design and use of learning solutions

Marja Kankaanranta, University of Jyväskylä, Finland
Heta Kangasniemi, University of Jyväskylä, Finland

Abstract
It is generally agreed on that ICT can have a meaningful role in teaching and learning. However, learners – children and young people – are still in an unequal position in regard of access to ICT and its pedagogically varied use in learning environments. There are also wide differences in how children use ICT at diverse life spheres, namely at school, home and with their friends. An essential concern is how well the existing ICT solutions apply to the personal needs and capabilities of learners as well as the teaching practices at the different levels of educational system.

This paper presents a value network model for the implementation of learning solutions in close interaction between research, pedagogical experts and designers of technology-based learning solutions. The aim is to build research-based principles for the design and use of learning solutions. The design principles focus especially on user-driven design process and usability evaluation. The use principles determine ways of support and good practices in the actual use of learning solutions and effects on learning. The value network currently includes seven partner countries, which enables and requires also focus on issues of localization and globalization. The paper presents experiences of the value network in Finland as well as in the six partner countries.

Keywords: learning solution, ICT use, value network
Introduction

Does a web-based math environment ‘10monkeys’ engage and motivate children to learn the concept of number? How can a location-based Nomadi-tool be utilized in teaching and learning for example history? What kind of features and contents the users expect from an evaluation tool for information society skills? Or how does a service concept for tablet use support teachers in take-into-use of technology? These are some of the questions that are examined in the Systemic Learning Solutions (Systech) project. These are also examples of the technology-based learning solutions under development in the Systech value network.

The Systech value network has the following main aims: firstly, to promote 21st century skills with user-driven and motivating learning solutions and secondly, to enable a large-scale and more versatile implementation of digital learning solutions across educational systems. The value network currently includes seven partner countries, which enables and requires also focus on issues of localization and globalization. This paper examines the creation and implementation of a value network model for the design, use and localization of technology-based learning solutions. The paper will start with the analysis of trends in ICT use that have indicated the need for efforts in the design and use of technology supported learning solutions. This analysis is followed with determining the principles for value network creation. Then, the paper presents the implementation of Systemic learning solutions value network.

Trends in ICT use at Finnish Schools

It is generally agreed that ICT can have a meaningful role in teaching and learning. However, learners – children and young people – are still in an unequal position regarding the access to ICT and its pedagogically varied use in learning environments (e.g. Kankaanranta & Puhakka, 2006; Ilomäki & Kankaanranta, 2009). From the perspective of students, this means that they are in an unequal situation in regard to possibilities for 21st century learning enhanced with modern technology. Earlier research has indicated several enablers but also challenges for versatile ICT use, such as the rapid development of technology, existing digital divides between students and teachers, and controversial trends of ICT’s pedagogical use (see Kankaanranta & Vahtivuori-Hänninen, 2014).

Last decade has been a period of strong and rapid development of information and communication technology (ICT). It has paved the way to digitalized schools. According to Ilomäki and Kankaanranta (2009) the nature of technology has changed from a technical connotation towards a communicative one, mainly because of the development of new applications in the Internet. This has increased the use of ICT dramatically in almost all areas of society, including education. Weller (2007) suggests that technological features have become social features and influenced the social values of the net. However, these elements do not characterize learning communities, not even e-learning communities. The challenge is how to integrate the technological possibilities – especially the sophisticated communication strategies of the learners accustomed to the Internet - and the formal structures of learning organizations (Ilomäki & Kankaanranta, 2009).
Access to ICT has developed rapidly during the last two decades. Similar trend of heavy ICT investment in education has become evident at schools all over the world (Law, Pelgrum, & Plomp, 2008). Nevertheless, despite the rapid ICT development, all schools have not adopted ICT for use in teaching and learning according to the available possibilities for ICT access. International comparisons have indicated large differences between regions, schools, and school levels but also within schools in the extent and quality of ICT use (Kankaanranta & Puhakka, 2008; Law et al., 2008).

