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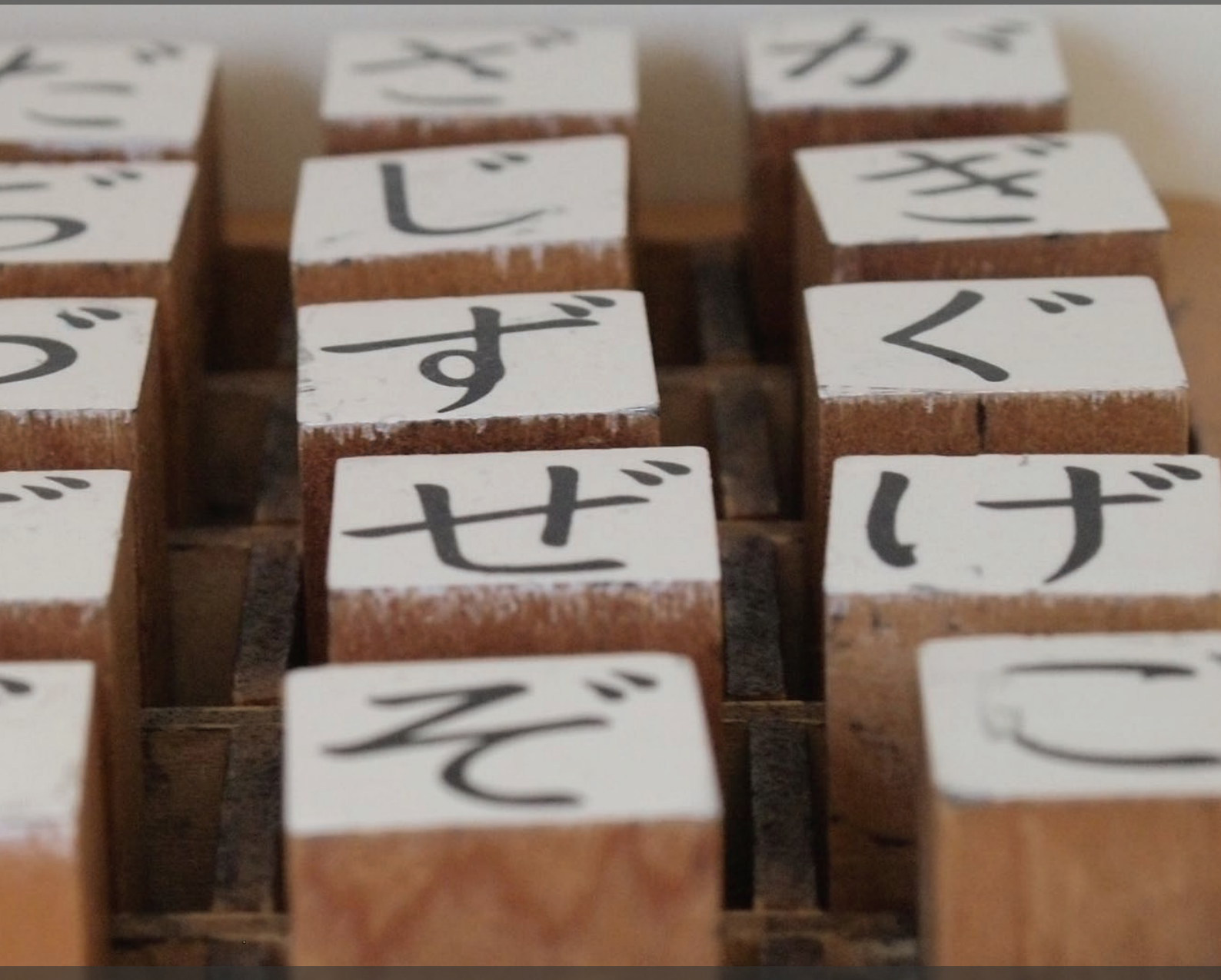

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Sakae 1-16-26-201
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Adina Stan, UNSW Global, University of New South Wales, Australia
Mahnaz Armat, UNSW Global, University of New South Wales, Australia
Elyssebeth Leigh, University of Technology, Australia
Elizabeth Rosser, UNSW Global, University of New South Wales, Australia
Nikki Hayes, UNSW Global, University of New South Wales, Australia

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Abstract:
Electronically-mediated technologies are prohibited from use in a major assessment component of a blended learning subject. This subject employs a multidisciplinary problem-based approach to explore international issues and perspectives using a rich blend of face-to-face, electronically-mediated, individual and team-based activities. The assessment is a role-play simulation which occurs during the second half of a year-long pathway to university program. Belief in the importance of helping students integrate knowledge with an understanding of learning strategies informs the design of this particular assessment task. To complete the task, small teams develop and display a hand-drawn poster summarising their understanding of a real life 'wicked problem' explored in depth during the semester. Composing and preparing their poster ensures that students create visual evidence of their learning about the context of a complex contemporary international issue which varies from year to year. It also introduces students to higher order thinking and develops critical and creative thinking skills.
By exploring the features of one such poster, the paper applies an 'artefact plus exegesis' approach to introduce and describe the principles informing the design of the assessment strategy. The task compels students to question information, seeking deeper engagement with data and generating first-hand engagement with the issue. The learning design also facilitates students' crucial skills of knowledge generation and learning management, and helps them apply this knowledge to other aspects of their future learning. This task bridges the gap between the technical and non-technical skills essential for success in the 21st century.

Keywords: blended learning, assessment, 'wicked problem', role play simulation

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Introduction

International Issues and Perspectives is an interdisciplinary subject, part of UNSW Foundation Studies, a university pathway program. It is designed to assist both international and Australian local students develop knowledge, skills and understandings which support an appreciation of the complexity of international issues. The course has been designed using the principles of **problem-based learning** in order to assist students to develop their problem-solving, research, critical thinking and communication skills. Problems are used to drive the curriculum and learning occurs through the problem solving process, when students are required to work collaboratively and to take personal responsibility for their learning while teachers act as facilitators. **A blended learning approach** enables both face-to-face learning workshops and online activities on platforms such as UNSW Moodle or UNSW Wikispaces. In this way, the course accommodates multiple learning needs, styles and outcomes and creates an empowered community of learners who come together to build and share robust knowledge. To further enhance the authenticity of the learning experience, assessment is performance-based and requires learners to demonstrate that they have mastered and are able to apply specific skills and competencies in situations resembling real world contexts (Khaira & Yambo, 2005).

This paper concentrates on one such assessment, the Role Play, a multidisciplinary and multimodal activity that enables learners to take on the role of real-life stakeholders and respond to real-life complex issues. While electronically-mediated technology underpins and supports nearly all the stages of the Role Play, there is one assessment component for which the use of such technology is prohibited. This is the Mind Map Poster analysis. This paper will analyse in details the learning principles underpinning the Mind Map Poster and argue that in this case it is the very absence of technology that is conducive to in-depth learning and creative, original expression. We aim to show that it is the fine-tuned, context-appropriate blend of advanced electronically-mediated technology and low-level technology, such as coloured pencils that may be the most effective use of technology in the classroom.

Role Play Overview

The Role Play assessment is a mature simulation-based learning strategy based on a design first developed at UNSW Foundation Studies by Elizabeth Rosser over ten years ago. Known as *The Big Paper b-Sim,* the original design was modelled on the highly successful *Mekong e-Sim* created by R. McLauchlan, D. Kirkpatrick, H. Maier and P. Hirsch (Baron & Maier, 2004). In its current format, the Role Play maintains its core structure and methodologies with changes to allow for upgrades in the technological tools used.

In the Role Play, participants attempt to solve contemporary international issues, known as 'wicked problems'. These are ill-defined social problems that are by their nature confronting, and as such have no known definitive or objective solutions (Rittel & Webber, 1973). Some of the real-world wicked problems students have investigated and responded to, include fuel for the future, fracking, water security, plastic pollution and gender inequality. The use of the role play approach fosters an environment of open inquiry, debate and reflection within an atmosphere of urgency that reflects contemporary international events (van Ments, 1989).

Learners step into the role of real-life stakeholders, develop empathy and experience real-life complex issues from multiple perspectives. The duration of the role play is five weeks and the group size is scalable. On average approximately eighty to one hundred learners across several class groups in Australian and offshore campuses participate; the latter join in via UNSW Wikispaces and/or Skype. Learners' age range from 16 to 21.

Learners are divided into teams and adopt the role of real-life stakeholders in a specific 'wicked' international issue introduced via a multi-media scenario. Each team has a unique UNSW wiki space within which to explore the role of their stakeholder and record their research and analysis in preparation for a public forum that brings together all stakeholder groups. This is known as the Emergency Summit. These online fora are maintained throughout the Role Play.

In preparation for the Emergency Summit, teams create an original Mind Map Poster to visually illustrate their response – in role as the stakeholder – to the 'wicked problem' raised in the introductory scenario. The stakeholder insights that each team publishes to their Wiki are crucial to the effectiveness and relevance of their response throughout the Role Play. Mind Map Posters will be displayed for viewing by all the teams in a gallery walk at the beginning of the three-hour Emergency Summit. During the summit, an emergency scenario is released and teams respond to this by creating an Action Plan to address the underlying problem/s. That plan is also visually presented as a poster, and then pitched in a two-minute presentation. Following this, learners step out of role to consider all ideas presented during the Emergency Summit and vote for the solutions they think have the most potential. This step allows all students the opportunity to reconsider their own ideas and reflect on the complexity of the wicked problem and the relevant solutions put forward by all the stakeholder teams. Following the Emergency Summit, students prepare individual Debriefing Reports in which they record their reflections on their learning experience throughout the Role Play.

Performance in the Role Play accounts for 30% of the formal assessment in the course with the following team and individual assessment components:

- The Mind Map Poster that illustrates visually the unique stakeholder response to the Introductory Scenario – a team assessment worth 10%;
- The Action Plan Poster that illustrates visually the implementation of creative solution ideas in response to the Emergency Scenario – a team assessment worth 10%;
- The Debriefing Report, a reflection on the manner in which lenses impact stakeholder responses to the wicked problem raised in the Role Play and lessons learnt in terms of teamwork – an individual assessment worth 10%.

The Mind Map Poster is the main focus of this paper. While, other elements of the Role Play rely heavily on technology-mediated learning, such technologies are prohibited from the performance of this particular component. This paper analyses one such poster to introduce the pedagogical principles and learning outcomes underpinning its instructional design.

Figure 1 below sets out the Role Play Learning Design with an emphasis on the Issues Investigation Stage (in weeks 3 and 4 of the process), which is the focus of this paper. This is the stage when the Mind Map Poster is prepared and, as such, it is a turning point in the process; it marks the learners' transformation from novices to experts. Hence, the Mind Map poster is a visual expression of teams' acquired expertise in the wicked problem raised in the Introductory Scenario.

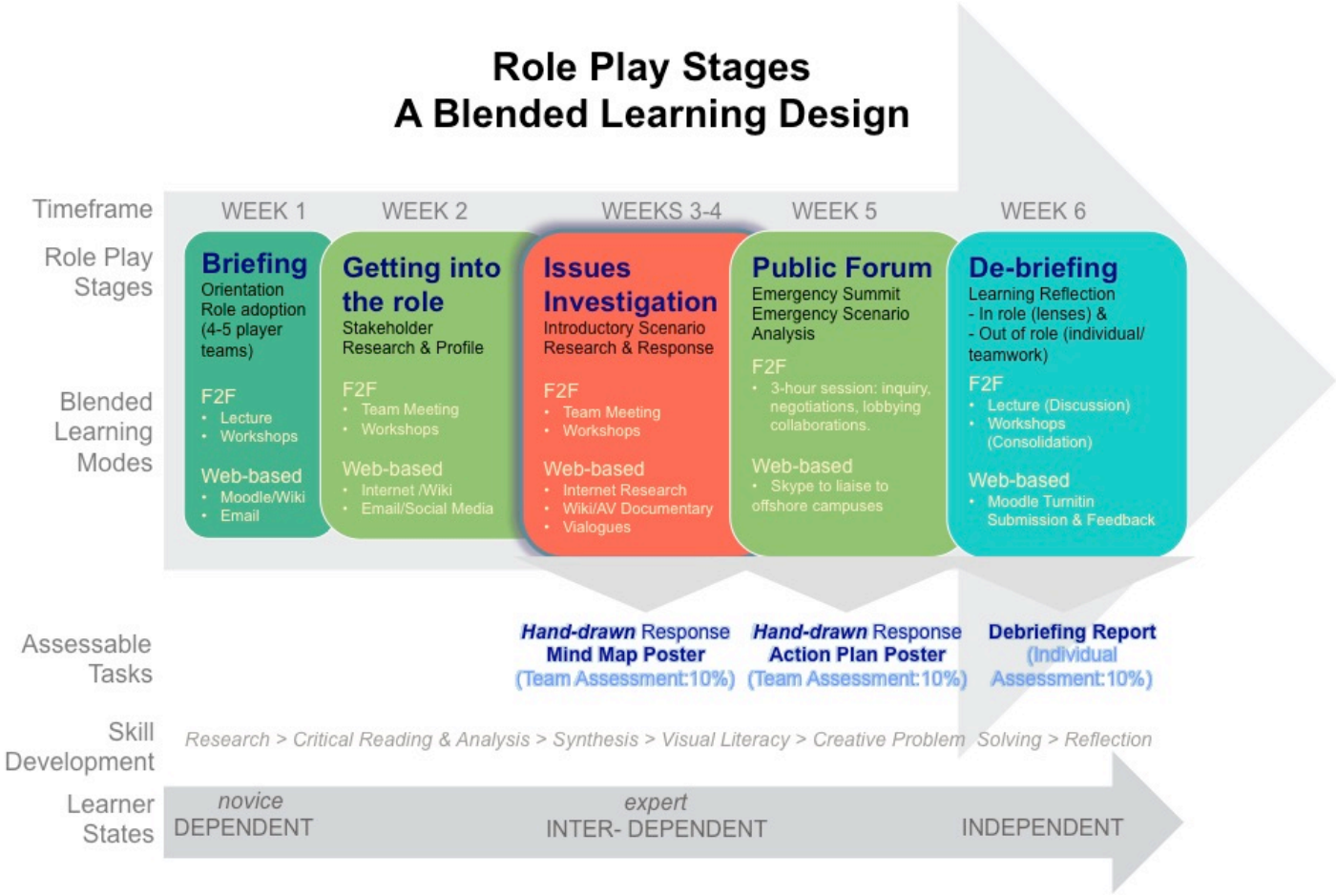

Figure 1: *Role Play Stages – A Blended Learning Design* ©

Conceptual Framework

The next section introduces educational concepts that support and underpin the Role Play learning design including the open/closed game dichotomy, mantle of the expert, and visual literacy.

Open vs. Closed Game

The overall instructional design is developed around the 'open game' principles outlined by Christopher and Smith (1988, pp. 148-151). This is because unlike closed games that are puzzles with pre-determined answers, open games are fluid and changeable by nature; players with conflicting interests navigate complex and nuanced relationships to reach collaborative solutions to ill-defined real-life problems.

Preliminary activities involving team and stakeholder selection as well as the introduction of the 'wicked problem' are aimed at revealing the heterogeneity of group members. Productive differences of opinions are valued as fuel for creative team-based learning, critical thinking and original expression. Progression from one stage to the next is driven by the release of new tasks, questions or news flashes (trigger events) intended to stimulate more focused lines of inquiry. Nevertheless, different stakeholder teams pursue their own directions and interests within the bounds of the wicked problem and their stakeholder role. Learners are, therefore, more likely to be process-minded than goal-oriented. In this context, the role of the teacher is to monitor proceedings and intervene as little as possible, preferably not at all while helping teams stay aware of their learning goals, time frames and required outcomes.

The transformative nature of the role play encourages learners to progressively gain expertise in their stakeholder role and insight into the complexity of related issues, and also has potential to create a deliberate sense of ambiguity, which is integral to the 'wickedness' of the problem they are addressing (Rittel & Webber, 1973). Hence, players find themselves constantly thoughtful and questioning as they are prompted to react to the unfolding situation. Thus, the emphasis of learner performance and assessment is on behaviour/performance rather than outcome. The authentic possibility of multiple decisions and outcomes ensures a safe environment for bold critical thinking, direct emotional engagement, originality and creative problem solving.

Mantle of the Expert

Acting as real-life organisations, the learners are entrusted with a 'mantle of the expert' which authorises them to investigate and address the issues ***as if*** they were the organisation experts (Heathcote & Bolton, 1995). This 'mantle' of expertise changes thinking and learning ***about*** the issues, to that of thinking ***from within*** the issues. Acting within this 'mantle', learners investigate and respond to the issues from the perspective of contributors to, victims of or activists against the issues rather than neutral passive observers. In this way learners experience an active, urgent and purposeful view of learning, in which knowledge is to be acted upon on, not merely taken in (Heathcote & Bolton, 1995). In addition to empowering the learners to drive their own learning, the 'mantle of the expert' gives legitimacy to trial and error and learning from errors. This stimulates critical review and self- and peer-correction as the learners engage with the task and co-construct their knowledge. This is especially so, as different stakeholder teams liaise with each other in search for relevant collaborations and partnerships that can help them address the issues. The gradual realization that there are a variety of stakeholders with opposing or even conflicting interests reveals the tension and reinforces the life-like 'wickedness' of the problem. The role of the teacher/lecturer is to facilitate a learning environment that develops in the learners qualities of leadership, competency and responsibility for their own learning (Aitken, 2013).

Visual Literacy

In the words of John Debes, who first used the term in 1968, 'visual literacy' describes the capacity of a learner to "discriminate and interpret the visible actions,

objects, and/or symbols, natural or man-made, that he encounters in his environment. Through the creative use of these competencies, he is able to communicate with others. Through the appreciative use of these competencies, he is able to comprehend and enjoy the masterworks of visual communication" (cited in Braden, 2001). Visual literacy is a key learning goal of the Mind Map Poster, which the players prepare in Week 4 (Figure 1 above). This is a hand-drawn visual expression of the learners' insights into and stakeholder response to the Role Play 'wicked problem'. As such, the poster is designed to communicate complex and meaningful messages demonstrating the learners' ability to construct and express meaning visually.

The theoretical framework underpinning the Mind Map Poster is visual discourse analysis, "a theory and method of studying the structures and conventions within visual texts, and identifying how certain social activities and social identities get played out in their production" (Albers, 2007). The rationale for selecting visual discourse analysis is that it provides learners with a more comprehensive and versatile form of expression where the focus can more readily be on creativity and message complexity rather than formality. This is especially so given the fact the participating learners are international students whose first language is not English.

Consequently, in preparation for the Role Play, learners explore relevant visual literacy techniques as well as corresponding skills of visual exploration, critique and reflection. Some of the techniques include analysis of visuals in terms of colour, size and symbolism of different image elements, positioning on the page, overall context of the image, possible direct and underlying messages, intended audience reaction, impact, etc.

In addition, a series of relevant visually represented analytical tools are explored either with a view to deciphering or illustrating complex visual messages. Some of these are:

- **Critical Lenses** such as socio-economic, financial, cultural, political, environmental, etc. Different stakeholders may highlight different aspects of the issues depending on the unique lenses. For example, in *The Plastic Age?* Role Play, a stakeholder such as the 5 Gyres Institute may be inclined to view the plastic pollution 'wicked problem' through environmental, education, scientific lenses while a plastic manufacturing company (e.g. MBA Polymer) is likely to use economic and financial lenses.

- **Issues**, namely, important problems or challenges that are difficult to address in isolation because of their strong connections with and implication for other problems or challenges. These *must* be consistent with the relevant stakeholder lenses.

- **Scale** of the issues and/or stakeholder impact (individual, group/family, local, regional, national, international, bilateral, multilateral, global)

- **SWOT Analysis** (Stakeholder Strengths, Weaknesses, Opportunities and Threats)

- **Stakeholder Disposition Map** to position the Role Play stakeholders with regards to the main issues on a scale ranging from a position of power (in favour and influencing the situation) to one of a victim (against and unable to influence the situation). This also allows the disposition of stakeholder against each other depending on their similar or antagonistic interests.

- **Fishbone Diagram (Ishikawa Diagram)** to identify and illustrate cause and effect relationships (https://www.mindtools.com/pages/article/newTMC_03.htm)

- **Forces and Impacts** of relevant issues

- **Known Knowns/Unknowns - Unknown Knowns/Unknowns** to drive in-depth meaningful research of the issues (http://mysticmundane.blogspot.com/2008/03/knowns-unknowns-and-project-management.html)

The Role of Technology

In the International Issues and Perspectives program, technology is not merely a tool for instruction delivery, but it is thoughtfully integrated into the curriculum to optimise learning and empower students to become independent learners (Mills & Tincher, 2003, Garrison & Kanuka, 2004). Thus, we believe we have achieved an effective blend of **instructional modalities** (facilitator-driven, learner-driven, flexible learning) and **delivery media** (multimedia, UNSW Moodle, lectures, workshops, PowerPoint Presentations, Prezis, Vialogues, workbooks); **instructional methods** (face-to-face and technology-based), **web-based technologies** (e.g. UNSW Wikispaces, Prezis, PowToons, Vialogues, Worldle, online discussion forums and blogs) and **learning states** (dependent, inter-dependent, independent). The combination of these depends on learning goals, course content, teaching and learning styles, and learner characteristics (Dziuban, Hartman & Moskal, 2005 in Kosar, 2016).

Hence, the Role Play also combines a rich blend of instructional modalities and methods that facilitate the learners' transformation from novices to experts (in terms of content knowledge) and from interdependent to independent learners (in terms of study skills and competencies). Lectures are used to introduce the Role Play wicked problem, stages and weekly tasks while workshops are allocated to learner-driven learning. The Role Play is hosted on UNSW Wikispaces (Figure 2), where teams develop and publish their stakeholder profile, investigations and response to the Introductory Scenario. They also use the wiki discussion board to liaise and seek collaborations with other participating stakeholders. An example can be viewed at: http://ufsb2016.unsw.wikispaces.net/

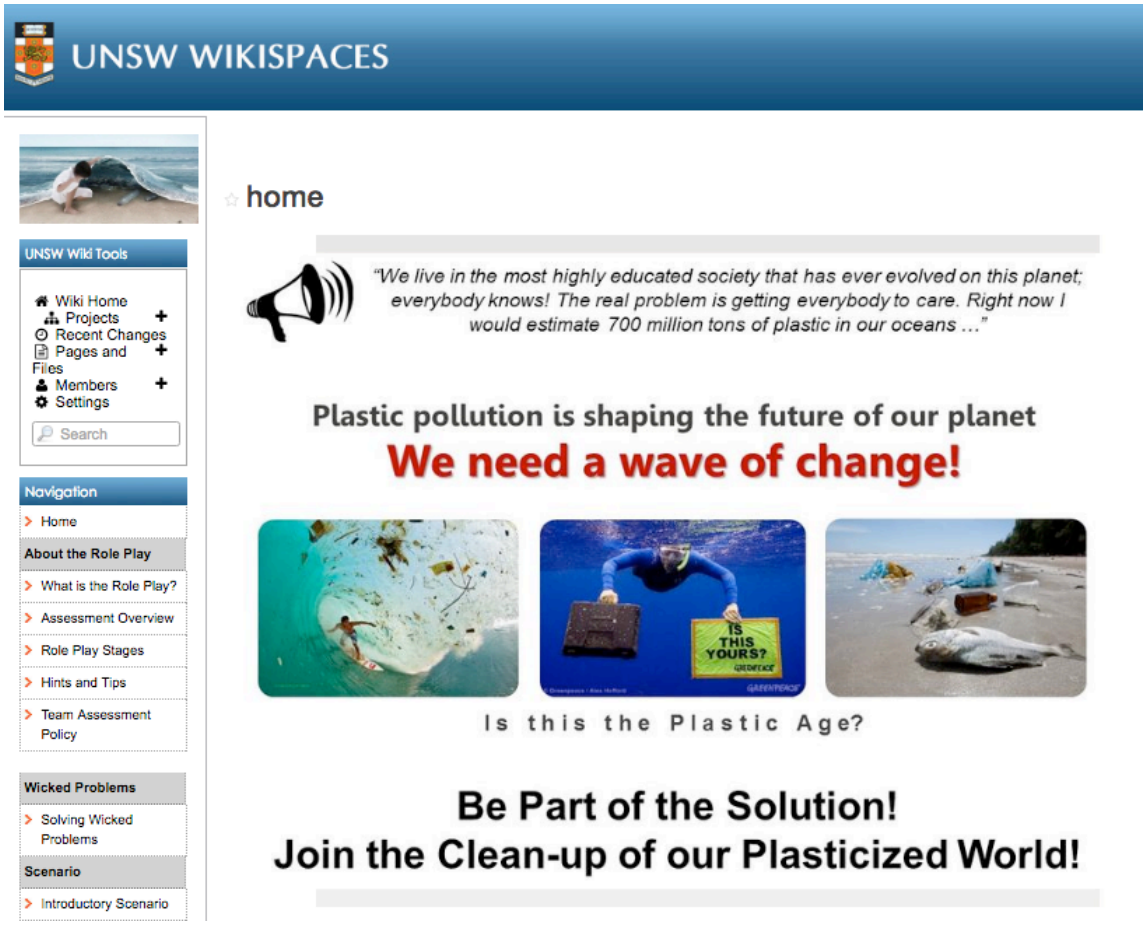

Figure 2: *A snapshot of the 2016 Role Play Assessment WIKI: The Plastic Age?* (http://ufsb2016.unsw.wikispaces.net/)

The Introductory Scenario, which offers an overview of the wicked problem, is a multimedia program which teams analyse via Vialogues (Figure 3). This online software facilitates private and autonomous team discussions about the video, creating opportunities for both synchronous and asynchronous interactions.

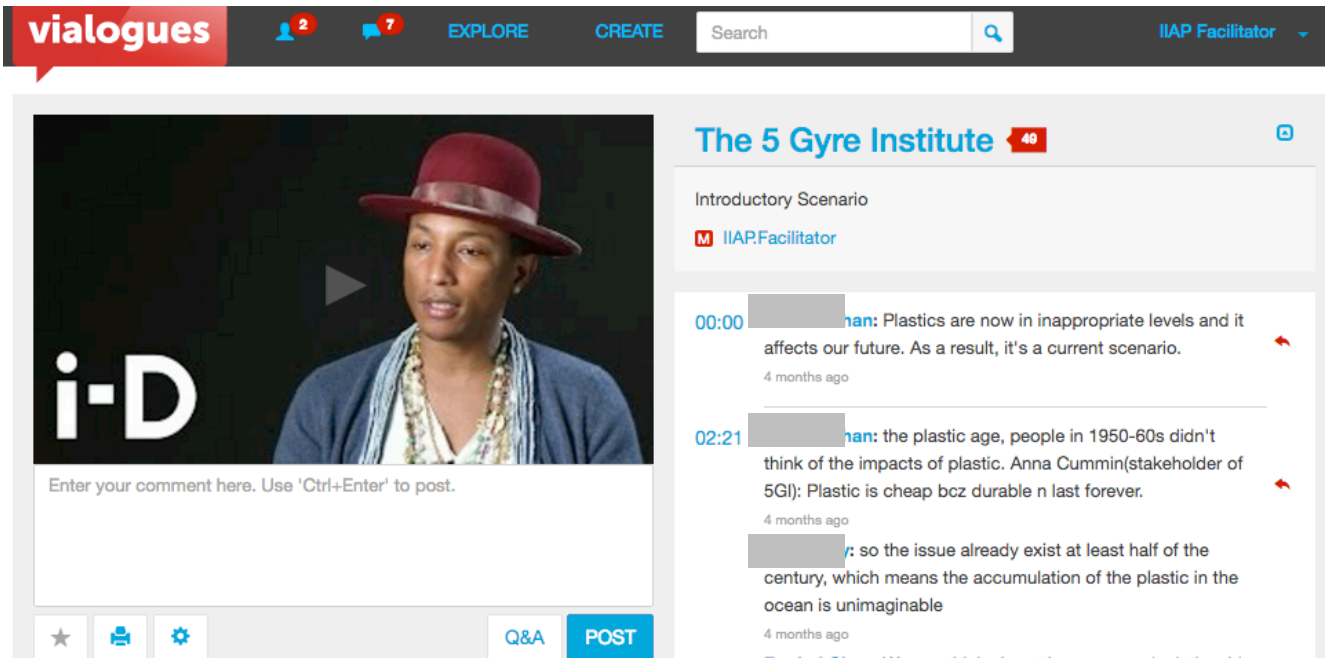

Figure 3: *A snapshot of an online discussion about the Introductory Scenario 2016 Role Play Assessment WIKI: The Plastic Age?*

For privacy reasons, the names of the students participating in this discussion have been covered.

While the stakeholder analysis and wicked problem investigation in the early stages of the Role Play are mediated by information and communications technology (ICT), the ensuing stakeholder response to the issues raised in the Introductory Scenario is presented visually in the form of a hand-drawn Mind Map Poster. In fact, the use of *any* electronically-mediated technology is prohibited in the performance of this task. This is to avoid learners' acceptance of knowledge/authority without questioning it, to ensure more genuine engagement with the issues, engage deeper thinking, foster a higher level of creativity and reward originality. The same applies in the case of the Action Plan, the stakeholder response to the Emergency Scenario, which occurs in the subsequent stage of the Role Play, the Emergency Summit.

Plagiarism-checking software is used for the submission and assessment of the final Role Play assignment, the Debriefing Report. This is to reinforce the academic rigor against plagiarism through the issue of an originality report.

The Mind Map Poster

This Mind Map Poster in Figure 4 was submitted by the stakeholder group representing 5 Gyres Institute and was their response to the plastic pollution 'wicked problem' raised in *The Plastic Age?* Role Play in September 2016. It represents visually the team's analysis and response to the major issues through the lens of their stakeholder. At the time when the posters are submitted, learners are not expected to put forward any solutions to the problems but only to indicate their position and response to the issues.

Conventional referencing is not required on the poster. This is to encourage active engagement with the ideas and drive creative, original expression.

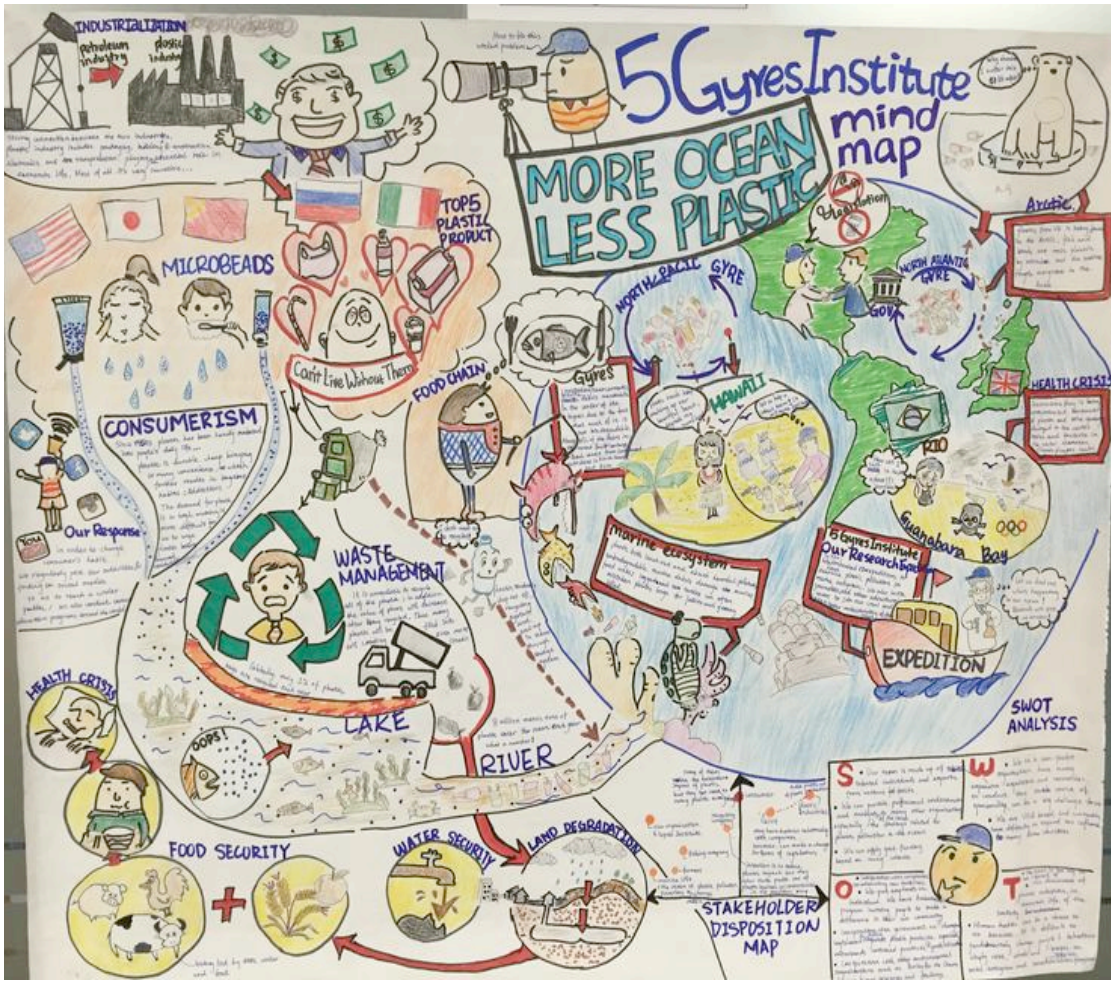

Figure 4: *Mind Map Poster illustrating the response of the 5 Gyres Institute Stakeholder to the plastic pollution 'wicked problem' raised in The Plastic Age? Role Play in September 2016*

Student permission has been given for using these materials.

After the completion of the Mind Map Poster, stakeholder teams are given the option to write a brief summary of the illustrated message. This allows them to critically reflect on their work and their mastery of visual literacy and gain further confidence in their own learning.

In the words of the 5 Gyres Institute Stakeholder Team, "*the Mind Map Poster aims to illustrate, from the top left corner: plastic is massively produced (**industrialisation**) and consumed globally (**consumerism**) however, there is a failure to manage it thoroughly during recycling. Plastic waste, which is not biodegradable, is dumped into landfills that pollute the soil. This leads to **land degradation** that contaminates drinking water systems and food production (**water and food security**). In addition, toxic microbeads directly flow into lakes and rivers through the drainage systems. Fish accidentally eat micro-plastics and, thus, toxins penetrate the **food chain** all the way up to humans (**health crisis**). Plastic waste that does not get recycled ends up in*

the oceans and tends to accumulate in the centre of ***ocean gyres*** *or float to seashores of many islands (****global environmental system****). The toxic plastic damages the* ***marine ecosystem*** *casing the* ***Arctic ecosystem*** *to become the victim of plastic pollution due to the chain of effects.* ***Responses*** *from our organization include: promoting activism through social media, conducting research expedition, corporation with government in legislation and beach clean-up action."*

The 'Wicked Problem'

Before embarking on the analysis of the pedagogical merits of the Mind Map Poster task, it is necessary to provide a brief summary of the relevant Introductory Scenario and associated News Flashes.

The Introductory Scenario is called: *The Plastic Age: A Documentary feat. Pharrell Williams* (https://www.youtube.com/watch?v=Pt6KlPCX1BU&t=2s). Through a series of interviews supported with visual and scientific evidence, the program draws attention to the 'profoundly dark effect' that plastic might have on the future of the ocean and implicitly the planet and cautions against *The Plastic Age*. Over 280 million tonnes of plastic are produced each year, and unlike paper, metal or glass, this does not oxidise or biodegrade but it persists and worse it ends up in the oceans making the ratio of plastic to plankton 100:1. One result of this is *The Great Pacific Garbage Patch* - a soupy collection of marine debris nearly the size of Australia. This has alarming environmental, economic and social consequences for Pacific Islands such as Hawaii. Bionic Yarn in partnership with Pharrell Williams and G-Star RAW produced the world's first denim line collection from plastic recycled from the oceans.

This scenario was selected because it offers the learners a useful starting point not only in terms of introducing the wicked problem but also for its original problem solving approach based on Bionic Yarn creatively capitalizing on plastic waste to develop a commercial opportunity: producing high performance yarns and fabrics from discarded raw materials including plastics. Also relevant to the Role Play is the fact that this solution is totally consistent with Bionic Yarn's economic and sustainability lenses. Moreover, this solution is made possible through partnerships with other stakeholders including Parley for the Oceans, Pharrell Williams, G-Star RAW. Hence, in the early stages of the Role Play process, the learners are shown an indirect example of how in-depth understanding of the problem can generate creative solutions within the stakeholder role.

In addition to the Introductory Scenario, further direction is given through several News Flashes or trigger events released on the Role Play Wiki. These aim to provide alternative perspectives of the relevant issues and/or stakeholders in order to escalate the tension and further reveal the 'wickedness' of the problem. In this case, News Flashes drew attention to the fact that plastic microbeads that rinse off synthetic clothes and cosmetics escape household drains and are increasingly found in US and Australian seafood (ABC TV *Catalyst: Micro-plastics*, 2016).

Mind Map Poster Analysis & Assessment

Visual literacy, in its complexity, meaning rendering layers of meaning through visual symbols, is the overarching learning goal of the Mind Map Poster activity. This is condensed in the following three assessment criteria (also see Figure 5):

1. **Relevance of stakeholder response** – the visual message needs to demonstrate understanding of specific information, issues, stakeholder interests included in and arising out of the Introductory Scenario and News Flashes.

2. **Depth of stakeholder analysis** – evidence of insight into own stakeholder role in terms of interests, scope and type of action, possible stakeholder collaborations and conflicts, strengths, weaknesses, opportunities and threats.

3. **Effectiveness of visual representation of major issues** – clarity of visual message

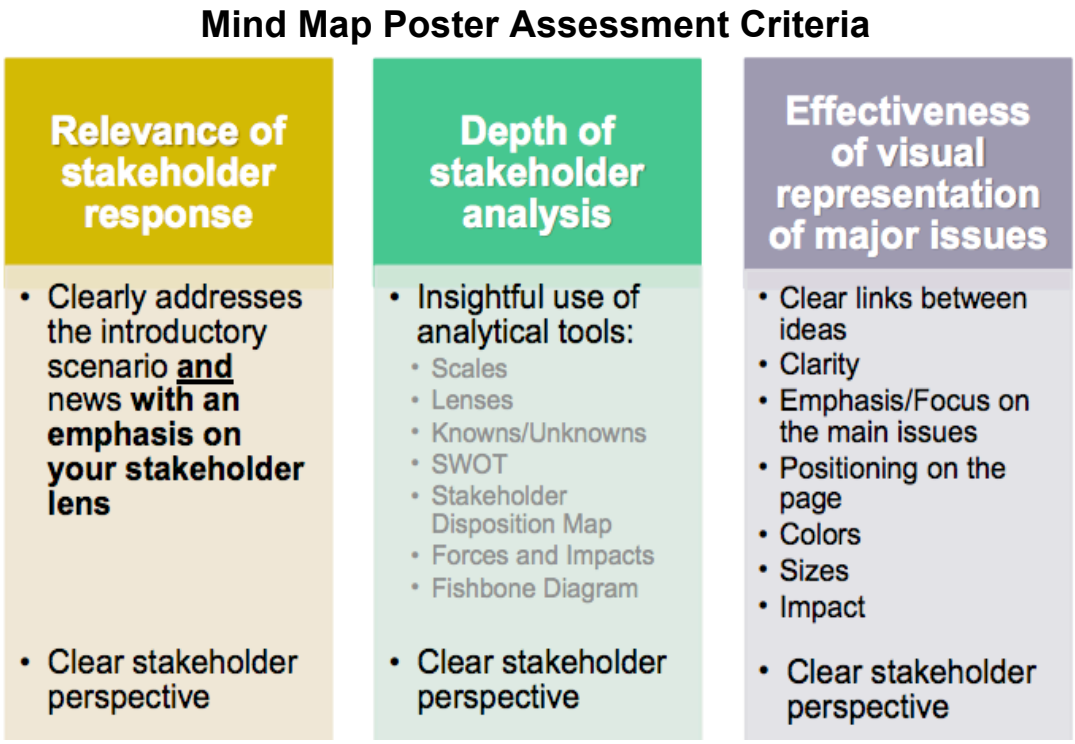

Figure 5*: Mind Map Poster Assessment Criteria*

The Mind Map Poster will be analysed from the perspective of the three assessment criteria and in light of the conceptual framework outlined above.

1. Relevance of stakeholder response

The Poster focuses clearly on plastic pollution by illustrating in bright red heart bubbles the world's love affair with the top five plastic products 'we can't live without' (Figure 6 below). The image of the happy money-making industrialist of indiscriminate nationality surrounded by the flags of USA, Japan, China, Russia and

Italy suggests, as does the Introductory Scenario, that most plastic generates from heavily industrialised countries and that it is a very lucrative enterprise. Further relevant to the scenario is the illustration of an overburdened and inefficient waste management system that leads to irresponsible landfills and soil contamination. The ensuing elements build on the issues raised in the scenario and provide broader but still relevant insights such as land degradation determining an increasingly toxic water cycle with repercussions on water and food security and ultimately generating a health crisis. This critical follow-through cleverly addresses all the three assessment criteria but above us points to genuine engagement with the issues in and arising out of the scenario.