One concern has been the formation of digital divides between students and teachers. The concept ‘digital divide’ refers to different social groups’ access to digital services, and their abilities to make use of various digital possibilities (e.g. Facer, 2002; Ilomäki & Kankaanranta, 2009; Van Dijk & Hacker, 2003). Already in 2006, Pedersen et al. argued that students and teachers were utilizing entirely different software, and they also had very different perceptions of what constitutes digital competencies. As van Dijk & Hacker (2003) point out the digital divide shows relative and gradual differences in the possibilities of using information and communication technology. According to Ilomäki and Kankaanranta (2009) the different experiences and conceptions about technology can lead to a digital gap in education. There also seems to be wide differences in how children use ICT in diverse life spheres, namely at school, home and with their friends. As ICT has a strong status in children and students’ everyday life, it is necessary to bridge out-of-school ICT-enhanced learning and school-based teaching and learning in ICT literacy (Ilomäki & Kankaanranta, 2009). This is necessary also in order to ensure that all children have an equal opportunity for varied ICT use and to become competent members of the knowledge society.

Another essential concern is how well the existing ICT solutions apply to the personal needs and capabilities of learners as well as to the teaching practices at different levels of the educational system. In 2011, the majority of Finnish school principals weighed the role of ICT very positively in school administration (89% of principals indicated that ICT has a very important role) and as a teachers’ tool for planning and management (62%) (Kankaanranta, Palonen, Kejosten & Ärje, 2011). Only 36% of the principals indicated its particular relevance as a tool for learning and teaching. In general, the principals were satisfied with how the existing infrastructure responded to the schools’ needs. The trend was similar with the experienced role of ICT use as the existing infrastructure responded best to the needs of administrative staff and was less suited for teaching and learning practices.

Further examinations of ICT use for teaching and learning indicate more promising aspects. Almost all schools included the pedagogical use of ICT as a natural part of their goals, and in about 60% of schools, ICT was integrated in a majority of teaching and learning practices (Kankaanranta et al., 2011). Nevertheless, the results indicated that there was still a large variation—among schools, educational levels, and different regions of Finland—in the ICT access, in the actions as well as obstacles related to pedagogical use of ICT as well as the ways of ICT use. In late 2000, there was also growing evidence that the pedagogical use of ICT at schools was decreasing in many schools or that it was not at the level it could be based on the issues of access (Ilomäki & Kankaanranta, 2009; Law, Pelgrum, & Plomp, 2008; Pedersen et al., 2006). An international Innovative Teaching and Learning Study indicated a strong relation of innovative teaching practices with the learning of 21st century skills at schools (e.g.}
Norrena et al., 2011). A deeper analysis of school practices revealed that innovative teaching methods were not widely used at schools. Innovators were most typically single teachers or small groups of teachers. The school factors most closely related to innovative teaching practices were collaboration between teachers, access to ICT, support of ICT use, and support of school leaders.

To summarize, one favorable development has been that most of the principals had a more positive view of the importance of ICT in the every day work of the school than they previously had. These administrators recognized the need for change and were committed to implementing the school’s shared visions and a functioning working culture in order to improve pupils’ future skills. (Norrena et al., 2011.) Ilomäki and Kankaanranta (2009) emphasize that the new technology has several such affordances and functionalities that are neither necessary nor needed for existing teaching and learning practices. This implies that to use the new functionalities effectively the existing practices should be changed. In formal learning contexts this seems to be difficult and demanding, as many studies indicate (Cuban, 2001; Ganesh & Berliner, 2005; Gibson & Oberg, 2004; Pedersen et al., 2006).

The enablers and challenges of ICT use inspired Finnish decision makers for several strong nation-wide and multi-field efforts to enrich and widen technology use in the educational system. In Finland, there have been several initiatives and programs for enhancing ICT use in the educational sector (see Kankaanranta, 2009; Kankaanranta & Vahtivuori-Hänninen, 2014). These have implied e.g. policy efforts, funding for schools to increase issues of access and in-service teacher training. Some of the main questions were:

- How to implement large-scale changes in the use of ICT at the whole educational sector?
- What is the added value of ICT for learning and teaching?
- How to support schools and teachers in scalable take-into-use of varied technologies?
- How to ensure transferability of best practices in the use of quality solutions?

This kind of questions necessitates a systemic and multi-party perspective for the design and use of learning solutions. This led us to conceptualize such work through the concept and model of a value network.