In addition, the references to microbeads in toothpaste and soap filtering through to rivers systems meaningfully integrate elements of the News Flashes, which indicate constant monitoring of the Wiki activities.

The key element that consolidates the visual message is the stakeholder *response* or reaction to these issues. It is in the formulation of this response that the developing expertise of the learners is framed. It is relevance and quality of this response that gives authenticity to the overall message of the Poster and differentiates high quality from mediocre performances. In this case the response is relevant and strongly in role. The 5 Gyres Institute aims to change consumer habits through activism via social media and other education programs.

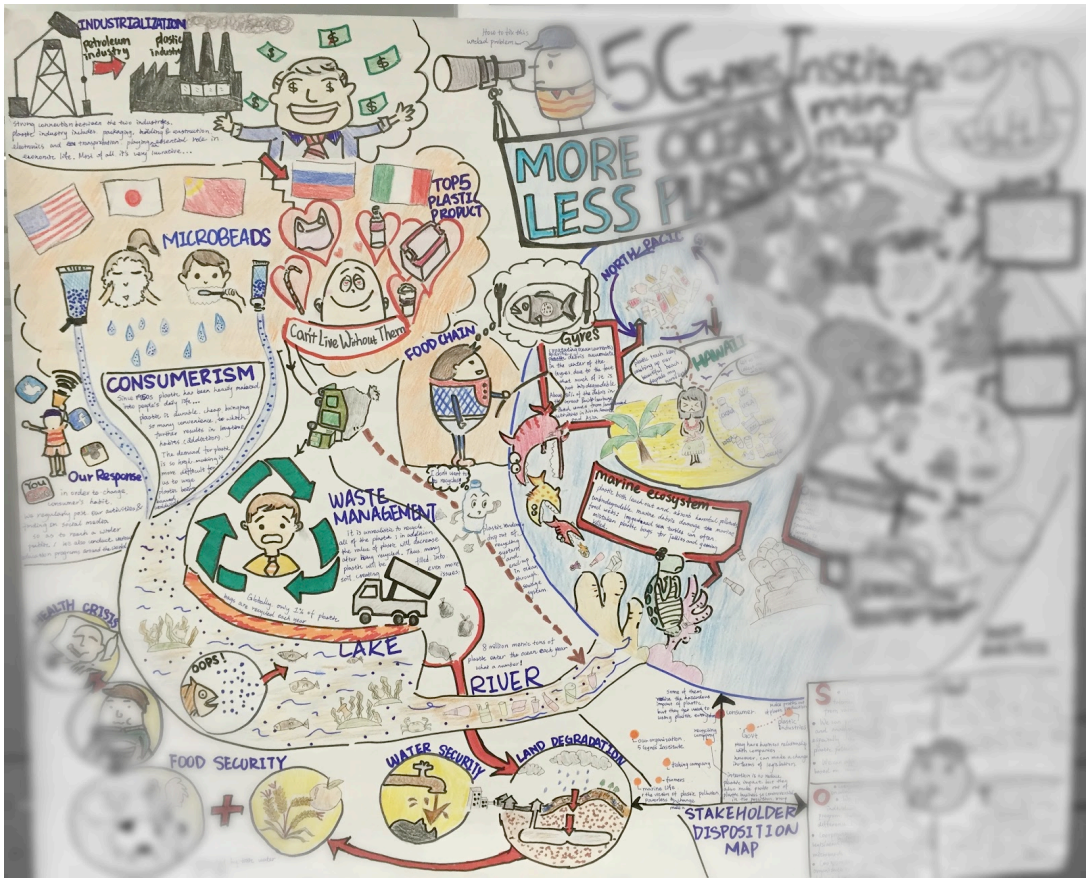

Figure 6: *Mind Map Poster illustrating the response of the 5 Gyres Institute Stakeholder to the plastic pollution 'wicked problem' raised in The Plastic Age? Role Play in September 2016*
To direct the reader's attention to the left side of the poster, the right side has been intentionally blurred.

The illustration of the 5 gyres with a main focus on the North Pacific Gyre, with its Great Pacific Garbage Patch and the island of Hawaii is not only relevant to the scenario but is also strongly in role (Figure 7 below). This is further substantiated by the initiative of a research expedition to further investigate the issues and search for solutions.

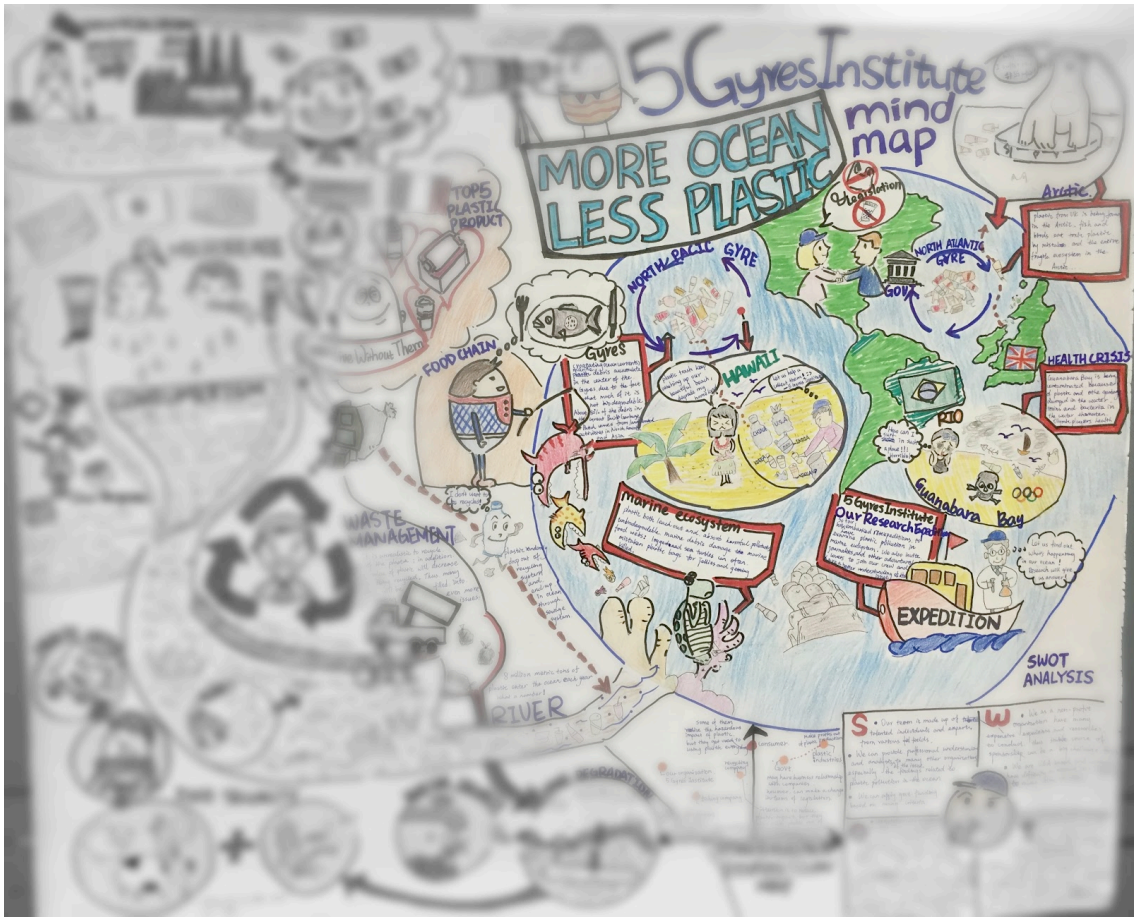

Figure 7: *Mind Map Poster illustrating the response of the 5 Gyres Institute Stakeholder to the plastic pollution 'wicked problem' raised in The Plastic Age? Role Play in September 2016*

To direct the reader's attention to the right side of the poster, the left side has been intentionally blurred.

2. **Depth of stakeholder analysis**

The message of this Mind Map Poster is especially compelling and insightful in that it is not limited to the illustration of the issues raised in the Introductory Scenario and News Flashes but goes far beyond these to extrapolate and visualize the stakeholder position towards the wicked problem based on the learners' analysis of the lenses, scale and capabilities of the 5 Gyres Institute.

The illustration of the globe as highlighted in Image 4 points to the 5 Gyres Institute operating on a global scale and the depiction of the 5 gyres collecting and spinning round marine debris indicates the stakeholder focus and scope rather clearly. The little vignettes associated with each gyre reveal localized underlying issues arising out of the plastic pollution. The issues illustrated are mainly of an environmental or health nature while the stakeholder responses tend to be based on science, education or adventure. All these are consistent with the lenses and capabilities of the 5 Gyres Institute. This demonstrates the learners' ability to filter a wide range of information

and critically distil meaning *as if* they were the 5 Gyres Institute. It is the purposeful autonomy of learning design that stimulates such confident thinking.

On the other hand, the aspects of the Poster that are illustrated in Figure 5 aim to reveal the stakeholders and issues that cause the plastic pollution of the gyres to occur. The fact that these issues are presented on a side (the left of the Poster) and outside the globe symbolizes that the 5 Gyres Institute is powerless to influence any of these. This adds another layer of meaning to the Poster and further consolidates that stakeholder position.

Furthermore, the SWOT and Stakeholder Disposition Map (Figure 8) offer further insight into the stakeholder capabilities to address the relevant issues and relate to other stakeholders in doing so.

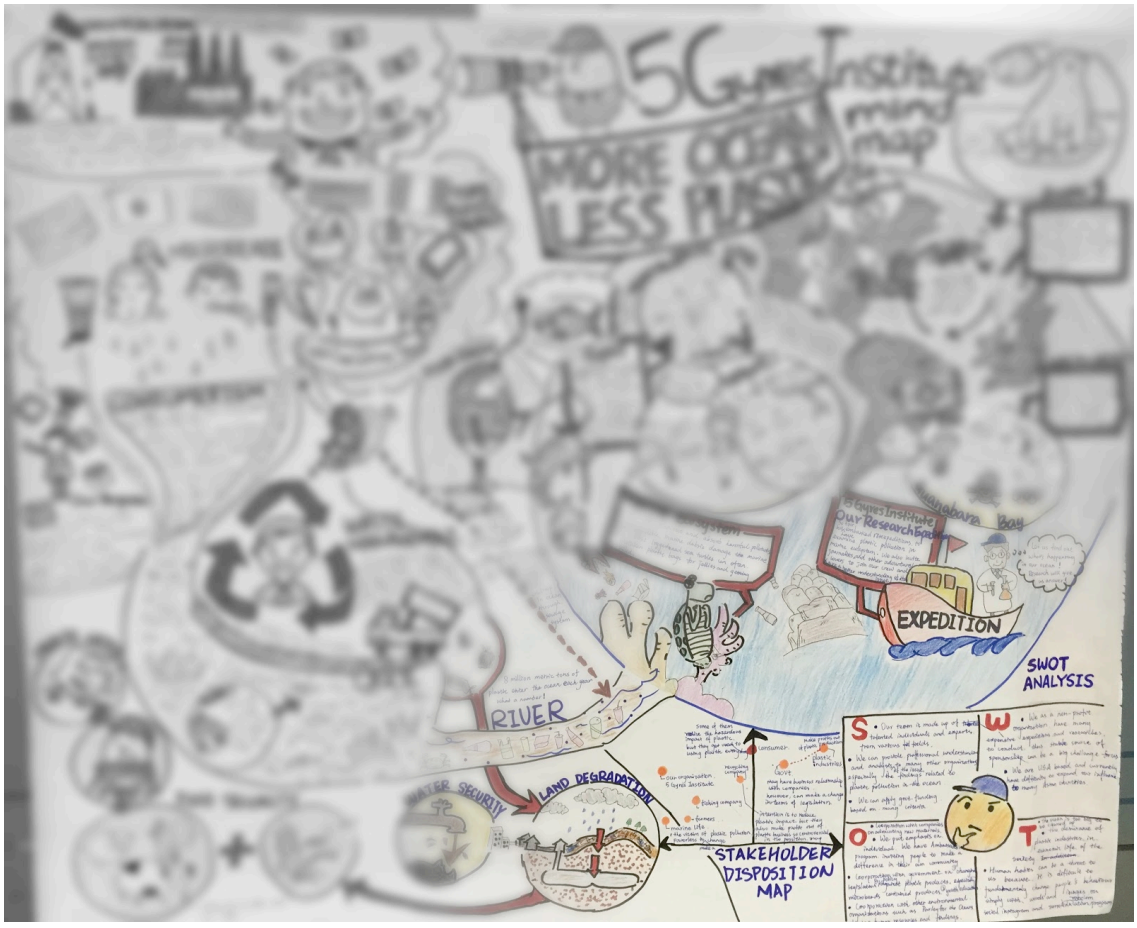

Figure 8: *Mind Map Poster illustrating the response of the 5 Gyres Institute Stakeholder to the plastic pollution 'wicked problem' raised in The Plastic Age? Role Play in September 2016*

To direct the reader's attention to the bottom right, the rest of the poster has been intentionally blurred.

3. Effectiveness of visual representation of major issues

As illustrated above, the Mind Map Poster is divided into two parts, the left-hand side analyses the wicked problem so as to contextualize the stakeholder response, while the right showcases the stakeholder view and scope of action.

Colour is used consistently to distinguish between positive and negative aspects, for example, plastic packaging floats in bright red heart bubbles while plastic trash in Hawaii looks dark grey. Arrows point to a chain of causes and effects such as the cycle of plastic waste though nature; and positioning on the page highlights forces and impacts, i.e. industrialization driving consumerism, which in turn puts pressure on the natural environment with devastating social and environmental impacts.

Also contributing to the clarity of the message is the consistency of the symbolics and thoughtful integration of textual evidence to substantiate the visual message. It is important to note that the images and words do not overlap and repeat the same information but are complementary. This is further evidence of masterful visual literacy.

Learner Testimonials

The following testimonials extracted from the 2016 *The Plastic Age?* Role Play participants' Debriefing Reports reinforce from the learners' perspective some of the learning design achievements illustrated above. Student permission has been given for using these materials.

> *"The Role Play has been the most exciting and unique assessment that somehow doesn't feel like an assessment. It engaged a large group of students sharing information and communicating with each other on the Internet and face to face - just like in the real world. I have never experienced this before." CHEN Siwie, 2016 representing the 5 Gyres Institute & one of the authors of the Poster Poster analysed in this paper.*

> *"The most frustrating stage for us has been creating the Mind Map Poster. We abandoned many drafts before finalizing the most satisfying one. It almost seemed impossible to achieve a quality mind map poster at first. Accepting the challenge, we reviewed the video of introductory scenario as well as the comments our team made in Vialogues several times and summarized the forces and impacts of plastic pollution in order to capture the main information for our mind map. This proved to be very effective later. In addition, we've learnt that combining the components of issues with visual literacy involved decision on images, positions, sizes and colours to illustrate an integrated and logical mind map. We were very surprised at our creativity when we finished the task. Moreover, we found that the mind map poster was such a direct, powerful and interesting tool to reveal the complexity of the wicked problem." The 5 Gyres Institute Team, the authors of the Poster Poster analysed in this paper.*

"One of the most notable experiences I've had during the Role Play was designing the mind map poster. Trying to visually represent concepts made me look at them in a different way. Without words, every other element such as shape, colour and size couldn't be overlooked. I had to think of ways to use them to get the maximum effect. I had to think about what MBA Polymer would put on the paper, what they would want the eyes of the viewer to focus on and what impression they wanted to give about the issue and their company's role. It was challenging to try and both give an honest picture of the issue and keep in mind what parts of that image MBA Polymer liked people to see. It was significant for me because it made me think a lot about the balance between the honest truth and the truth someone with bias wants to show others. It taught me to recognize bias." Shima Golmohamadi representing MBA Polymer

Figure 9: *Testimonials extracted from the 2016* The Plastic Age? *Role Play participants' Debriefing Reports*

Limitations

Some of the limitations of this educational approach are related to the learners' abilities to express their ideas visually in the absence of advanced technological support. Those who are not confident with their drawing skills may find the task extremely demanding especially at the early stages of preparing the poster due to insufficient familiarity with the assessment criteria. This can create a sense of frustration in some teams and even demotivate some learners at the start of the task. Some learners need more time to adapt than others but ultimately all participate actively and appreciate the challenge as an enriching learning experience.

It is not only learners but also educators that need to adjust to this teaching/learning approach. They need to allocate more time to clarifying the marking criteria and most importantly reassuring students that the mastery of drawing skills and sketching is not the key to success in this Role Play task but the relevance and complexity of the visual message conveyed.

To overcome the afore-mentioned challenges, educators can introduce the assessment criteria at the beginning stages of the task and explain each component providing some examples of previous posters especially the ones that are more aesthetically pleasing and demonstrate above-average drawing skills but do not entirely meet the marking criteria in terms of the complexity of the message delivered. This can be done as a complementary classroom activity prior to the stage in which team members are asked to produce their Mind Map Posters. This can not only alleviate the amount of frustration learners might face but also can assist in directing their attention to the criteria and reduce any chance of diverging from the focus of the task.

Conclusion

The preparation of the Mind Map Poster is a turning point in the Role Play learning process for most learners especially because of the restriction on the use of electronically mediated technology. This is the stage when team members are compelled to physically come together to discuss, question, analyse, synthesize information and distil their understanding. It is during these very interactions that

learning is crystallised. The fact that learners are compelled to express their learning in a visual form away from the filter and support of ICT software, genuinely pushes them out of their comfort zone in a way that stimulates their critical and creative thinking. The Role Play procedural framework ensures versatile support through the provision of guiding content references as well as a variety of analytical tools and complex visual literacy skills. While electronically-mediated technologies are prohibited for the actual Mind Map Poster task, this is employed extensively as a scaffold for the preparation leading up to this task. Hence, the success of this learning experience is thoroughly dependent on the fine-tuned integration of the electronically-mediated technology with stripped-down original expression.

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Bringing Persuasive Design into the Development of Mobile Interactive Media for Road Safety Education in Young Children

Manasawee Kaenampornpan, Mahasarakham University, Thailand
Pornpan Kaenampornpan, Khon Kaen University, Thailand
Nicholas John Gorman, Khon Kaen University, Thailand

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Abstract
Parents become an important part in giving knowledge about road safety to their children. Apart from its attractiveness, the animation is a powerful tool to demonstrate a graphical scene for the children to understand the impact of their behavior. Moreover, the mobile interactive media have great potential to be a great tool for the joint engagement between parents and children in learning. Therefore, in this research we propose a mobile interactive media to be a tool for parents in teaching their children about the road safety at anytime and anywhere. In order to develop an educational and pleasurable media, the persuasive design is an important concept that we adopted during our design process. Based on two chosen categories of the persuasive system principles and our analysis of the characteristics of young children and parents in the context of teaching road safety topic, we design the application to support the user's primary tasks of tailoring and simulation principles. In the dialog support category, we choose praise and liking principles in our design as they are simple for the children to understand and related to. The paper prototypes were used to get the feedback from the users at the early stage. As a result, we get the clarification about our design before doing the long and expensive process of programming. We have tested our final product with the nursery school students. From our pretest and posttest, we found that students have a better understanding about the road safety. Moreover, they are eager to use the application and find it very attractive.

Keywords: mobile interactive media, young children education, persuasive design, road safety

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Introduction

Road Safety is an essential topic to teach children in order to let them do day to day routine. The road safety topic is a small part in the school curriculum due to a time limited in the academic year. Therefore parents become an important part in giving knowledge about road safety to their children. However, teaching young children is not easy. They get distracted and get bored very easily. Moreover, not all parents have an experience in teaching. Even though young children learn better through examples. But the road safety topic can be dangerous to show by example. Apart from the attractiveness that the interactive media provides to the children, the animation is a powerful tool to demonstrate a graphical scene to the children for them to understand the impact of their behavior. Furthermore, mobile technology is widely used by parents. They have access to the mobile device seamlessly. The Google play store and Apple store are the key apps marketplaces that distribute digital content to people around the world. The content on the marketplaces reaches many people very quickly compare to the old resources such as TV, newspaper, website, book and radio. Therefore, in this research we propose the mobile interactive media that reaches as many people around the world. It is also a tool for parents to teach their young children about the road safety topic at anytime and anywhere.

In order to develop an educational and pleasurable media, the persuasive design (Fogg, 2003) is an important concept that we adopted during design process. It has been applied in designing technology in many domain such as health (Coorey, et al., 2016) and education (Wiafe and Nakata, 2012; Mintz and Aagaard, 2012). The aim of the persuasive design is to develop an application that enrich user experience while using this application to motivate, facilitate and support individuals through the behaviour change. In this definition, there are three potential successful outcomes for a persuasive system: the voluntary reinforcement, change or shaping of attitudes and/or behaviors. Based on 2 chosen categories of the persuasive system principles (Torning and Oinas-Kukkonen, 2009) and our analysis of the characteristics of young children and parents in the context of teaching road safety topic, we design the application to support the user's primary tasks of tailoring and simulation. This will give the children conceptual idea about road safety and they can see the effect of each road safety scenario that related to their everyday life. In the dialog support category, we choose praise and liking principles in our design as they are simple for the children to understand and related to.

The mobile interactive media is developed by adopting a participatory design technique where the users become an important part of our design and developing process. According to our design decision based on the persuasive system principles and our analysis of the characteristics of our context of use, paper prototype is used to get the feedback from the users at the early stage including character design, interaction GUI design and scenes design. This stage gives us the clarification about our design before doing the long and expensive process of programming.

We have tested our final product with the nursery school students. From our pre-test and post-test, we found that students have a better understanding about the road safety after interacting with our application. Moreover, they are eager to use the application and find it very attractive. The final interactive media products are in both Thai and

English languages. They are ready to be uploaded from Apple store and Google play store for people around the world.

Methodology

The research process is divided into 6 parts. The first part is the important part of literature review about the related works. This includes the researching about the school road safety course syllabus and road safety situations that are related to young Thai children everyday life.

The second part is done in order to understand about young children and road safety education in the context of teaching by parents and teachers. It took around 3 months to finalize the road safety situations that are used in the application development. As this work is design based on the participatory design technique, users including teachers, parents and children are included in the focus group to analyze and finalize the situations. Moreover, the requirements from the children, teachers and parents are gathered at this stage too. The situations were finalized at this stage. This included drafting the script of the scene in each situation.

In our third part, we applied the persuasive design into our application. From the requirements and the analysis of the characteristics of users, we setup the usability goals for our application. Then the persuasive system principles (Torning and Oinas-Kukkonen, 2009) were analyzed and selected to apply in our design. As a result, paper prototypes were developed. The paper prototypes were used in the focus groups with parents, teachers and children in order to evaluate the interface design and usability goals. This stage took longer than we expected as we had many version of paper prototypes. Also the high level prototypes were used to evaluate the animation for each scenario in the situation too.

The fourth part is to develop the final product based on the result of the evaluation of the prototypes from the previous section. The third and fourth parts are done simultaneously in order to make sure that the product meet users' requirement. It is an iterative design process in order to build a closed understanding with the users. The finalized products for both platforms were developed. The sound team created the sound for each scene to complete the final products.

The fifth part is an overall evaluation of the final products. The final product was used to test with young children at the nursery school. The evaluation was done later than we expected in our research schedule as we have done an iterative design and evaluated with many more prototypes in the earlier steps. As we believe it is cheaper and save more time to get it right the first time than wait to get users' feedback at the end of the development process after the final product is done where the complex and time consuming coding is already done. This helps our overall evaluation to get satisfaction from the users with minimal changes.

After our user testing, the final products "Road Safety for Young Kids" are launch on the Apple store and Google play store.

Results

From our method of research, the results divided into two main parts the result of the iterative design using prototypes and result of user testing.

In first part, the result is concentrated on the design based on the users' requirements and persuasive system principle. There are 4 categories for the persuasive system principles including primary task, dialogue, system credibility, and social support. The design principles in the primary task category support the carrying out of the user's primary task. Any interactive system provides some degree of system feedback to its users, potentially via verbal information or other kinds of summaries. There are several design principles related to implementing computer-human dialogue support in a manner that helps users keep moving towards their goal or target behavior. The design principles in the system credibility category describe how to design a system so that it is more credible and thus more persuasive. The design principles in the social support category describe how to design the system so that it motivates users by leveraging social influence. Based on the context of teaching young children about road safety, only 2 categories are directly related to our project – the primary task and dialogue. The system credibility and the social support categories are explicitly related so we just applied by making sure there is no error in the application. However, based on the persuasive system principles and our analysis of the characteristics of young children and parents in the context of teaching road safety topic, we design the application to support the user's primary tasks of tailoring and simulation. Our characters and situations in the application are tailoring to children interests or relevant to them. It seemed to be more persuasive as they can relate themselves to the characters and situations. Animations in the application provide simulations to enable children to immediately link between cause and effect in each situation. This will give the children conceptual idea about road safety and see the effect of each scenario of the road safety situation that related to their everyday life. According to the dialogue support category, based on the characteristics of young children, they like being praise as they are simple for the young children to understand and related to. Therefore our application offers praise by giving children applauses when they select the right answer. Moreover, the main objective of the application is to provide visually attractive animation as children are likely to be more persuasive. The paper prototypes were used to get feedback from users during focus group in order to change the design before actually doing the coding. Figure 1 shows some sample of our prototypes.

Figure 1: Example of our prototypes.

In the second part, our final product is being test with the real children in order to evaluate the application. Figure 2 demonstrates our experiment with children. Apart from the persuasive design principle, the application design also takes consideration of interaction design for children too such as larger and longer feedback, larger buttons and balancing between the visual stimulus and desired reaction speed. Results of the road safety knowledge pretest and posttest questionnaires demonstrate that the average of the pretest results is equal to 3.5 and the average score of the posttest results is 5.6 out of 6. It indicates that the children gain a higher score after interacting with the application. This shows that education about road safety through interactive media creates awareness to children about how to behave appropriately and safely on the road. Moreover, from our observation and interview with the children, it is notable that the application is an excellent medium that can draw children's attention. The children like the characters and can related to the characters. The animation used bright colors. The sound effect complements the animation that is enjoyable for children. Apart from gaining the knowledge about the road safety, the application allows the children to manually choose the situation that they are interested to see the outcome of their choice. The animation demonstrates the result of carefulness or negligence of the road usage in different situations. As evidenced, the teachers and

parents found the application easy to use and easy to learn how to use as they can use without any explanations before usage.

Figure 2: Example of our experiment with children.

Conclusion

From the result, we found that the project is useful for children and parents. For further studies of our design, the application will be tested with more children, teachers and parents in order to understand further impacts in children behavior. The real situation setup will be used instead of questionnaire in order to understand the knowledge transfer of the application in children. Furthermore, the understanding about the joint engagement between parents and children will be studied in order to come up with the design guideline for application that will increase the efficiently in the joint engagement between caregivers and young children.

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Contact email: Manasawee.k@msu.ac.th

Massive Open Online Challenges in Education: Using Various Analytics to Evaluate the Success of a MOOC

Jihan Rabah, Concordia University, Canada
Anik De St Hilaire, KnowledgeOne Inc., Canada

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Introduction

The world today is witnessing an increasing interest in Massive Open Online Courses (MOOCs). This new form of Technology-Enhanced Learning (TEL) is in the spotlight, particularly when it comes to the topic of the evolving nature of higher education learning (Shrader, Wu, Owens-Nicholson, & Santa Ana, 2016). Advocates of MOOCs propose that open courses are being celebrated because they make education accessible to all with their wide and free of charge reach (Lewin, 2012; Wulf, Blohm, Leimeister, & Brenner, 2014). On the other hand, opponents of MOOCs focus on the lack of empirical evidence to support TEL as the promised advancement to 21st-century pedagogy (Wei-Ping, Ping, & Si-Yuan, 2016). They suggest that the scale of pedagogical improvements offered and provided by MOOCs has been modest with mixed results regarding successes in meeting the needs of the diverse and changing forms of learning. This report will attempt to list best practices and target the advantages of MOOCs as a valid means for online teaching and learning.

There is no doubt that creating a well-designed MOOC is an interdisciplinary effort emanating from the input of various specialties and disciplines. While this report strongly advocates for the creation of MOOCs as yet another opportunity in this day and age to democratize teaching and learning, it also assesses the ways in which MOOCs could be more successful in doing so. In that sense, the goals for this paper are twofold. One is to describe the approach to utilizing different analyses to assess the success of a MOOC, with some comments on the variety of aspects of this methodology. Basic types of analytics used and their purpose in assessment of a MOOC are described then illustrated in this paper. These include descriptive, diagnostic, predictive, and prescriptive analytics. In addition, the authors also evaluate the overall design, user experience and satisfaction of a MOOC course offered by the United Nations Environment Programme and delivered by Concordia University. A plethora of information rising from learners' interactions with each other, the system, and the content is included in this report.

The data collected for this report was based on:

- Registration information retrieved from the Open EdX Platform, which was the MOOCs Learning Management System (LMS);
- Results of the online Likert survey questionnaire delivered to all participants at the end of the course offering;
- Predictive multivariate statistical analytics;
- Google Analytics reports;
- Qualitative, open-ended comments from users/learners;
- Final report from the Implementation and Support System (ISS) Officer responsible for student correspondences.

The following variety in data was collected and analyzed to contribute and ensure the comprehensiveness of this evaluation report.

Descriptive Analytics

Descriptive analytics inform the reader what has happened such as past action. In that respect, they give hindsight. They provide the stakeholders with real life data on what has happened. Descriptive analytics could be helpful in revealing patterns. They might be helpful when used alongside diagnostic analytics to reveal predict or even recommend best practices. In this report, descriptive analytics were extracted from three different sources: the learning management system (LMS), Google analytics (GA), as well as survey questionnaire submitted electronically to all users.

a. Enrolments. According to the Open EdX Platform data report, the number of enrolled students: 3117

b. Certificates issued. According to the Open EdX Platform data report, the number of certificates issued: 278

According to the platform registration data and the difference in the number of certificates issued, the attrition rate was: 91.08 percent. This low completion rate is typical for MOOC courses because users tend to exit for multiple reasons. Survey data indicate that users quit the course because of lack of time, or simply because the course did not serve their interest. However, the exit survey numbers completed in this round are very small (N=3). Hence, the results are inconclusive.

c. Age. Based on the Google Analytics reports, the age of users who are producing traffic on the website are as follows:

Age Range	Percentage
25-34 age range	35%
35-44 age range	19%
45-54 age range	12%
18-24 age range	21%
55-64 age range	9%
65 plus age range	4%

Table 1. Age of Users

It appears the majority of users are around 25- 34 years. Also, survey reports answered by 218 participants indicated that 1% of users are under 17 years old.

d. Gender. Based on the Google Analytics reports, 60 percent of the traffic is done by female users while male users appear to be doing 40 percent of the traffic.

e. Referrals. Google Analytics reports shows most of the traffic (75 percent in total) is coming from direct course link (users typed in “environmentacademy.org”) and through organic search results (users clicking on “environmentacademy.org” from search results). Twenty-five percent of the traffic appears to be coming from referrals, such as third party websites and social network sites.

Six percent of the users' traffic from the 25 percent total referrals (social network sites referral and third party referrals) appear to be coming from Concordia website, amounting to 1.5 percent from the overall traffic.

In addition, 5 percent of the overall traffic appears to be coming from social network sites. From those, 77 percent seem to be coming from Facebook, 14 percent from Twitter, 6 percent from LinkedIn and 3 percent from Pocket. This corresponds to the following: 3.85 percent overall traffic appear to be coming from Facebook, 0.7 percent overall traffic from Twitter, 0.3 percent overall traffic from LinkedIn and 0.15 percent overall traffic from Pocket.

f. Top 10 countries. Based on the Google Analytics report, the location and percentage of traffic from users appear to be originating from the following top 10 countries:

Country	Percentage
Canada	12%
Kenya	9%
USA	8%
Philippines	7%
UK	4%
India	3%
South Africa	3%
Mexico	3%
Australia	2%
Latvia	2%

Table 2. Top 10 Countries

g. Education background. Based on the survey reports when participants were asked: *What is the highest degree or level of schooling you have completed?* 217 participants answered as follows:

Schooling Degree	Percentage
High school	5%
College degree	5%
Trade/technical/vocational training	3%
Associate degree	1%
Bachelor’s degree	35%
Professional degree	4%
Doctorate degree	12%
Other	2%

Table 3. Highest Degree of Schooling

It appears the majority of users (more than 80%) completed a higher level of education. The majority of users completed a Bachelor's Degree or even a Master's Degree.

h. Employment status. Based on the survey reports, when participants were asked*: Are you currently…?* 212 answered as follows:

Employment Status	Percentage
Full-time employed	46%
Part-time employed	14%
Self-employed	12%
Student	21%
Retired	1%
Professional degree	4%
Out of work	3%
Other	3%

Table 4. Employment Status

It appears that the majority of the users (60%) were full-time employed or part-time employed.

i. Specialties. Based on the survey reports, when participants were asked: *What is your education/work specialty?* 210 participants answered as follows:

Specialty	Percentage
Agriculture and natural resources	25%
Engineering	13%
Social sciences and history	5%
Biological and biomedical sciences	11%
Education	12%
Business, management, marketing	10%
Out of work	3%
Other	24%

Table 5. Education and Work Specialties

It appears that almost half of the users have a specialty in the sciences since 25% of users came from Agriculture and natural resources field, 13 % from Engineering, 11% from biological and biomedical sciences

h. ISS officer feedback. In this section, all comments and encountered difficulties from users that contacted the help desk are compiled via a theme-based analysis. The salient categories of comments are as follows:

1. Technical issues. Upon reviewing the file of students who contacted the support services for help, 17 students reported encountering technical issues influenced by the

learning system. Examples of these technical problems were printing the certificate, errors posting on the discussion board, and issues viewing pins on the interactive map.
2. Course navigation. 12 students experienced difficulties navigating the course or misunderstanding the procedures to obtain their course grade. Also, students contacted the support services because they were unsure how fast to progress through the course, and some misunderstood that the final exam was open for the duration of the course (not on a specific date). Other students found the interactive map to be complicated and overloading with information (not enough filters).
Last but not least, some students had trouble finding the following in the course: where to view and print their certificate and where to register for the MOOC.
3. Missing required technical configurations. Missing plug-ins and slow Internet connections were reported to support services by eight students. These issues afforded the users a lower level of quality and accessibility to course components.

Diagnostic Analytics

Diagnostic analytics inform and give stakeholders insights and in-depth exploration of what has happened and specifically why it has happened. The result usually is an analysis report. Diagnostic can sometimes be combined with descriptive analytics to reveal predictive or even prescriptive analytics. Diagnostic analytics inform the readers why things have probably happened in the past.

For this specific MOOC, diagnostic analytics were extracted from the online survey distributed to all participants to explore the perceptions of the users towards global course effectiveness, courses ease of use, quality of course content, application of knowledge gained from course content, technical issues faced during course, affordances of online and open course accessibility as well as gathering open comments.

a. Global course effectiveness. According to the survey results, when students were asked about their perceptions of global course effectiveness, the majority had a positive experience (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following statements related to courses global course effectiveness were as follows:

1. Excellent course. More than 96% agreed or strongly agreed that this course was excellent overall.
2. Increased knowledge. More than 99% agreed or strongly agreed that overall, their knowledge of the subject matter has increased because of this course
3. Recommend to others. More than 98% agreed or strongly agreed that they would recommend this course to others

b. Course's ease of use. According to the questionnaire results, when students were asked about their ease of use in manipulating the course, the majority agreed that they had a pleasant experience (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following individual statements related to course's ease of use as follows:

1. Navigation. More than 94% agreed or strongly agreed that they understood how to navigate the course's format from the beginning.

2. Clarity. More than 97% agreed or strongly agreed that the course content was designed and presented in a clear manner.
3. Presentation. More than 97% agreed or strongly agreed that the overall presentation of the course content was helpful to them.
4. Support. More than 95% agreed or strongly agreed that the Help and FAQ pages were useful.

c. Quality of course content. According to the survey questionnaire results, when students were asked about their perception of quality of the course content, the majority perceived the course content to complete the course as useful (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following statements related to courses quality of course content as follows:

1. Course objectives. More than 99% agreed or strongly agreed that the course objectives were clearly stated at the beginning of the course.
2. Course outline. More than 97% agreed or strongly agreed that the course outline was concise, complete and included all of the information relevant to the course.
3. Knowledge quests and module quizzes. More than 93% agreed or strongly agreed that the knowledge quests and module quizzes helped me pass the final test
4. Discussion board. More than 85% agreed or strongly agreed that the Discussion Board facilitated and added to the interaction between students
5. Interactive map. More than 80% agreed or strongly agreed that the Interactive Map was a very useful tool for the course.
6. Course materials. More than 91% agreed or strongly agreed that they saved the course materials (e.g. pdfs, study guides, etc.) to their computer for future reference.

In addition, when participants were asked: *which elements of the course was the most helpful to them*, 167 users answered as follows:

Course Elements	Percentage
Written components of the modules	72%
Study guides	56.89%
Resource sheets	50.90%
Lecture videos, clips, movies	69.46%
Discussion Board	24.55%
Interactive map	23.95%

Table 6. Written Components of the Modules

The majority of users seem to have found the written components of the module the most helpful (72% percent). They also found the lecture videos, clips, and movies helpful (69.46%) as well as the study guides and resource sheets (56.89% and 50.90% respectively).

d. Application of knowledge gained from course. According to the survey questionnaire results, when students were asked about their long-term knowledge gained from the course, the majority agreed they improved their knowledge on the

subject (Refer to Table 7 titled Composite Variable & Internal Reliability Results in the Appendix). In fact, 153 students answered the following statements related to courses their application of knowledge gained from the course as follows:

1. Work. More than 96% agreed or strongly agreed that they plan to use what they learned at their current work position.
2. Thesis. More than 69% agreed or strongly agreed that they plan to do their thesis (BSc, MSc, PhD, etc.) based on what was learned in the course.
3. Project. More than 79% agreed or strongly agreed that they plan to initiate a project based on what they learned.
4. Studies. More than 83% agreed or strongly agreed that they plan to use what they learned in their current studies.
5. Advanced course. More than 84% agreed or strongly agreed that they plan to pursue the advanced-level course.

e. Technical issues faced during course. According to the survey results, when students were asked about technical issues faced during course, the majority agreed they did not face many technical problems (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following statements related to technical issues faced during Course as follows:

1. Website. More than 98% agreed or strongly agreed that the course website was always available.
2. Personal computer. More than 86% agreed or strongly agreed that the computer used to access the course website had all the necessary software to run the materials.
3. Technical difficulties. More than 66% disagreed or strongly disagreed that they experienced technical difficulties that hindered their enjoyment of this course.

f. Affordances of Online and Open Course Accessibility. According to the questionnaire results, when students were asked about their perceptions regarding the affordances of online and open course accessibility, the majority agreed that it was important for this course to be free and accessible to all (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following statements related to affordances of online and open course accessibility, as follows:

1. No fees. More than 97% agreed or strongly agreed that it was important for them that there were no fees for this course.
2. Open access. More than 98% agreed or strongly agreed that it was important for this course to have open access.
3. Online learning. More than 99% agreed or strongly agreed that online courses are convenient and a flexible way to learn.

g. Qualitative open-ended feedback. With regards to the additional narrative from students regarding suggested improvements to the course or technical difficulties encountered while taking the course, the following results emerged from a theme-based analysis of the comments at the end of the questionnaire. The salient categories of comments are as follows:

Theme 1: No complaints to report. 79 students commented that there were simply no problems to report. Many praised the content of the course, saying it was thorough and enjoyable. Students also thanked and congratulated the contributors to this course asking for other similar classes to be created.

Theme 2: Complaints related to students' technological infrastructure. *Overall*, 20 users' comments fell under this theme. 13 out of 20 students reported having Internet connection issues due to their geographic location. Other students mentioned that they were logged out of the course frequently due to inactivity, and/or they lacked the software needed to view the course materials.

Theme 3: Recommended improvements. *17* students suggested course recommendations. The latter fell under two sub-themes: content-based, and technology-based improvements. Regarding content-based suggestions, students expressed the need to have more interaction between a subject matter expert and the students via the discussion board. Other students suggested that they would like the course modules to cover more geographical regions, and discuss more concepts related to the ecosystem sustainability. Technology-based recommendations included students suggesting to have the course more mobile-friendly, or to have an app to access the course via mobile phones. Improvements to the interactive map and discussion board were also suggested.

Theme 4: Complaints regarding technical issues encountered. 16 users' comments were regarding technical issues encountered. Users stated that the interactive map and discussion boards would not work properly on certain browsers and/or were not user-friendly. Other users commented that the certificate was hard to print, and some users had trouble with links or videos not loading.