Value network – definitions and principles

Recently there has been a lot of scientific discourse about value creation in networks or simply value networks mainly within the marketing, management and other business science disciplines (e.g. Gummeson & Mele, 2010; Möller & Törrönen, 2003; Möller & Svahn, 2009; Lusch, Vargo & Tanniru, 2010). Since business is more and more done through technological development there is often a networked nature in developing new businesses or innovation. Instead of traditional production of physical products there is more concentration on the market on development of services which often are developed in cooperation with other actors. Thus networks, cooperation and co-creation can be seen having a growing importance in various fields (Palo & Tähtinen, 2011).
Even though in business disciplines value networks are perhaps in the spotlight there is less discussion of value and networks when expanding the focus on joined development activities in ICT use in education. There are various definitions of value networks in the literature but several viewpoints are reckoned to the context of this particular study. For instance, Allee (2009) defines value networks as “…any purposeful group of people or organizations creating social and economic good through complex dynamic exchanges of tangible and intangible value” (p. 429) stressing the complex dynamic exchanges happening within the network. Since the Systech value network consists of researchers, educators and learning solution developers creating innovative learning solutions a more specific term of an innovation network could also be applied. Innovation networks are perceived to cross organizational as well as industry boundaries and having the shared purpose of creating certain social goods or outcomes (Allee, 2009).

Service-dominant logic viewpoint on the other hand stresses value creation within and from the network as well as temporal loose structures. As defined by Lusch, Vargo and Tanniru (2010) value network is ”...a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology…” (p. 20). This is also a definition we see well fitted in our understanding of a value network as an expanding and changing loose structure with common goals and co-creation that different actors are approaching from various different viewpoints.

The purpose of a value network is in utilizing tangible and intangible assets to convert them into more negotiable forms of value. Furthermore, network actors can realize negotiable forms of value by converting them into gains or improvements in tangible or intangible assets. (Allee, 2008.) Applied to this context tangible assets could be understood for example as tablets or software components whereas intangible assets as pedagogical knowledge applied. Simply put, together the assets can form combinations that are in this context more valuable (e.g. game-based learning software for tablet use). When thinking about the basic principles of value networks also co-producing service offerings, exchanging them and co-creating value should be in the focus (Lusch, Vargo & Tannuro, 2010).

In their work Büchel and Raub (2002) have defined four stages of network development through which also value networks can be reviewed (Figure 1). In stage one the knowledge network is focused through aligning the burning issues that are addressed in that particular network, sufficient management support is ensured and links created to bring together network actors and enable the network communication.
Stage two on the other hand handles the creation of the context the network is situated in by establishing mutual knowledge among network actors, making choices about the communication mechanisms that are the most appropriate for that network as well as creating and fostering trust within the network. Defining the suitable network roles within the network is in the key focus of stage three where network activities are routinized. This enables the network to establish the so-called network heartbeat that holds the network alive and pushes it forward. Finally, in stage four the network results are leveraged through demonstration of tangible network outcomes. It should be noted that a network does not necessarily go through the four stages linearly and it should not be assumed that a partly or entirely achieved stage could be automatically kept. The network is constantly developed and the network context changes all the time thus in different points of time a network (or parts of it) can be in very different phases. It is also noteworthy that in our opinion through the four stages also the sub-networks and their relationships to each other can be studied.

**Creation of Systech value network**

The concept of value network was central as the Finnish Funding Agency for Innovation (Tekes) launched in 2011 its program Learning Solutions. It called funding applicants to form value networks consisting of diverse parties of business and research units for the development of new know-how and networks. However, it remained up to the applicants to further determine or construct the practical version of the concept.

Our basic idea for the development of learning solutions quickly received interested co-applicants or possible network members. As a preparation activity we conducted a survey of their expectations to better understand the perspectives of various parties. The expectations for the construction of a value network focused especially on the following five categories:

- to understand user experience and usability in order to better respond to real needs,
- to receive expert feedback for further development of products, special focus being on pedagogical items,
- to indicate learning outcomes, effects and quality of learning,
- to develop know-how - a possibility to develop staff’s core competence and working methods, and
- general networking and synergies among the participants of the value network.

In many of the insights, the idea of an ecosystem for product development was brought forward. The survey raised expectations especially from the perspective of companies aiming at the development of learning solutions. However, our earlier projects related to ICT use at schools added to this the needs and challenges of educational sector. The examination of these led us to build a value network for the design and use of learning solutions with three main components:

- A research project aiming at the development of research-based principles for the design and use of learning solutions,
- Product development projects in companies aiming at the design of technology-based learning solutions as part of compilation of learning solutions, and
- Pedagogical network of educational and working environments for the creation and sharing of good practices and knowledge on the use and effects of learning solutions.

In the second phase of the Systech value network (2014-2015) we added as fourth component a network of international partners in six countries. This also widened the scope of the project to explore the issues related to localizing and globalizing of learning solutions (Mäkelä, Kankaanranta, Young & Alshannag, 2014).

Originally in the national phase of the Systech value network there were 13 Finnish learning solutions involved. These learning solutions were addressing different areas within the education spectrum (e.g. mathematics game for primary level students, team building skills, business simulations for higher education) as well as different target groups within formal, informal and non-formal education (e.g. primary school students, citizens wanting to assess their ICT skills). These learning solutions were originally described through a categorization of 6 product families: 1) learning games, 2) mobile learning, 3) portfolios, 4) learning and assessment tasks, 5) content solutions and 6) infrastructure.

Later on it was realized that such a categorization of the learning solutions was not necessary in the development of the value network since it was seen as too detailed. Thus in the beginning of the Systech second phase the categorization was simplified to consist of 1) content solutions, 2) tools and platforms and 3) pedagogical service concepts. At this time, several new learning solution developers also joined the activities of the value network and in total there were 18 Finnish learning solutions within the value network. As of fall 2014 more than 30 international learning solutions have been suggested for expert evaluations and it is yet to be seen how the value network expands when the international learning solutions are further explored.
Towards international value network for the design and use of technology supported learning solutions

There are several reasons and aims for the development of the international phase within the value network. Since nowadays technology-based markets are often both complex and globalized (e.g. Palo & Tähtinen, 2011; Teece, 2010), it is important to build a global understanding of the activities related to the value network. Thus providing and in-depth international understanding of the design, use and localization of the learning solutions is at the core of the research activities at the level of the whole value network.

The international phase is built upon three main elements, namely 1) collection of evaluated learning solutions, 2) analyzing and comparing national policies and practices and 3) development of criteria for localizing and globalizing of learning solutions. Naturally, building these elements consists of activities conducted in the seven partner countries of the value network.

At this stage there is constant sharing of international multi-disciplinary research experiences within the value network. This sharing of research experiences is one key component in the future development of the international value network, but the activities are seen to widen and deepen in the future in many additional ways. There are several options that can be identified for strengthening and deepening the collaboration in the future of the value network, where the activities are continuously expanded and developed further.

In the future it is possible to see sub-networks of different actors developing within the value network and expanding its activities. Examples of such sub-networks can be for instance international pedagogical networks consisting of teachers and other educators concentrating on sharing and developing good practices for ICT use in education; or sub-networks of learning solution companies concentrating on developing a pool of complementary and overlapping learning solutions supporting the learners’ development in a more holistic level. It is also important to see the reciprocal collaborative activities between international experts, educators, researchers and learning solution developers deepening. Thus these sub-networks would not only consist of actors of the similar type but would develop around phenomena that joint activities of different types of actors could address.

One crucial element in the international value network collaboration is to build a collection of evaluated learning solutions, enabling the different network parties to effectively utilize this compilation across different countries is also of significant importance in the future. It is seen that easily grasping a wide picture of learning solutions available from different countries can benefit e.g. teachers and educators in their busy work schedules. Hence a compilation of readily evaluated and tested learning solutions should be utilized effectively. Since the evaluation of learning solutions itself provides a somewhat limited view of the use of the learning solution in the educational institutes’ daily life, piloting of the learning solutions from the partner countries in different educational systems raises to be a central issue as well. As the value network is developed within international and intercultural collaboration a more in-depth understanding of the underlying cultural perceptions affecting the
collaboration can also be seen vital in terms of finding successful ways of collaboration also for the future purposes of the value network.
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Technology in Schools everyday life II. University of Jyväskylä: Finnish Institute for Educational Research & Agora Center. (In Finnish)


Contact email: marja.kankaanranta@jyu.fi


Valuation of emerging learning solutions

Marja Kankaanranta, University of Jyväskylä, Finland
Heta Kangasniemi, University of Jyväskylä, Finland

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Abstract
Last decade has been a period of strong and rapid development of information and communication technology (ICT). However, schools have not adopted ICT for use at teaching and learning according to the available possibilities for ICT access. It has been indicated that students are in rather unequal situation in regard of 21st century learning enhanced with modern technology. This paper presents efforts to make technology-based learning solutions as an integral part of teaching and learning and to promote 21st century learning with the aid of systemic learning solutions. The paper describes an ongoing large-scale project “Systemic Learning Solutions (SysTech)”- so called value network project – which aims at collaborative efforts between researchers, companies, and educational institutions for the design and effective use of learning solutions. The project originated from the desire to refine and spread out the teaching practices, innovative ICT concepts, and procedures as learning solutions and services that can support educational institutions. The project develops a cyclical process model for the development of learning solutions in a multi-field value network among seven participating countries.