Predictive Analytics

Predictive analytics inform the reader what is likely to happen and give foresight on trends, clusters, exceptions and the like. Predictive analytics explain what might have happened. For this specific MOOC, predictive analytics were extracted by applying multiple regression models to data derived from the online survey. In fact, predictive the factors impacting global course effectiveness were derived. Table 8 titled *Factors Impacting Global Course Effectiveness* in the Appendix displays the unstandardized regression coefficients (B) and its corresponding standard error, the standardized regression coefficients (β), R^2 and adjusted R^2. The adjusted R^2 value of 0.55 indicates that more than a half of the variability in global course effectiveness is predicted by the perception of the participants regarding how the course provided them with expert knowledge on the subject, how helpful the overall presentation of the course content was to them, the application of knowledge gained from the course and the advantages that online and open access learning offer to MOOC users worldwide.

Results showed that, for students, a positive impression of course effectiveness is most strongly predicted by how helpful was the overall presentation of the course content (β= .302, p<0.005), as well as the application of knowledge gained from the course (β=.258, p<0.001), with the advantages of online and open access MOOC courses (β=.257, p<0.001) and having expert knowledge on the subject(β=.249, p<0.001). For students,

perceptions of clarity of course contents (β= .082, p not significant), perceptions of how helpful the course quizzes and knowledge quests were with regards to learning the course material (β= -.009, p not significant), as well as how useful were the FAQ and help pages (β= .002, p not significant), their perceptions of the course's ease of use (β= -.110, p not significant), and perceptions of technical issues and mishaps faced during the course (β= .077, p not significant), did not predict a positive impression of course effectiveness.

Prescriptive Analytics

Prescriptive analytics usually consist of a list of recommendations to take to optimize the course. Prescriptive analytics pave the way for optimization. They determine subsequent actions to be taken. For this specific MOOC, prescriptive analytics were extracted from user feedback to make the course a better course. Recommendations emanating from user feedback included the following:

Recommendation 1. As the interactive map was a feature highly useful to 80% of the users, a tech recommendation needs to be added to that course element including optimal browser to be selected. In addition, more filters should be added to improve the search and to minimize the amount of "pins" found on the map. A standard picture size could also be embedded, so the dimensions of the post are all the same.

Recommendation 2. To have the certificate available to download as a PDF in order to have it in a good resolution

Recommendation 3. To include a more robust and clean FAQ embedding and adding to it issues related to possible technical issues faced

Recommendation 4. To better guide the students in terms of time management and progress updates, include an agenda with guidelines on which chapters to do each week

Conclusions and Final Recommendations

While online courses attract a variety of profiles, it is important to take into consideration the catering of these courses to employed individuals. 72% of the population who took this particular MOOC were either employed full-time or part-time or self-employed, making learning at unconventional hours of the day and the manageable chunking of content necessary to move along one's education path. Of course, in these regards, MOOCs allow for self-paced learning, from wherever and whenever. Progress tracking, chunking and small wins become thus essential to the design.

That being said, the MOOC was more than just fitted to the learner's schedule and learning style, it was relevant to their educational and career needs. It came at the right time with the right packaged information. This MOOC's analysis had overall learner satisfaction skyrocket, with more than 96% of learners agreeing or strongly agreeing that this course was overall excellent and more than 98% agreeing or strongly agreeing that they would recommend this course to others due to their increase in knowledge for having taken the course. Surveys, generally indicated that

learners are planning on using their newly acquired knowledge and that the expert knowledge transmitted was relevant to their field of work. The predictive statistical modeling thus went further by bringing the conclusion that this MOOC was more than just accessible, it was meaningful to users.

It is clear that the pedagogical formula, online design, and learning tools were supporting the meaning learners' found behind their knowledge acquisition. Future MOOC development will further explore the online features and functionalities to best maximize learning online.

Appendix

Composite Variables & Internal Reliability Results

Composites		Inter-correlation	Cronbach's α
Student-Related Composite Variables (N=153)			
Quality of Course Content		.154 to .591	.737
	M (SD)		
The course objectives were clearly stated at the beginning of the course.	3.65 *(0.49)*		
The course outline was concise, complete and included all of the information relevant			
The knowledge Quests and module quizzes helped me pass the final test.	3.41 *(0.61)*		
The Discussion Board facilitated and added to the interaction between students.	3.09 *(0.67)*		
The Interactive Map was a very useful tool for this course.	3.07 *(0.74)*		
I saved the course materials (e g pdfs, study guides, etc) to my computer for future ref.	3.47 *(0.62)*		
Average Composite Mean & SD	***3.38 (0.41)***		
Course Ease of Use		.222 to .588	.683
	M (SD)		
I understood how to navigate the course's format from the beginning.	3.44 *(0.58)*		
The Help and FAQ pages were useful.	3.30 *(0.55)*		
The course content was designed and presented in a clear manner.	3.56 *(0.54)*		
The overall presentation of the course content was helpful to me.	3.48 *(0.55)*		
Average Composite Mean & SD	***3.44 (0.40)***		
Application of Knowledge Gained from Course		.396 to .664	.836
	M (SD)		
I plan to use what I learned at my current work position.	3.50 *(0.58)*		
I plan on doing my thesis (BSc, MSc, PhD, etc) based on what I learned in this course.	2.89 *(0.90)*		
I plan on initiating a project based on what I learned.	3.10 *(0.77)*		
I plan to use what I learned in my current studies.	3.22 *(0.78)*		
I plan on pursuing the Advanced course.	3.32 *(0.80)*		
Average Composite Mean & SD	***3.21 (0.60)***		
Technical Issues Faced During Course		.258 to .450	.570
	M (SD)		
The course website was always available.	3.67 *(0.51)*		
The computer that I was using to access the course website had all the necessary software			
I experienced technical difficulties that hindered my enjoyment of this course.	2.90 *(1.01)*		
Average Composite Mean & SD	***3.34 (0.57)***		
Global Course Effectiveness		.700 to .719	.880
	M (SD)		
Overall, this course was an excellent course	3.59 *(0.58)*		
Overall, my knowledge of the subject matter has increased as a result of this course.	3.58 *(0.51)*		
I would recommend this course to others.	3.66 *(0.52)*		
Average Composite Mean & SD	***3.61 (0.48)***		
Affordances of Online Learning and Open Accessibility		.506 to .804	.834
	M (SD)		
It was important to me that there were no fees for this course.	3.71*(0.51)*		
It was important that this course had open access.	3.72 *(0.49)*		
Online courses are convenient and a flexible way to learn.	3.71 *(0.47)*		
Average Composite Mean & SD	***3.71 (0.42)***		

[1] Response measured on a four-point scale from strongly disagree (1) to strongly agree (4);

Table 7. Composite Variables & Internal Reliability Results

Predicted Variable: Students' Perceptions of Course Effectiveness (Composite)

Factors (including both Questionnaire Items and Composites)	*B*	*SE B*	*β*
The course content was designed and presented in a clear manner. [1]	.073	.092	.082
The knowledge quests and module quizzes helped me pass the final test. [1]			
The Help and FAQ pages were useful. [1]	.002	.078	.002
The course provided knowledge for experts. [1]	.183	.046	.249***
The overall presentation of the course content was helpful to me. [1]	.263	.086	.302**
Course's ease of use. *(Composite)*	-.132	.210	-.110
Application of knowledge gained from course. *(Composite)*	.207	.055	.258***
Technical issues faced during course. *(Composite)*	.065	.053	.077
Affordances of online and open access courses. *(Composite)*	.291	.077	.257***
R^2	.58		

*$p < .05$ **$p < .005$ ***$p < .001$
[1] Response measured on a four-point scale from strongly disagree (1) to strongly agree (4)

Table 8. Factors predicting composite variable of students' perceptions of global course effectiveness (N=153)

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Contact email: jihan.rabah@knowledgeone.ca

Toward the Cognitive Analysis of Non-Native Speakers' Handwriting in Japanese with iPad and LMS

Makoto Shishido, Tokyo Denki University, Japan
Rie Kudo, Tokyo Denki University, Japan
Nari Matsushima, Tokyo Denki University, Japan

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Abstract
Tablet computers have gathered attention in classrooms in Japanese university. Apple's iPad is the most popular among several varieties. BeeDance is a learning management system (LMS) for iPads created by a Japanese company to facilitate active participations of learners. The study was conducted at a Japanese university for learners who are not native speakers of Japanese. The learners' behaviors, stroke orders of hiragana, katakana, and kanji, and Japanese typing by keypad were observed. The future research possibilities for the analysis of cognitive understanding are introduced. In this paper, cognitive analyses of non-native speakers' Japanese handwriting are examined through the uses of BeeDance in classrooms.

Keywords: Japanese, handwriting, cognitive understanding, tablet, LMS

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Introduction

BeeDance is a Learning Management System (LMS) for iPad developed and sold by SCSK Corporation. Tokyo Denki University, School of Information Environment purchased 100 iPads and BeeDance system in April, 2015 and has been using them for English and Japanese language education. By using this system, we can ask questions from a teacher side and send files to multiple student iPads. In addition, students' iPad screen can be confirmed by the teacher or projected in the classroom through the projector, so students can check the answers among the students within the class.

First of all, we compare how the major LMS for the computers such as Blackboard Learn and the LMS for other tablets differ from BeeDance. In general, LMS has functions such as delivery and evaluation of teaching materials as course management in the same way, but BeeDance has several unique functions. In one of the image board functions, learners draw characters and letters by hand, and the teacher can observe how and what they do in real time. Moreover, with the text board function, it is possible to observe the dictation exercises by distributing video or audio files to the students' iPad, listening to the audio and filling in blanks, and observing the way the letters have been input when the students answer in real time. The function to observe the real-time response of BeeDance is not provided in other LMS currently used in general.

LMS for Computers

Blackboard Learn

Blackboard Learn, which is used by many universities around the world and is the largest LMS in the world, was developed in 1997 and has the functions of course delivery, communication engagement and content management. It has various functions ranging from preparation of learning content, assignment, management to learning evaluation, which is extremely useful. It also has an effective communication function for information sharing and notifications with students, which can be said to be a very useful LMS for improving education efficiency. For tablets and smartphones, Blackboard Mobile is on sale. The mobile version is a simple type for PC, and it does not have any unique functions.

Moodle

Moodle, an open-source e-learning platform developed by Martin Dougiamas in 1999, is a learning management system that helps create high quality online courses. It contains such functions as content management, creation, questioning and management of exercise in quiz format, functions, and Forum. Although it is possible to browse and use tablets and smartphones, since it was developed for PC, it does not have specialized functions for tablets.

Sakai

Sakai, released in 2005 under the assistance from the Andrew Mellon Foundation, is educational software developed by various universities and organizations around the

world, and has the function of class management. Delivery of teaching materials, confirmation of strengthening, submission of tasks, examination, etc. can be carried out and managed. Also, it has a bulletin board and chat function. As it was developed for PCs in the same way of Moodle, there are no special features for tablets or smartphones.

LMS for Tablets

eden LMS

Kraft Works' eden LMS is a cloud-type e-learning system that can be used not only for PCs but also for tablets and smartphones. Although it can create and distribute learning contents, it can be said that it is suitable for internal compliance education, new employee education, or store staff training from the background developed for enterprises. It lacks features for handwriting input which is a feature of tablets and smartphones.

Platon

Platon is a teaching material delivery, e-learning support system for PCs, tablets, smartphones sold by Logos Ware. It was developed for employee education to conduct conventional group training with e-learning, and seems not to be suitable for use at university. It is also impossible to observe the learning situation in real time.

Learning Ware

Learning Ware is a learning management system sold by Pro-Seeds. In addition to PC, tablets and smartphones are also supported. Although it has functions such as learning management and video distribution, it is suitable for human resource development and management of projects at companies rather than for school education. It has no function of handwriting input and learning situation observation.

BeeDance

General Overview

Examples of development of lectures using BeeDance and their effects are reported in Shishido et al. (2016). Regarding functions, BeeDance is an LMS developed specifically for the uses on the iPad, is completely different from the LMS for general PCs, tablets, and smartphones as mentioned in the previous section. Main functions include response, image board, text board, recording, and file sharing. In the following, we will introduce the features and application examples of each function, and also describe the unique features of BeeDance.

Response

With the response function, you can distribute the multiple choice questions (Figure 1) and descriptive questions all at once to the students, totalize the answers in real time (Figure 2), and project the results onto the projector. Everyone in the classroom can check the screens. For multiple choice questions, it is possible to create up to 5

choices. Immediately after answering, we can find out the comprehension level of the students. It can be used as a practice exercises like quizzes. In addition to questions, it can be applied to questionnaires as well. Furthermore, since it is possible to instantly show the result of the answers with a graph (Figure 3), the students can check the comprehension level of the whole class and the situation of their own answer. In the response function, after learning a word or grammatical matter, it can be used as a small test to check comprehension level. Fill-in-Blank type of questions is very effective for this function. Other LMS can also display questions of multiple choices and descriptive questions, however, displaying correct answers, showing graphs of correct answer rates, displaying response time and ranking (Figure 4) etc. are unique functions of BeeDance.

Figure 1: Response


Figure 2: Checking answers


Figure 3: Graphic Statistics

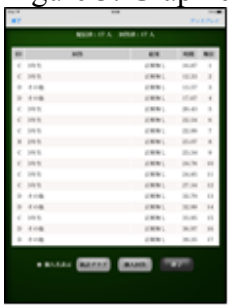
Figure 4: Ranking and Time of Response

Image Board

Like the whiteboard, the image board function can be used for handwriting by students on a blank screen. Questions created with the jpg files format including images, picture, and illustration can be delivered simultaneously and handwritten answers can be observed in real time. It is also possible to correct the student's answer from the teacher's iPad and project it to the screen in the classroom. As exercises using the image board, as vocabulary study, writing hiragana, katakana, and kanji by handwriting are possible (Figure 5). It is possible to use this function for drawing and answering the words of the part indicated in the illustration or paintings explained orally by the teacher. We can project the screens of the students to the whole class through the projector (Figure 6), and observe the situation of answering by handwriting in real time. We can also correct mistake or mark on the student's screen (Figure 7). These are unique features provided only on BeeDance.

Figure 5: Handwritten Answer


Figure 6: Viewing Responses of Whole Class

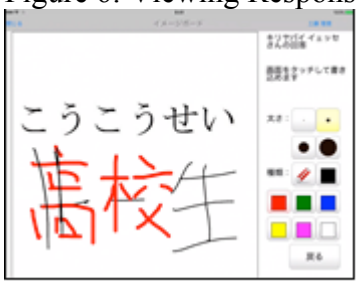

Figure 7: Correction on Student's iPad

Text Board

The text board function (Figure 8) can distribute questions using images, video, and audio files all at once. The students can answer them by keyboard input, and the teacher can check the response status in real time. We can correct student's answer from the teacher iPad and project it to the screen. The text board function can be used like a simple Language Laboratory (LL) device. As an example of utilization, it is

possible to transmit video and audio files together with fill-in blank questions, performing dictation exercises. Although any typical LMS have a function to deliver audio and video files and present a question, the function of observing the response situation in real time and sending the comments back to the students iPad can be unique only for BeeDance. (Figure 9).

Figure 8: Text Board

Figure 9: Teacher's Comment on Student iPad

Recording

The recording function allows students to save the voice uttered by students as a file. Also, they can submit the saved file by sending it to the teacher. For the utilization of the recording function, we can let each student record their utterance and let the other students listen to the recorded voice, make mutual evaluation of the pronunciation, and so on. Also, since some students do not like giving a speech standing in front of the classroom and presenting them in a form to announce them in front of the classroom, we can also let them submit their own speech with the recorded file and the teacher later opens the audio file. We can listen and evaluate their speech later.

File Sharing

In the file sharing function, it is possible to deliver and receive files between the teacher and students. Major files of MS-Office such as Word, Excel, PowerPoint, PDF, jpg file, etc. can be saved. We can also attach a file attached to a mail and send it, or we can link with files of photos and videos taken on iPad.

Analyzing Cognitive Understanding through BeeDance

Observation and Analysis of Learning Activities through Image Board

Observing Stroke Order through Image Board

As computers have become widespread, writing of letters by hand has been getting less used, but for the learners who learn Japanese as a foreign language, it is considered important to acquire the stroke order of hiragana, katakana, and kanji. Rather than learning characters like a figure, we understand the characters from various meaningful influences such knowledges as stroke order, radicals, phonological, graphonomical, and semantic. Learning correct stroke order is fundamental to writing activities (Tamaoka & Yamada 1999).

In the image board function of BeeDance, learners can write letters by handwriting, and the teacher can observe the situation in real time (Figure 10). Since there is a limit to observing the state of all the students during the lecture, we connected the teacher's iPad to the Mac PC and used the Quick Time recording function to record the whole situation of the activity. After the lecture it is also possible to observe the whole situation slowly (Figure 11).

Figure 10: Observing Stroke Order of Kanji


Figure 11: Viewing Responses of Whole Class

Cognitive Analysis from Observation of Stroke Order

In the case of international students from the kanji areas, there are no particular problems with respect to writing stroke of kanji, but those from non-Kanji areas seem to feel difficulties in understanding stroke order. Regarding hiragana and katakana, regardless of kanji or non-kanji areas, it seemed to be influenced by how those students learned basic Japanese. Those who received formal Japanese guidance seem to understand relatively correct stroke order, but those who have started learning Japanese by self-taught and who did not receive guidance of proper stroke order at the basic stage are ambiguous in stroke order. We have found some differences in understanding of Japanese characters based on these factors:

1. Where the students are from.

One of the students observed was from Taiwan. She was already familiar with kanji, had enough knowledge, and so she did not have big problems. On the other hand, the other three students in this experiment were from Indonesia and Finland and they were not familiar with kanji. They had big problems since they did not have enough knowledge necessary to understand kanji. However, hiragana and katakana seemed to be a little easier than kanji to learn the stroke order even for those students.

2. Formality of education

There were some differences in understanding of kanji between the students who learned Japanese formally and informally. Some students said that they have learned Japanese for the first time through reading manga, playing video games, or watching Japanese anime on TV. They did not receive any formal education of the Japanese language at the beginning. Those students seemed to have difficulties in understanding stroke order and made mistakes rather often. On the other hand, those who receive formal education of the Japanese language at the beginning did not seem to have major difficulties in writing. They have acquired correct orders of stroke from the beginning.

Observation and Analysis of Learning Activities through Text Board

Observation of Learning Activities through Text Board

With the text board function, we can ask dictation format questions to fill in blanks with video. When students answer, they use keypad to input characters. At that time, it is possible to observe the state of character input by each student in real time. (Figures 12 and 13)

Using the keypad, it is possible to observe and record what kind of difficulties the learners have when entering Japanese, such as conversion from Roman alphabet input to hiragana and katakana, selection of errors and typos in converting to kanji. As an example actually seen, it seemed that trial and error occurred when entering a loanword with katakana.

Figure 12: Typing

Figure 13: Over all

Cognitive Analysis of Observing Learning Activities

In the answer to the dictation type questions, when inputting the heard sound as a character, it was possible to observe the state of errors input from the influence of uncertain knowledge and mistakes in understanding. In terms of sounds, things that

cannot be entered accurately, even if they are used to listening, are noticeable when expressed in letters. From these aspects, it is considered that it is useful to use the text board to elucidate the cognitive understanding about character input.

Conclusion

As mentioned above, by using BeeDance, it is possible to observe various learning behaviors of learners in real time. As technology progresses in the future, behavior observation using tablets and LMS is expected to be useful for clarifying further cognitive understanding.

In conclusion, we can observe and analyze non-native students handwriting especially stroke of order through BeeDance. The recording with Quick Time is helpful for checking the response after class. We hope this method will help analyze student cognitive understanding of Japanese characters. However, we need further studies for this topic to clarify more details about cognitive understanding of Japanese characters by non-native speakers.

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Contact email: shishido@mail.dendai.ac.jp

Crafting Digital Strategies: Empathy, Technology and Design Education

Daniel Echeverri, College of Arts and Creative Enterprises, Zayed University, Dubai

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Abstract
"Designer of 2015", a report published in 2009 by the AIGA, generated a series of competencies for future designers and outlined the impact implementation of these competencies would have on the future of design education. Among these, the research mentions experiences, systems, and services as new trends in design education. These design competencies go beyond the creation of single design artifacts and into the creation of multilevel strategies. The value of these trends have been reinforced by the International Council of Design and the UK Design Council. Another consideration in designer competencies is empathy. Endeavoring to embrace empathy as a valuable design tool has gained importance in design education. Empathetic design as a design process, adopts the understanding of people (*users*), not only based on their specific needs, but also in their relational contexts, constraints and general understanding of their world.
This paper will focus on the work created by students from several design courses at the College of Arts and Creative Enterprises at Zayed University in Dubai. In these courses, empathetic design was used to develop strategies that rely on the creation and use of technology with outcomes such as mobile applications, digital visualizations, or even gadgets. The student's projects were classified under three categories: empathy through game mechanics (*gamification*), empathy through business models (*monetization*), and empathy through digital companions (*facilitation*). The three categories were defined based on patterns found in student work submitted in the past two years. The works presented here show that project-based learning and empathetic design allow students to conceptualize complex strategies that solve specific user needs. The outcomes will be discussed in this paper, as well as the implications of students as generators and creators of new technology and mediums instead of being only technology consumers.

Keywords: Empathy, Design Education, Interaction Design, Digital Media

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Introduction

By definition, design seeks to solve specific problems through the use of creative means, while conceiving purposeful solutions. These creative means divide design from other practices as they are acquired by students in workshops and studio courses. This *"studio"* approach is originally based on the curricular structure defined by Walter Gropius, director of the Bauhaus in 1920's. During this era, the center of all learning activities was the notion of "building". Students experimented with basic concepts such as color, shape and material in the first year of training and then moved into specific skills by executing practical work at workshops and studios directed by Johannes Itten, Paul Klee, Josef Albers and László Moholy-Nagy **(Fig. 1)**. This type of formative training encouraged students to present their own designs, while moving away from the idea of copying from models and being repetitive apprentices. However, design education has evolved greatly since the times of Gropius and several pedagogical models and methods, have appeared based on different cognitive theories.

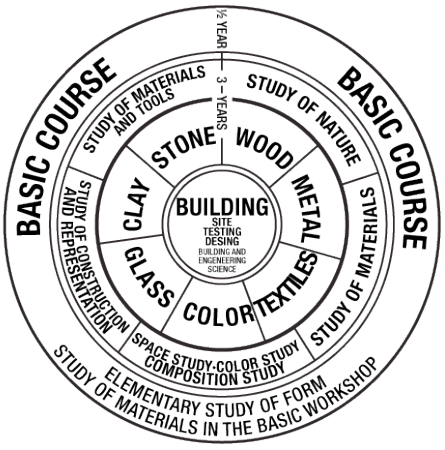

Figure 1. Diagram of the Bauhaus design curriculum. Graphic adapted from *Design and Form: the Basic Course at the Bauhaus* by Johannes Itten (1936).

In a recent survey, Maya and Gomez presented a compilation of contemporary teaching models used in design education that reveal a diversity of methods used in the education process. (Maya & Gomez, 2015). Some of these models have epistemological origins such as *Situated Learning*, based on interactions between the learner and the environment, or *Systems Thinking* that seeks to explore nonlinear thinking starting from the evaluation of complex problems and then onto each of its elements (Brown et al, 1989, Park & Benson, 2012). Other models are based on educational trends like *Learning by Doing*, based on the reflection of outcomes and stimulating iterations of a single solution, and *Problem Based Learning*[1] where knowledge is acquired by the student as needed. (Trowsdale & Clark, 2013, Ovesen, 2013). Other educational models have origins in art practices, neurological studies, or engineering (Maya & Gomez, 2015).

Independent from its origins, the future of design education presents challenges as the practice is rapidly shifting and being heavily influenced by technology, new macro-economic trends, and cultural paradigms (Bennett & Vulpinari, 2011). These challenging aspects impacting design education account for the changes that need to be addressed: moving from artifacts to services and experiences, but also adapting to

[1] According to Ovesen (2013), *the problem-based learning model encourages the students to take a rather active role in organizing their own time and study activities. It also forces them to independently track down the specific literature and other sources needed in order to work their way around the given tasks and thereby meeting the learning goals of the particular semester.*

new contexts (Dubberly, 2011). This is leading to a multidisciplinary approach, where the design student becomes a strategist able to think in artifacts created for the digital realm (screens, multimedia, and dynamic content), but also taking into account the experience of the human user.

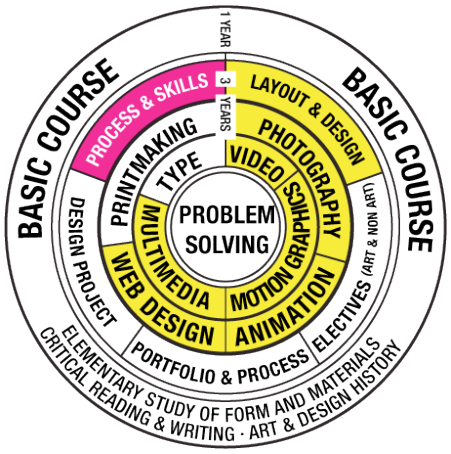

Figure 2. Current design curriculum. Adapted from *Big Bang technology: What's next in design education, radical innovation or incremental change?* Fleischmann (2015). In yellow subjects that relate to technology. In magenta, empathy inside design process and skills.

This approach was briefly described in early 2009 by the AIGA in their *Designer of 2015* article, a report that outlined a series of competencies relevant to future designers. Among them were the ability to use basic design principles, such as typography, hierarchy and the capacity to solve problems based on research by using prototypes, and other means of testing. The article highlighted the importance of having an empathetic user-centered approach in which the solution is related to cognitive, social, cultural, economic, and technological contexts. Technology has particularly impacted design education, and this is reflected on the way design programs have been expanded in the past 15 years to include subjects related to technology and new media **(Fig. 2)**.

For this paper, a *Digital Strategy* is defined as a design concept in which technology facilitates a specific task. This way, the intention is not for the student to create just the mockup and application of the technology, but to understand the user, the needs, the technological requirements, the outcomes, and the real-world application of the idea. Considering this, three types of technology-centric empathy modes are presented: *Game Mechanics*, in which students generate empathy through mobile games. *Business Models,* in which empathy allows the student the creation of a business concept that involves a digital medium. The last strategy is *Digital Companions*, which facilitates empathy when the student generates an idea that fulfils a specific user need by operating virtual assistants.

Empathy Modes: Crafting Digital Strategies

Gamification: Game Mechanics

There is a growing interest in the design industry in the creation of games as a way of fostering awareness to specific social and cultural issues instead of just having an entertainment purpose. This, according to Belman and Flanagan (2010), empathetic games challenge *players' social or political assumptions by allowing them to "see" events or topical issues from perspectives other than their own*. For this empathy mode, design students consider the dynamics of play while thinking about the player's decision making process. An important factor in this empathy mode is that games are more effective when there are similarities between the players and the characters in the game. This in particular is exemplified in *Healthy Gobble*, a game designed for mobile devices by Maryam Alsuwaidi, and in *Pet Dash*, by Sarah Almatrooshi. Both

projects were developed as the final exercise of the *Information Design* course that sought Graphic Design students to visualize and convey complex information while generating empathy through the use of technology. This was a joint exercise with the *Planning and Evaluation in Health Promotion and Health Education* course. This course is offered by the College of Natural and Health Sciences at Zayed University to students of the Public Health and Nutrition program. The Information Design students based their game concepts and prototypes on semester-long research shared by the Health Promotion students that sought to identify and understand common health problems in the UAE such as obesity, high blood pressure and diabetes.

The purpose of *Healthy Gobble* is for young children with diabetes or at risk of diabetes, to learn about the benefits of having wholesome meals and learning to identify and avoid junk food **(Fig. 3)**. The game mechanic is simple; the player must "gobble" fruits and vegetables while skipping hamburgers and donuts falling from the sky. The healthier the food consumed; more points will be awarded to the player while food increases its falling pace **(Fig. 4)**. The student also included in this game three play modifiers: one booster that allows the player to earn additional points, a time modifier that adds additional play time to the level, and a bonus points booster that duplicates the amount of points earned. Each booster is specifically related to a diabetes care task, such as measuring glucose levels, or having insulin shots **(Fig. 5)**. The player also learns about the benefits of a healthy diet every time they complete a level unlocking new fruits or boosters.

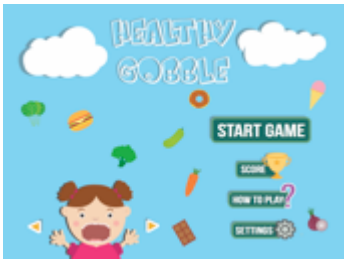

Figure 3. *Healthy Gooble.* Start Screen (Source: Maryam Alsuwaidi, Zayed University, 2016)

Figure 4. *Healthy Gobble.* Food description and point earning values.

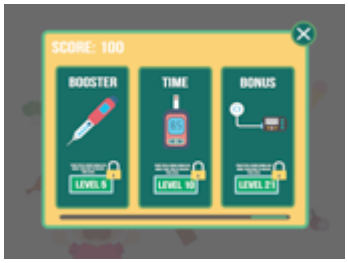

Figure 5. *Healthy Gobble.* Booster, time and bonus game modifiers.

Pet Dash is a game created to foster empathy to physical activity in children that combines a location-based gameplay and a digital pet. The pets are colorful and minimalistic creatures that mirror the physical activities carried out by the children when using their mobile phone or tablet. Upon starting the game, the user is asked to input their age, weight, height, and to give a name to their pet **(Fig. 6)**. Based on this, a new profile is created and the pet starts to live in its own virtual world **(Fig. 7).** The game keeps records of the physical activity by relying on data generated by the device's accelerometer and pedometer. It presents achievements based on the activity level of the user and daily walking distance recorded. The child's pet earns points based on its activity, which these points can be redeemed later for toys for the pet. This application presented the student the implications related to online privacy of children, their immersion with mobile devices, and the direct benefits and threats it brings to the underage users. It also generated a healthy discussion about the dependence of children on new technology and the importance of parents being

involved in the monitoring of their children's online presence. As a design concept, Pet Dash can be further explored as a way of fostering physical activity using augmented reality in a similar manner to other successful mobile games such as Pokémon Go or Tamagotchi.

Figure 6. *Pet Dash.* Pet Profile. (Source: Sarah Almatrooshi, Zayed University, 2016)

Figure 7. *Pet Dash.* Virtual World.

Monetization: Business Models

In this empathy mode, design students strategize about monetizing and generating revenue out of their ideas. This, not only reinforces their analytical abilities, but allows them to learn entrepreneurial skills. Gunes (2012) highlights the importance of including specific curriculum that prepares future designers with necessary managerial, economic and strategic thinking that allows a business to survive. This curricular addition could introduce basic concepts such as microeconomics, consumer culture, demand-supply, and pricing. According to Gunes, *entrepreneurship is an indispensable action or condition of design practice* (Gunes, 2012).

Lend A Hand is an application designed by senior student Afrah Shaheen, which seeks to facilitate the process of finding volunteering opportunities with NGOs in the UAE. This application was designed based on Afrah's own experience as she noticed the lack of a common platform to find and communicate with NGO's offering volunteer opportunities within the country. She conducted several interviews and discussions with other volunteers in order to understand their needs and of the different organizations **(Fig. 8)**. She developed a business model similar to those used in search engines in which advertisers or organizations in this case, pay for the publication of the event **(Fig.9)**. Organizations also had the possibility of paying extra for having featured or highlighted placement, priority placement in the search results, and the generation of customized notifications. Among other features of *Lend a Hand* was geolocation based results, and multiple ways of filtering data, including event date, location, and type of volunteering opportunity **(Fig. 10)**. The revenue generated by the publication supports the cost of tech support and traffic of the platform, which allows this service to be free for the users and have a low cost for the organizations. This project also featured an NGO web dashboard that allowed them to create and publish their ads, as well as manage specific information, such as geolocation targeting, administration of keywords, submission of push notifications, and picture sharing.

Figure 8. *Lend a Hand.* (Source: Afrah Shaheen, Zayed University, 2016)

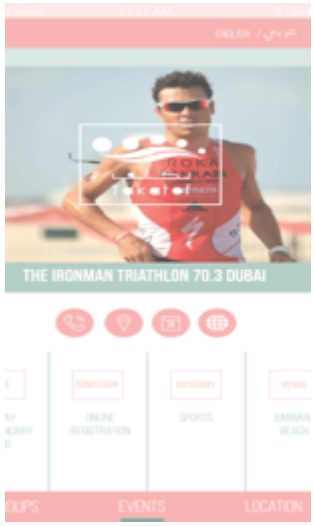

Figure 9. Event detail screen.

Figure 10. Search results filtered by location.

Facilitation: Digital Companions

In this empathy mode, the students consider digital tools that facilitate daily life while understanding the context of the user and its needs. Thanks to empathy, designers, for example, are now able to recognize health issues by experiencing simulations of the symptoms and conditions of patients and users, while grasping a better view of possible solutions. Being able to recognize the users' needs and contexts, facilitates the creation of effective design solutions. Institutions like GE Healthcare, the Cleveland Clinic and the National Institutes of Health, to name a few, are using empathetic tools to shape a holistic healthcare experience (Köppen, 2014, Cleveland Clinic, 2013, Carmel-Gilfilen, & Portillo, 2016). Among the benefits this holistic approach has brought to health care is the ability of a patient or a caregiver to monitor, record and track the evolution of a specific health condition using a mobile application.

Figure 8. Velcro in the finger joints to limit fine motor skills.

Figure 9. *W.R.A.P.* Apple Watch Application. Initial screen
(Source: Sarah Almatrooshi, Zayed University, 2016)

Graphic Design senior Sarah Almatrooshi created *W.R.A.P (Wrist Rheumatoid Arthritis Pal)* as part of her final project for Graphic Design IV, a studio course that presents the students with the necessary tools to apply empathy and design thinking to design projects. To understand this medical condition, the student developed a series of empathetic experiences that included the use of Velcro wrapped around the finger joins to limit the movement of the fingers **(Fig. 8)**. Later, the participants were asked to do specific tasks that required fine motor skills such as writing text on a piece of paper, using the keyboard of a mobile phone, opening a medicine bottle and button or unbutton a shirt. She used the Business Model Canvas (BMC) and Value Proposition Canvas (VPC)[2] frameworks to identify the specific needs and struggles of the user. At the end of the research, she conducted a series of interviews and had discussions with patients to further understand the issue and identify the context of application of the idea. By creating *personas* with different Rheumatoid Arthritis stages, Sarah developed an application for a wearable device that allows the patients to log their activity, generate reminders related to the medical treatment, and define specific goals **(Fig 9)**. The interface of this digital companion was designed considering the needs of the patient and its limitations with fine motor skills.

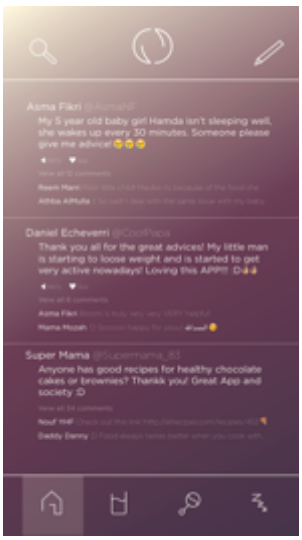

Figure 10. *Bloom.* Mobile forum for parents. (Source: Asma Fikri, Zayed University, 2016)

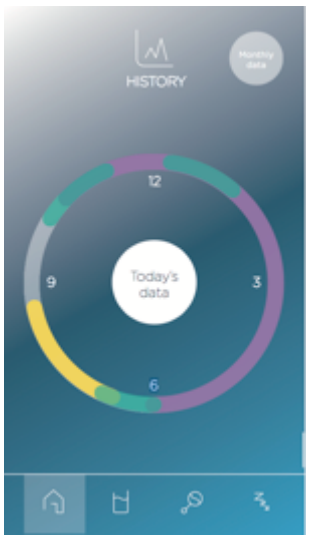

Figure 11. *Bloom.* Children information and progress tracking.

Bloom is another example of a digital companion, designed for parents whose child has weight problems. It was created by Asma Fikri as the final project of the Information Design course. This concept is based on the research presented by students from Health Promotion course and supported by a report that concluded that youth obesity in the UAE is two to three times greater that the international standard, having implications to public health policies in the country (Al-haddad et al, 2005). *Bloom* allowed parents to form a digital community in which they could discuss their parenting and find a support group **(Fig.10)**. It also included the virtual presence of health experts and pediatricians that could guide parents through their questions related to childhood obesity. This forum worked in a similar manner to other social media platforms in which the participants are able to "like", share and generate discussions towards specific health topics. This application also featured a set of tracking tools that included the evaluation of sleeping patterns and food intake **(Fig. 11)**. It also offered a minimalistic interface that presented complex

[2] Business Model Canvas (BMC) and Value Proposition Canvas (VPC) are frameworks designed for strategic management oriented towards the creation of business models. BMC is used to describe and design a business model while VPC seeks to understand the needs of a customer around produces and services. Both frameworks can be downloaded from https://strategyzer.com

data as simple interactive visualizations and graphics to facilitate the understanding of the evolution of the child's condition.

Discussion

The curricular expansion in design courses that include web design, video, animation, motion graphics, digital photography and multimedia courses has brought challenges to design programs as courses are "crammed" to teach all the skills a designer might need (Fleischmann, 2013). The packing of skills has a deep impact, because it prioritizes formal skills against other equally important skills, such as writing, theory, and history (McKnight, 2004). However, at the same time it presents an opportunity, as this type of hybrid multimedia designer can bring comprehensive solutions that are able to fit better in the needs of a market. These designers can generate unexpected results as they are more flexible about form and function than a traditionally educated designer. Empathy can act as the bridge between the digital and the human user. The digital realm relies on the creative ability to use and manipulate technology while the human one seeks to solve specific human-centered problems.

Empathy can allow the designer to widely understand the problem even when it is not design related; from health care, to business management to product marketing. This empathetic flexibility is innate to the design practice since, according to Richard Buchanan: *Design problems are 'indeterminate' and 'wicked' because design has no special subject matter of its own apart from what a designer conceives it to be* (Margolin, 1995). Empathetic design, an important component in Design Thinking, has been part of the latest expansion given to design curricula in the past years in schools and universities everywhere. In the specific case of empathetic design, this new skill is delivered to students as a component inside a course, in individual seminars or lectures, as part of a program unit or a combination of all of the above (Melles et al, 2012). Many schools mirror or base their Design Thinking courses on Stanford's design thinking pioneer D.School Bootcamp Manual, as it offers a simple and accessible *empathize-define-ideate-prototype-test* framework.

The empathy modes presented in this paper have emerged from the experience of the author in the implementation of technology oriented projects for design students to acquire or improve their creative skills. Technology continues to drive change in design schools, as it becomes more complex. New design students; those who can be digital visitors or digital residents[3], are able to grasp that complexity and generate sophisticated, yet compelling ideas. The projects presented here are a small sample of that. Crafting digital strategies require the collaboration between several disciplines; while designers transition into co-creators, those non-designers participants will be essential in the creative process (Echeverri, 2013). The use of any of these strategies in the classroom are oriented towards design projects that seek for the student to

[3] According to White and Le Cornu (2011), *the Visitors and Residents continuum accounts for people behaving in different ways when using technology, depending on their motivation and context, without categorizing them according to age or background.* This is a response to the criticized notion formulated by Prensky of new students being Digital Natives (*Our students today are all "native speakers" of the digital language of computers, video games and the Internet*) (Prensky, 2001). For the sake of this paper, the author believes the visitor/resident view fits better to the concept of students as generators of digital strategies.

improve creative skills on a project-based learning environment. The unpredictability of these projects, in terms of having open-ended results from an initial problem allow the students to widely to understand, discuss and engage it. These projects present a high level of complexity, for example, understanding arthritis, its symptoms and treatment, in order to develop a sense of ownership in the student and generate inquiries on their own (Helle et al, 2006). Major and Govers present a motivating conclusion regarding this: *projects are initiated and managed by the students, which is what distinguishes them from briefs or assignments. The students interact with the project tasks, in the sense that projects provide an opportunity for students to explore, experiment, and push boundaries* (Major & Govers, 2015). The creation of Digital Strategies based on empathy as a learning tool, aligns with efforts to stablish STEAM (Science, Technology, Engineering, **Art** and Mathematics) based-education and Project-based Learning initiatives that support active and deeper learning.

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Contact email: Daniel.Echeverri@zu.ac.ae

A Tree-Based Chart for Visualizing Programming for Problem Solving

Po-Yao Chao, Yuan Zu University, Taiwan
Yu-Ju Chen, Yuan Zu University, Taiwan

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Abstract
Programming for solving problems has been an important skill in computer programming education. However, most of the assessment for the skill tends to emphasize on the product of programming rather than the process of programming. Considering students' process of programming may gain insight into the understanding of students' difficulties and their performance, this study incorporates problem solving and visual programming activities to develop a programming learning environment where students interact with the learning environment to solve computational problems. By examining students' behaviors and strategies of problem solving exhibited in the environment, the process and product of students programming activities can be visualized with a tree-based chart. The features and patterns of the tree-based chart may indicate different combination of programming strategies and their effects on performance of problem solving. A case study was conducted to explore the patterns of the tree-based chart. The findings show that the patterns of the tree-based chart were categorized into three different types: accuracy, trial-in-error, and revision. The follow-up interviews were conducted to explore the relationships between the patterns, personal factors, and performance of problem solving.