Keywords: learning solution, information and communication technology (ICT), pedagogical use of ICT
Challenges in pedagogical use of ICT

Last decade has been a period of strong and rapid development of information and communication technology (ICT). The expectations for applying technology and its applications in teaching and learning are high, but practical processes in taking it into use are challenging (e.g. Cuban, 2001; Buckingham, 2007). However, schools have not adopted ICT for diversified use at teaching and learning according to the available possibilities for ICT access. There is strong research evidence of the relation of ICT use and innovative teaching practices with 21st century learning (Norrena, Kankaanranta, & Nieminen; Shear et al., 2010). At the same time, recent trends have indicated large regional, school level and also within school differences in ICT resources, students access to ICT, and its pedagogical application (e.g. Law, Pelgrum, & Plomp, 2008; Kankaanranta & Vahtivuori-Hänninen, 2014). This places students in an unequal situation regarding the possibilities to use ICT in ways that enhance 21st century learning and skills such as information literacy (Binkley et al., 2012).

This paper presents an ongoing project “Systemic Learning Solutions (SysTech)” that aims at collaborative efforts between researchers, companies, and educational institutions for the design and effective use of technology-based learning solutions. This SysTech value network project started as a Finnish national initiative, but has broadened its scope to an international level with the collaboration of partners from 6 countries. The focus of this paper is on the added value of this international phase.

Systemic learning solutions

Systemic Learning Solutions project originated from the desire to refine and spread out innovative ICT concepts and related teaching and learning practices. The main aims of the SysTech project are: 1) to make technology-based learning solutions as an integral part of teaching and learning and 2) to promote 21st century learning with the aid of systemic learning solutions.

The project develops a cyclical process model for the development of learning solutions in a multi-field value network among seven partner countries, namely Finland, Chile, Hong Kong, Singapore, Spain, South Korea and United Arab Emirates. The model consists of four components: 1) development of research based principles, procedures, and methods for the design, use and internationalization of learning solutions, 2) a compilation of evaluated and tested technology-based learning solutions from seven countries, 3) creation and sharing of good practices and knowledge of the ways and effects of using learning solutions, and 4) building international understanding of the design, use and localization of learning solutions.

Building internationally valued learning solutions

The aim of the international collaboration is to provide an in-depth international understanding of the design, use and localization of the learning solutions. The main elements in the international phase of the SysTech project are (see Figure 1):

1. Collection of evaluated learning solutions. The collection is based on the Finnish learning solutions designed by the companies in the Systech network. In autumn 2014 the six partners countries have suggested a selection of their exemplary learning solutions.
2. Analyzing and comparing national policies and practices related to the educational systems and especially trends in the pedagogical use of ICT in seven countries.

3. Development of criteria for localizing and globalizing of learning solutions.

![Figure 1: The process of evaluating learning solutions and developing principles for globalization and localization.]

The learning solutions are evaluated through expert evaluation in two phases: 1) Finnish learning solutions were evaluated by altogether 75 experts during spring and early autumn 2014 in six partner countries, and 2) the learning solutions from partner countries will be evaluated by Finnish experts during late 2014-early 2015. Prior to expert evaluation all the selected learning solutions go through usability analysis in order to ensure their technical readiness. In the expert evaluations educators and other related experts evaluate the learning solutions with the aid of a criteria consisting of three main parts: 1) education, teaching and learning, 2) culture and society and 3) the learning solution and its use. Examples of the developed criteria of each part are presented in Figure 1. Additionally, the overall impression of the learning solution is assessed.

**Future developments and expectations**

Sharing of international multi-disciplinary research experience is in the heart of the collaboration. Through this collaboration the international value network activities is continuously expanded and developed further. The activities in the network will also be developed in sub-networks for different actors. There are several options for strengthening the collaboration:
- Deepening the reciprocal collaborative activities between international experts, educators, researchers and learning solution developers
- Enabling different network parties to effectively utilize the compilation of evaluated learning solutions across different countries
- Piloting the learning solutions from the partner countries in different educational systems
- More in-depth understanding of the underlying cultural perceptions affecting the collaboration.
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Contact email: marja.kankaanranta@jyu.fi