Keywords: visual programming, tree-based chart, problem solving

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Introduction

With the advancement of computer technology, the computational thinking is more and more important (Grover & Pea, 2012). Learning programming is not only a skill but also can help individual improve their reasoning. Due to the importance of computational thinking, many counties advocate for the promotion of programming education in K-12 and childhood education. Moreover, it is believed that computational thinking is related with the development of logical thinking and creativity (Sáez-López, Román-González & Vázquez-Cano, 2016). In Liao and Bright (1991) meta-analysis, they analyzed 65 research about the computational thinking studies. Fifty-eight studies (89%) demonstrated that the computational thinking has a positive impact on the development of children's thinking abilities. Computational thinking is an essential skill for the 21st Century (Einhorn, 2011).

Learning programming is not easy for students because the programming is essentially a problem solving activity (Areias & Mendes, 2007). Programming requires not only basic knowledge of programming concepts and skills but also the ability of problem solving (Linn, 1985). Therefore, assisting students to learn how to formulate problems, analyze problems, and design workable solutions to the problem is important to programming learning. Because the concepts of programming is abstract (Muller & Haberman, 2008) and the syntax of programming language often involves complicated logics, novice learners hardly success in programming (Wilson & Moffat, 2010). Considering learning programming involves understanding abstract concepts, visualization of these abstract concepts may serve as a important tool in learning computational science (Brodlie et al., 1993). Since visualized programming learning environments may offer concrete and intuitive information, programming in these environments may help students comprehend abstract concepts and realize complicated logics when compared with traditional programming languages (Sáez-López et al., 2016).

Assessment is a process that uses information gathered through measurement to analyze or judge a learner's performance on some relevant work task. (Sarkees-Wircenski & Scott, 1995). The traditional programming education tend to more concentrate on the products of programming rather than on the process of programming. Considering students often exhibits strategies of problem solving in the process of solving programming problems, including measurement relevant to the process of programming may improve accuracy of assessment for students' programming abilities. Therefore, in this study, we develop a programming learning environment where students interact with the learning environment to solve computational problems. The environment containing a robot character with which students need to instruct the robot to solve computational problems with pre-defined graphical instructions. Students' behaviors and their use of graphical instructions were visualized and logged for further analysis. The logged data were employed to explore different dimension about the process of solving computational problems. For more detailed address in the state of problem solving, Gagne and Yekovich (1993) defined three different states of problem solving: starting, intermediate, and goal. In this study, the three different states were employed to depict students' process of problem solving in a tree-based chart. The chart aims to reveal different combinations of programming strategies and their corresponding effects on problem solving.

Method

To explore students' behaviors and strategies of problem solving, a case study was conducted to explore the patterns of problem solving in a visualized programming learning environment. The learning environment includes a computational problems and a set of pre-defined graphical blocks. As shown in Figure 1, to the right the graphical representation of computational problems. Students were asked to collect flowers or fruits with limited amount of graphical blocks. Students first create a base to edit instructions to a robot character, and then they can drag and drop graphical blocks to compose programs to instruct the robot to solve computational problem. The programming concepts needed to know for students to solve the problem include sequence, operator, conditional, loop, and variable.

Ten participants were asked to participate in the case study. They were classified in two groups, one is who have programming experience and the other is novice of programming. Participants were asked to solve two parts of computational problems: training and basic. At the beginning, the participants solve training problems that would help them get familiarized with the environment and the function of graphical blocks. After they finished the training problems, the researcher would verified that all the participants did not have problems in solving problems in the visualized programming learning environment. The participants were asked to solve basic problems that were harder and more complex when compared with training problems. Once a participant completed all the basic problems, he/she was given an interview. The interviews were recorded to explore different combination of programming strategies and the relationship between tree-based chart and user's performance.

We use the tree-based chart to visualize the process of the problem solving. The features of the tree-based chart reveal the pattern of problem solving. The features include depth, node number, density, instruction accuracy. The depth is the number of segmentation of the problem. The node number is the number of execution. The density is the accuracy of the problem solving. The instruction accuracy is the ratio of insert instruction and update instruction. The higher the value, the more accurate.

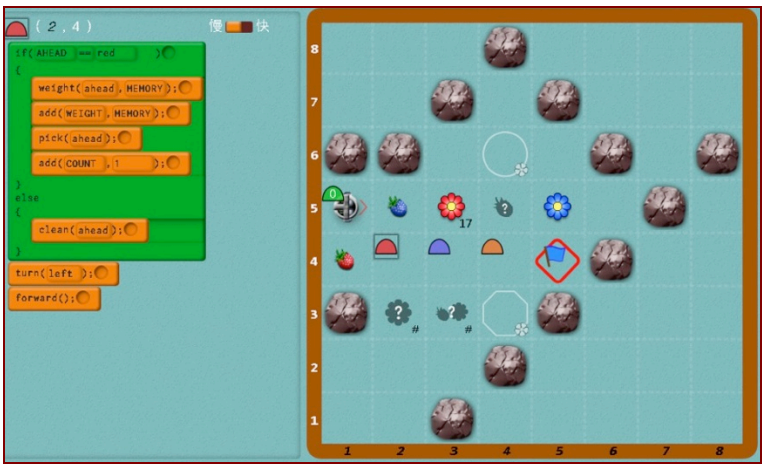

Figure 1: Example of Computational Problems.

Result

10 participants (4 competent users and 6 novices) in the case study, age about 20 to 30 years old. According to the features and pattern of the tree-based chart, the patters were categorized into three types: accuracy, revision, and trial-and-error (Figure 2). Different color of tree node in the tree-based charts represents different states of problem solving. The green, red, and blue node represent starting, intermediate, and goal state. When users execute the instruction of a base, the execution creates a new node in next layer representing the new state of the execution. Participants could back trace to the previous base on the map, which changes the state of problem solving.

Tree type	Depth	Node Number	Density	Instruction Accuracy
Accuracy	4	4	1	100%
Revision	5	7.5	1.5	91%
Trial and error	7.5	14.1	1.89	68%

Table 1: Participants' averages of problem segmentation, execution, and instruction accuracy in solving a computational problem.

Table 1 shows participants' averages of problem segmentation, execution, and instruction accuracy in solving a computational problem (Figure 1). Participants were divided into three groups: accuracy, revision, and trial-and-error. The accuracy group shows low density and high instruction accuracy. However, the trial-and-error group reveals high density and low instruction accuracy. The revision group demonstrates medium density and high instruction accuracy. To visualized participants' patterns of solving problems, the abovementioned indicators were transformed into tree-based charts (Figure 2). The accuracy tree-based chart features almost no branch, all degree is 1. The revision tree-based chart has small amount of branches around 2 to 3. Finally, the trial-and-error tree-based chart has large amount of branches.

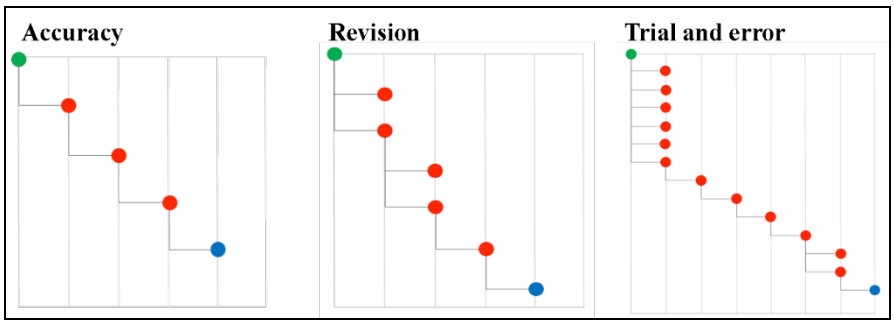

Figure 2: Types of tree-Based Charts

In the interview, we compared participants' problem solving behaviors between competent and novice students. In terms of problem segmentation, competent students tend to complete a series of steps, and then create a new base to solve the rest parts of the problem. For example, they pick up all of the flowers, then create a base to clean the grass. However, the novices tend to make many bases, because they want to minimize the number of instructions for each base. In terms of loop use, if competent users find something needs to repeat many times, they will use the loop to complete the problem. On the other hand, the novices seldom use the loop at the beginning. They will not use loop blocks until the amount of graphical blocks exceed the limit.

For debugging, competent users generally applied breakpoints to observe robot's behavior and perceived the breakpoints very useful for debugging. The novices rarely used breakpoint functions but always try many time to find the errors.

Though the interview and data, we can explore the relationships between the patterns, personal factors, and performance of problem solving. Some of the competent users tend to demonstrate accuracy features. They always had good strategies in the problem, so they seldom encounter mistakes. Their tree will like the step that was no branch. Their value of instruction accuracy was very high. Some of the competent users tend to exhibits revision features. When their instruction occurred an error, they would use breakpoints to debug. They can find error accurately, so they did not execute many times to find an error. Their tree would have some branch but not too more. Novices tend to trial and error. They executed many times in same instruction or made a lot of bases. So, the tree of novices will produce many nodes in the same layer or more depth than competent users.

Conclusion

The visualize programming learning environment seems effective to help learner learning computational thinking and promote their motivation to solve problems. Many users, especially novices, who think the environment allows him/her to learn the basic concepts of programming.

In this study, by examining students' behaviors and strategies of problem solving exhibited in the environment, the process and product of students programming activities can be visualized with a tree-based chart. The chart is easier to observe students' process of problem solving. For example, a tree has many nodes in the same layer may reveal that a student may have obstacle in understanding programming concepts when solving computational problems. The large amount of program execution may demonstrate that the student try and error many times. The features and the patterns of the tree-based charts may help teachers or students assess the performance of solving computational problems, which may gain insight into students' process of programming for solving problems.

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Across Disciplines, Cultures and Technologies: An Item Response Theory Approach to Assessment of Learning

Jenny Mei Yiu Huen, The University of Hong Kong, Hong Kong
Yue Zhao, The University of Hong Kong, Hong Kong
Paul Siu Fai Yip, The University of Hong Kong, Hong Kong

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Abstract

In the process of educating for change, we must strategically design assessment to examine how well our students are learning. This subject is important but easily neglected by educators or misrepresented in the education field.

This study applied the Item Response Theory (IRT), a contemporary psychometric approach that models the relationship between the response to individual items on a test and the underlying abilities being measured, to examine the psychometric properties of binary (true-or-false) question items designed to assess how much a sample of 209 Hong Kong Chinese students have learned in a web-based learning program accompanied with classroom teaching. The IRT analysis procedure was illustrated, from checking model assumptions, calibrating items to assessing goodness-of-fit.

Principal results of this study offered information for estimating item discrimination and item difficulty for each question item and provided test information to indicate how well the test contributes to the assessment of learning along a continuum ranging from low to high abilities. In this direction, the IRT approach offers useful information for design, diagnosis and revision of test items. For example, items with high discrimination are particularly useful and should be retained, whereas items with low difficulty are not particularly useful and could be considered for removal.

In conclusion, this study put forward an IRT approach that can be widely applied to design and modify test items such that assessment of learning can be better suited to the discipline, culture and technology in context.

Keywords: Item Response Theory; Assessment; Learning

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Introduction

With the emerging technologies in teaching and learning, such as digital instructional materials, holographic technologies, Massive Open Online Courses, online platforms, Radio Frequency Identification technology and social media (IAFOR, 2017), educators have been focusing the discussion on the usage of these technologies in the classrooms. A pertinent subject seldom being discussed and implemented rigorously by educators is the assessment of students' learning in response to the technology being used, the discipline being taught, and the culture in context. Assessment of learning informs educators how much students have learned or mastered and identifies the gap between intended learning goal and current level of learning (e.g. Mok, 2012). Students' abilities or learning have been measured through various forms of assessment, usually through tests (Chatterji, 2003). In this direction, educators should ensure that tests, especially those constructed by teachers for assessment and evaluation purposes, are rigorously constructed. Several psychometric approaches have been well established in the assessment literature which can enhance the psychometric properties of tests. Among them, Item Response Theory (IRT) is a contemporary psychometric approach that models the relationship between the probability of response to individual items on a test and the underlying abilities being measured by the test (e.g. Hambleton, Swaminathan, & Rogers, 1991). IRT could not only provide validation to large-scale standardized tests (such as GRE tests), but also provide valuable information for educators to enhance small-scale and locally-constructed tests.

Built on the above background, the purposes of this study were to apply IRT to examine and enhance the psychometric properties of the test questions of a small-scale knowledge test constructed for a web-based learning program accompanied with classroom teaching for Primary 4 and Primary 5 students in Hong Kong.

Methodology and Methods

The program

The program was designed to promote positive attitudes and values to local Primary 4 and Primary 5 students in Hong Kong. The contents covered in the program include brain-based learning strategies, emotional management skills, thinking errors identification, problem-solving skills, effective communication skills, active listening, thankfulness towards others, etc. The program was a combination of a web-based program (11 e-lessons in total) and classroom teaching (8 classroom lessons in total). The e-lessons were used to prepare students for the content of upcoming classroom lesson. During classroom teaching, interactive activities such as role play, group discussion and card games were used to facilitate the teaching and learning.

The test

The test consisted of 10 true-or-false questions assessing students' knowledge on the contents covered in the program. The test was administrated to students in a classroom session upon their completion of the whole program. The students were asked to decide whether each of the ten statements was true or not. One sample statement, translated from Chinese to English, is "Negative emotions, such as anger

and anxiety, are something which we should not have even to a mild extent.". For any correct answer, students would score 1 point and 0 for incorrect answers. Hence, they would be able to score a minimum of 0 point to a maximum of 10 points.

Participants

Participants in this study consisted of 150 Primary 4 students (M = 9.33 years, SD = 0.72 years) and 59 Primary 5 students (M = 10.10 years, SD = 0.30 years) who participated in the program, completed all the questions in the test, and gave consent to the use of their test data for research purpose. Thus, the sample size was 209 (Male = 99; Female = 110) for the analyses.

Analyses

In an IRT analysis procedure, the analyses conducted include: 1) checking model assumptions on test dimensionality, 2) fitting the two-parameter IRT model and calibrating item parameters, and 3) assessing goodness-of-fit. These analyses were conducted using SPSS Statistics Version 23.0 (IBM Corp., 2015) and IRTPRO (SSI Inc., 2015).

Results and Discussion

The descriptive statistics of test scores are reported in Table 1.

Table 1: Test Score Descriptive Statistics

Test Question	Descriptive Statistics (N = 209)			
	Response frequencies (%)[a]			
	1	0	*M*	*SD*
Question 1	94.3	5.7	.94	.23
Question 2	89.5	10.5	.89	.31
Question 3	85.2	14.8	.85	.36
Question 4	90.0	9.1	.91	.29
Question 5	42.6	57.4	.43	.50
Question 6	28.2	71.8	.28	.45
Question 7	50.7	49.3	.51	.50
Question 8	82.3	17.7	.82	.38
Question 9	96.7	3.3	.97	.18
Question 10	60.8	39.2	.61	.49

Note. N = sample size; M = mean; SD = standard deviation.
[a] Response score categories are: 1 = *correct response* and 0 = *incorrect response*.

The test score distribution for the 209 students had a mean score of 0.72 (1 point as maximum) with a standard deviation of 0.25. Over 90% of the students got Question 1, Question 4 and Question 9 correct. From the descriptive statistics above, some questions may be easy for students.

Unidimensionality of data is an important model assumption to be checked before fitting the data with the unidimensional IRT model. Results from exploratory factor analysis on our test data showed that the first eigenvalue and its percentage of total

variance explained were greater than that of the second eigenvalue (see Table 2), suggesting one dominant factor/dimension which accounted for about 20% of the variability. Further, from the scree plot showing the eigenvalues on y-axis and the number of factor(s)/dimensions(s) on the x-axis (Figure 1), the slope has its greatest level-off moving from 1 factor/dimension to 2 factors/dimensions, indicating that one factor/dimension should be generated by the analysis. The above findings provide evidence that the unidimensionality assumption has been met to a reasonable degree level by our test data. In other words, we can assume that there is a single unidimensional ability in common underlying students' test performance in a set of 10 test questions.

Table 2: Eigenvalues and its Percentage of Variance Accounted for

Factor(s)/ Dimension(s)	Eigenvalue	% of variance accounted for
1	1.94	19.42%
2	1.32	13.21%
3	0.93	9.31%
4	0.87	8.66%
5	0.95	9.51%
6	0.91	9.06%
7	0.77	7.66%
8	0.77	7.74%
9	0.80	7.99%
10	0.74	7.44%

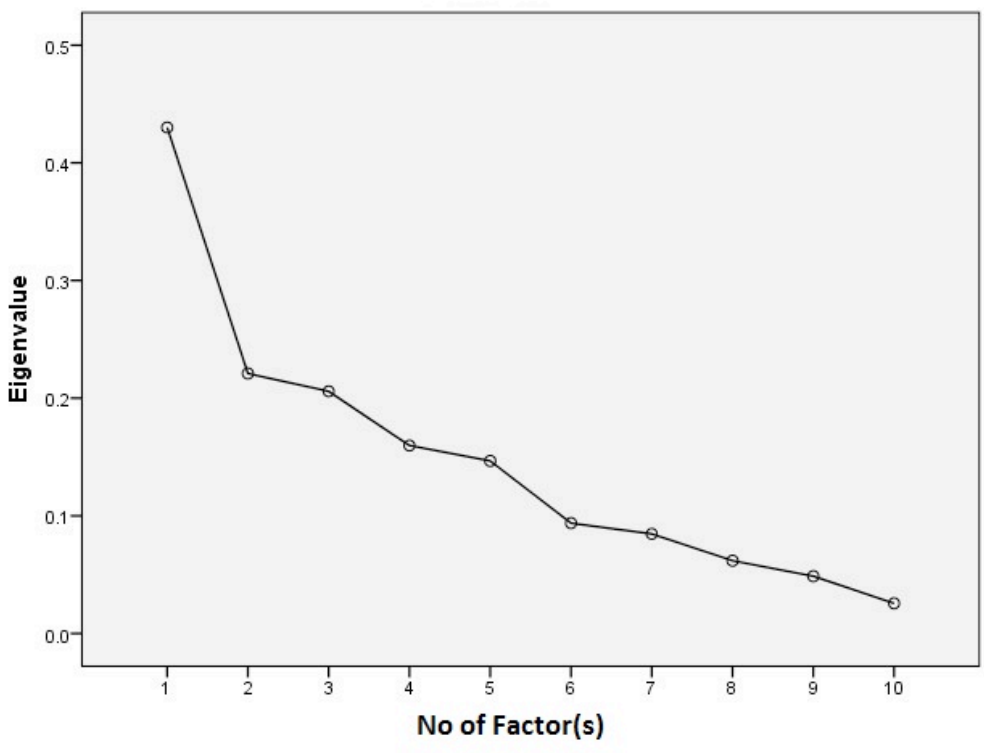

Figure 1: Scree Plot of Eigenvalues against Number of Factors.

The two-parameter IRT model (item discrimination and item difficulty as the two parameters being estimated) was then fit to the test data. The estimates obtained after item calibration are reported in Table 3. Item discrimination (denoted by *a* values in Table 3) addresses how well a test item can differentiate between students at different ability levels. The higher the item discrimination, the better the item can differentiate between students at different ability levels (such as low, medium and high abilities). From the results, the discrimination estimates range from -0.13 to 1.91. Item 1, Item 2, Item 4 and Item 9, are particularly low in discrimination, that they cannot differentiate well between students at different ability levels. Item difficulty (denoted by *b* values in Table 3) taps the difficulty level of a test item to the students. From the results, Item 1, Item 4, and Item 9 are very low in difficulty that these test items can be expected to be answered correctly by most students. This is consistent with the observation that over 90% of the students got Question 1, Question 4 and Question 9 correct (refer to Table 1). In summary, there are items in our test identified to be low in discrimination and difficulty. Considerations could be made to remove these items or revise them accordingly to enhance the psychometric properties of the test.

Table 3: Item Parameter Estimates.

Test Item	Item Parameter Estimates	
	a	*b*
Item 1	0.19	-14.78
Item 2	-0.13	16.58
Item 3	1.40	-1.66
Item 4	0.34	-7.01
Item 5	0.99	0.36
Item 6	0.78	1.35
Item 7	1.20	-0.03
Item 8	1.73	-1.31
Item 9	0.34	-9.94
Item 10	1.91	-0.36

Note. *a* = item discrimination; *b* = item difficulty.

An item level fit ($S{-}\chi^2$ statistic) statistic for each item are reported in Table 4, which served as evidence of model fit. Results showed that model fit (*p* at the .01 level) was good except for Item 8. This item could also be considered for removal or revision for a better model fit.

Table 4: Model Item Fit Statistics.

Test Item	Model Item Fit Statistics		
	χ^2	*df*	*p*
Item 1	4.69	4	0.32
Item 2	4.64	5	0.46
Item 3	11.81	4	0.02
Item 4	6.75	5	0.24
Item 5	8.70	4	0.07
Item 6	6.97	4	0.14
Item 7	2.90	4	0.58
Item 8	15.84	3	0.00
Item 9	2.44	3	0.49
Item 10	4.53	4	0.34

Note. χ^2 = Chi-Square; *df* = degree of freedom; *p* = probability.

The test characteristic curve (Figure 2) and the test information function with standard error of measurement (Figure 3) serve as a good summary of the test information. As observed from the test characteristic curve, the average student (theta = 0) could be expected to achieve a score about 70% on the test, whereas students of lower ability (theta ≈ -1.5) could be expected to achieve a score about 50% on the test. The test was thus generally easy for students. From the test information function with standard error of measurement, it can be seen that the test was providing a good level of measurement (i.e., high total test information and low standard error of measurement) for students performing from about .5 *SD* to 1 *SD* below the mean. The test may be improved in the future by replacing easy items with more difficult items which can provide good discrimination for students in the upper half of the test score distribution.

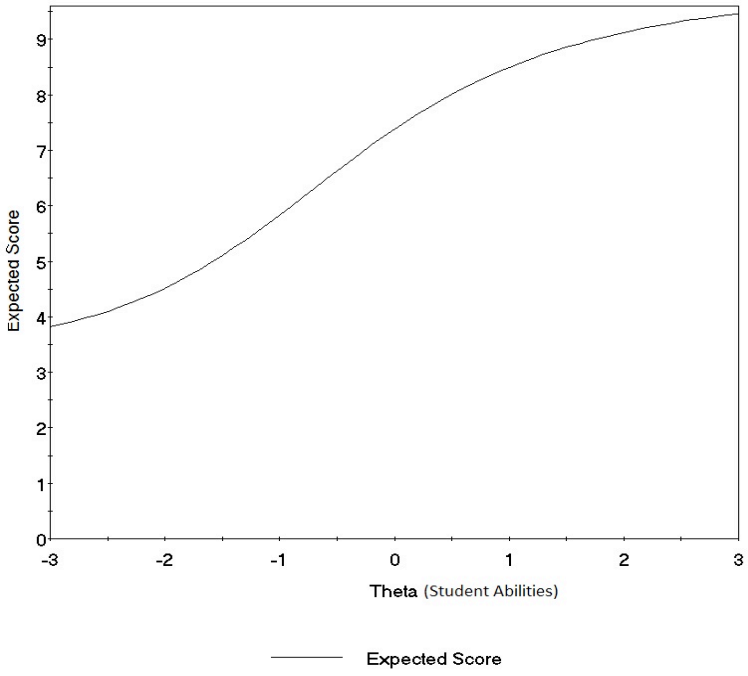

Figure 2: Test Characteristic Curve.

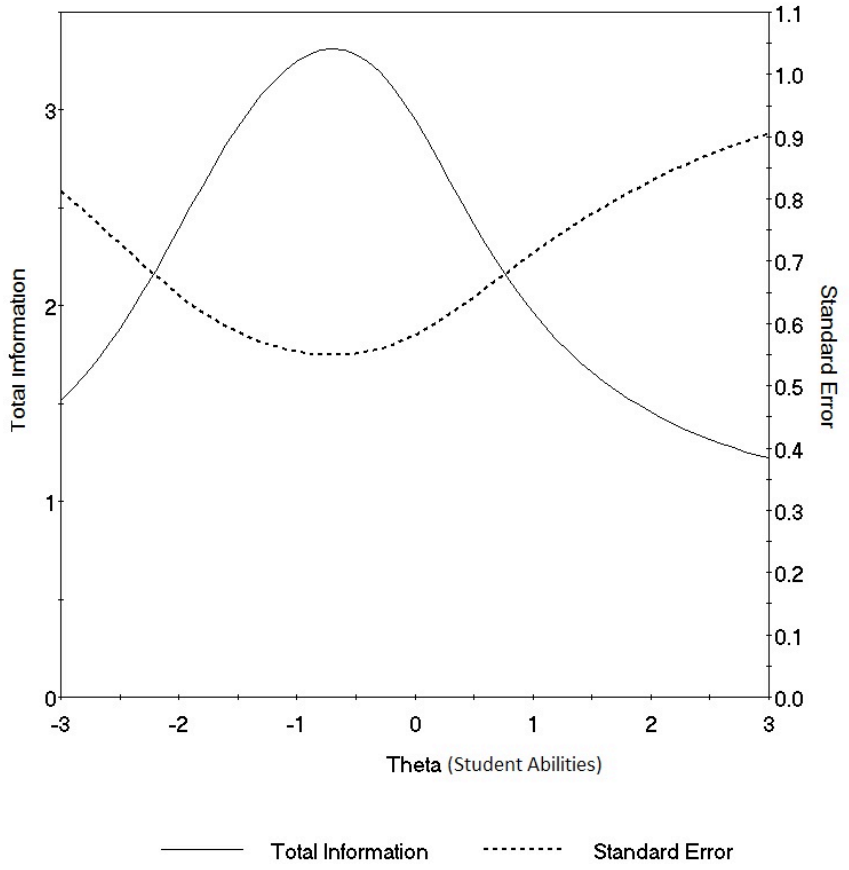

Figure 3: Test Information Function with Standard Error of Measurement.

Conclusion and Limitation

This study made use of an IRT approach to examine the psychometric properties of the test questions of a locally-constructed and small-scale test. It was noted that very few studies in the education field have focused the study on this subject before, especially in the local context. One exception was a study by Yao and Mok (2013) which applied the Rasch Model, a special kind of IRT model that estimates discrimination parameter for each item while keeping discrimination equal across all items, to develop and improve a locally-constructed Mathematics test to inform teaching and learning.

In this study, the IRT analysis procedure was illustrated with sufficient detail to make it possible for replication in other similar tests. Principal results offered useful information for design, diagnosis and revision of question items. Items with low discrimination and low difficulty were identified. These items were not particularly useful and could be considered for removal for revision. However, given the limitation of small number of test items in this test (only 10 items in total), loss of items could not be afforded. Yet, should there be revision to any of the test items, another iteration of IRT analysis procedure is required.
To end with, this study puts forward that the IRT can be widely applied to assessment of learning, across academic disciplines, cultural populations and emerging technologies.

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Contact email: jennymyhuen@connect.hku.hk

The Use of Sibelius Software in Learning Counterpoint at Music Department of Indonesia Institute of the Arts Yogyakarta

Oriana Tio Parahita Nainggolan, Indonesia Institute of the Arts Yogyakarta, Indonesia

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Abstract
As a subject for Music students, Counterpoint contributes to the ability to create a melody. Students must pay attention to the rules applied in counterpoint when they make a melody. It considers the flow of the melody in vertical and horizontal line (interval) and a musical texture of the melody. In making counterpoint melodies, students spent a lot of time to follow the rules of the interval, and they particularly do not pay attention to the musical texture of the melody, so it makes the melody lose its musical senses. This study will examine the use of Sibelius software in learning counterpoint at Music Department, Institut Seni Indonesia (ISI) Yogyakarta. An observation and interview were used to collect the data. The result of this study is that by using the Sibelius software, the work of making counterpoint melody would be said more efficient, and it also gives an opportunity to the students to consider a musical texture of counterpoint melody after working with the rules of counterpoint. The conclusion can also be drawn that by using the Sibelius software, students still have a lot of time to practice in making the counterpoint melody so that they become more skillful in making the counterpoint melody.

Keywords: Counterpoint, Melody, Sibelius Software

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Background

In the western classical music tradition, music theory concerning about the construction and combination of melodies. There are two similar subjects that deal with the construction and combination of melodies: Harmony and Counterpoint. Harmony concerns with the construction and combination of melodies on the vertical line (chord), while Counterpoint focusing on the horizontal line (melodic contour). It seems that the vertical and horizontal are a separate parts of the subject, however, both of them are needed as a consideration in making a musical texture of melodies.

The term of Counterpoint is derived from Latin "punctus contra punctum" or "note against note". The emphasis word from the word "note against note" is on the word "against". Contrapuntal lines (contrapuntal melodies) are played or sung against, not with, each other, so that the resulting sounds like a 'conflict'. Of course, the conflict is not in the violent sense. It is more nearly that two or more lines, with each characteristic, functioning simultaneously with a common artistic purpose moving together (Norden, 1969).

There are three materials employed in contrapuntal construction, those are: (1) The vertical movement; (2) The horizontal movement; and (3) Musical textures. The vertical movement refers to the movement between the upper and lower note (chord). The horizontal movement is the movement of the melodic line (melodic contour). Musical texture refers to the numbers of musical layers and how these layers related to each other. As mentioned above that contrapuntal melody consists of two or more melodies, the musical texture is an important consideration to keep all musical layers connected to each other.

Counterpoint is one of the compulsory subjects that must be taken by students in the Music Department of ISI Yogyakarta. This subject is being taught in two consecutive semesters. The learning content of the first semester is focused on introductory of Counterpoint, the general rules of Counterpoint, and implementing the general rules in exercises. In the second semester, the learning content is emphasized on making two voices invention (two line contrapuntal melodies). In this semester, the students will practice making two voices invention starting from 8 bars up to 32 bars melody.

In Music Department of ISI Yogyakarta, Counterpoint subject is taught by lecturing and workshop method. The lecturer will explain about learning materials, and after that, the lecture will provide exercises to the students. The lecturer will guide and assist the students in doing exercises. These exercises are given to the students in order to gain the skills in making contrapuntal melody. Students do the exercises manually by writing the contrapuntal melody on a piece of stave paper. They construct a new melody according to the three materials employed in contrapuntal construction, try to listen to the melody, evaluate the melody, and making a correction if there is an error.

In the earlier observation that was conducted by the teacher (who also as research) found that there are several obstacles in learning Counterpoint especially in the second semester, which emphasized on making two voices invention. Here are the

obstacles: (1) Students write their melody manually on pieces of paper, and based on the previous description this process takes a lot of time; (2) In order to get more skillful in making contrapuntal melody, students should spare their time in doing a variety of exercises. So, it is very important allotting the time in learning Counterpoint, the more exercises you do, the more skill you will get; (3) Based on the evaluation of the students' works it was found that most of them loses their musical textures, whereas it is important to consider so that the contrapuntal melody does not lose their musical sense, since contrapuntal melody is a music.

As an offer to solve the problems, the teacher gives a solution by using the Sibelius software in learning Counterpoint. Sibelius software is a score writer program. It is used by composers, arrangers, performers, music publishers, teachers, and students, particularly for writing classical, jazz, band, vocal, films and television music. Besides that, Sibelius can also play back the music while writing the music. The features involved in Sibelius software will help the students to solve their problems in learning Counterpoint, especially in making two voices invention.
According to the previous description, this paper will examine how to use Sibelius software in learning Counterpoint at Music Department of ISI Yogyakarta and how Sibelius software can shorten the duration in making two voices invention and can improve the student's ability in making two voices invention.

Theoretical reviews

Technology in globalization era is an integral part of human's life. It is true because globalization concept emerges from the development of technology. According to Rahim (2005) globalization is an ideology of cultural, social, and political changing that emerges from the development of information and communication technology (ICT). The concept of globalization is the world without border, information liberation, global learning concept, cultural changing concept, and so on. These concepts bring a massive change in everyday's life of a human.

The concept of globalization in education is learning without border (global learning concept), this means that student could learn everywhere not only in a classroom or they can still learn in a classroom and use technology which helps them in learning. Learning is a process of interaction between educators, learners and learning resources in a learning environment. In the global era, learning should be defined as a process of interaction between educators, students, and technology. Although in a global era we can't separate technology from in learning situation, not all of technology can be used in learning. The technology can be used in learning in a global era is ICT.

According to Riyana (2008), There are three main functions of ICT in learning: (1) as a tools, it means ICT is a tool for students to help learning such as process data, work with numbers, make the elements graphics, create a database, and so on; (2) as a knowledge, it means that ICT as part of the disciplines to be mastered by students; and (3) as material and learning tools (literacy), it means the technology is defined as learning materials as well as tools for computer-aided control of a competency.

Aside from being a tool, ICT can also be used as a learning media for a student. The term of media can be defined as a conveyer or a mediator. According to Sudjana (1991) in the learning process, the functions of media are: (1) as a tool to achieve effective teaching and learning situations; (2) learning media is an integral part of the overall teaching situation. This means that the learning media being one of the elements in learning that should be developed by educators; (3) learning media also being an integral to the purpose and content of teaching; (4) the use of learning media not merely as entertainment tools in the learning process in order to get attention from students; (5) learning media used to accelerate the learning process and help students in capturing the information given by the educators; and (6) priority the use of media in learning is to enhance the quality of learning and teaching.

Educational technology emphasizes the learning aspects of learners. The main success factor of an education is to emphasize how students can learn to identify, develop, organize, and use all kinds of learning resources. Seeing the success factors that have been described, the problem solving is with the use of educational technology through utilizing learning resources.

To use the learning resources, the ICT should be done by considering a few things such as (1) the purpose of learning, ie appropriateness of the characteristics of learning objectives with the characteristics of learning media will be achieved; (2) effectiveness to determine the most effective media to deliver the content of the subject; (3) the accuracy, which chosen learning media appropriate to the characteristics and abilities of learners (4) availability, the media should be readily available or easy in the procurement; (5) the technical quality has been tested with good results; (6) cost of acquisition. The acquisition costs should fit between the costs incurred with the benefits to be obtained; (7) the flexibility and convenience of the media. The choosing media should give the flexibility, hence the technology can be used in any situations and when not in use it is not harmful; (8) the ability to use the media, of course, no matter how high utility the value media is, it will not provide many benefits for people who are unable to use it.

The importance of using technology as a medium of learning in learning counterpoint in the Music Department of ISI Yogyakarta is based on the opinion of Webster (2001) which states that: "Regardless of one view of the centrality of technology as part of music experience, there is no denying that children today do not know the world without computers, electronic keyboards, MP3 files and players, Compact Discs, the internet and other digital devices ". A similar opinion was also expressed by Muro (1996) which states that the computer is an ideal teaching tool in teaching music, mainly by using computer software that is user adjustable to the learning objectives.

It has been mentioned in previous paragraphs that in general learning media serves as a mediator or regulator messages device in learning activities which provide stimulus to the students to understand the material presented by teachers, from abstract concepts into the image of a more concrete, so the student's attitude and behavior will develop. The changes obtained after students have gained the knowledge and new experiences. The use of computer media with Sibelius software applications in learning counterpoint will help students to acquire new knowledge and experiences

through the material presented by teachers than if teachers do by way of lectures/verbal approach.

There are two theories that are used as a framework for this study: Cognitive Theory (Brunner) and The Cone Experience Theory (Edgar Dale). Brunner's cognitive theory states that a person's cognitive development occurs in three stages defined by the way he viewed the environment, such as: (1) Direct experience phase (eractive), an individual stage to understand the environment by doing activities; (2) Pictorial phase (ekonit), an individual stage to see the world through pictures and verbal visualization, such as drawings, paintings, photographs and others; (3) Symbolic stage, is the stage where people have abstract ideas strongly influenced the language and logic of thinking.

The theory which also supports the use of technology in learning is a theory cone of experiences. Dale (1946) classified learning experiences ranging from concrete things up on things that are considered abstract. The classification of experiences is called by the cone of experience. In this theory, the learning success is measured by the level of students' learning experiences gained in learning depends on the treatment. This theory consists of 12 classification learning media which is often used instructional: (1) Direct experience and aims. This experience gained by the student when dealing directly with the objects, events, or the actual object; (2) Experience imitation. This experience obtained by students through objects or events that actually imitations; (3) Experience through dramatization. The experience gained in the form of various movements of drama that performed on stage and in the open air; (4) Demonstration. The experience gained through the examples or the show of a process; (5) the experience through field trips. The experience gained by getting students to the outside object of the classroom with the intent of enriching and expanding students' experience; (6) the experience through the exhibition. The experience gained through performing the work of students; (7) the experience through television. The experience gained through the educational program that aired on television; (8) Experience through live images or movies; (9) the experience over the radio. The experience gained through radio broadcasts in the form of lectures, interviews, skits, and so on; (10) the experience through pictures. The experience gained from everything that is manifested visually in the form of two-dimensional as an outpouring of feelings and thoughts; (11) the experience through visual symbol. The experience gained through visual symbols; and (12) Experience with the symbol of the word. It is gained from books and reading materials.

The basis of the experience of this cone is to measure the level of abstraction for the reception of learning content or messages using direct experience, in line with the increasingly consolidated these conceptions, the function of learning media not only as a tools, but also as a conveyor of information or a learning message to students which will solve the barriers in communication, physical limitations in the classroom, students' passivity and also unify their observations.

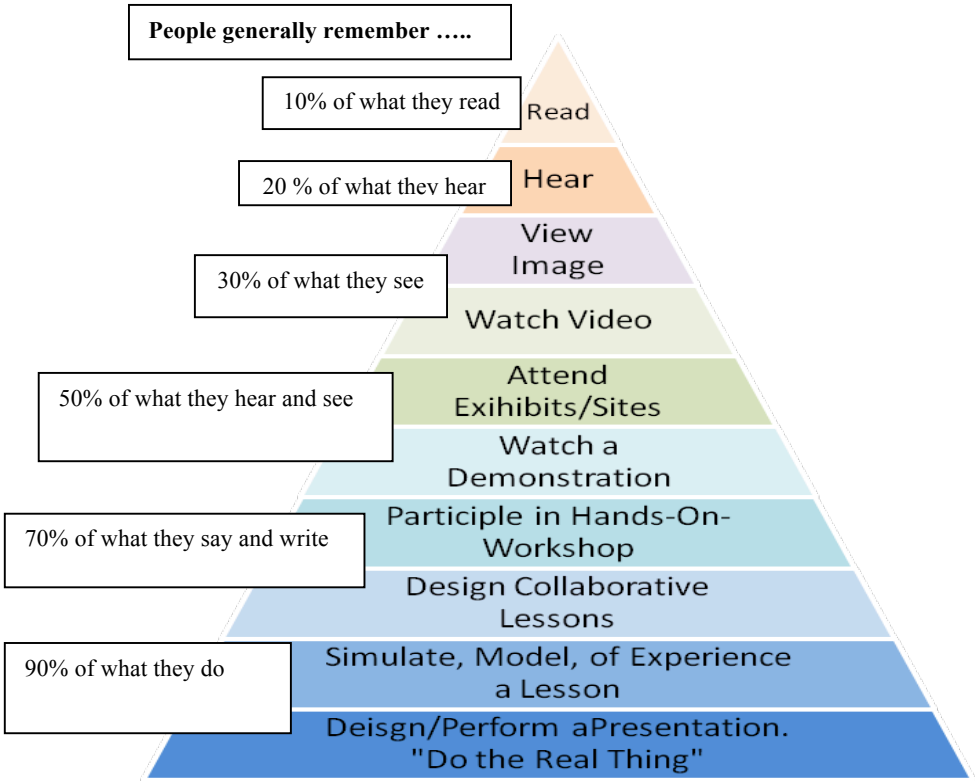

Figure 1: Cone of Experiences

From the picture of cone experience above, it can be explained that the treatment in learning will affect the learning experience, the more abstract treatment of learning for instance with lectures that use symbols, learn to read, then the learning experience gained is not too significant, otherwise increasingly using the medium that directed the real activities (performance) then the learning experience will be gained to the maximum. Learning media have an important role in improving the information that we remember which is 70% compared to the rehabilitated and reconstructed by the lecture method of learning by 20%.

Result And Discussion

This study is classroom action research (CAR). CAR is a research done to overcome the problems in the classroom. It is done with the aim to improve the quality of learning effectively (Sukanti, 2008). CAR is used as a way to describe the use of Sibelius software in learning Counterpoint in Music Department of ISI Yogyakarta with the aim to improve the quality of learning and also to solve the student's problem in learning Counterpoint. It is expected that the use of Sibelius software in learning counterpoint will make learning more effective.

The CAR is the development of action research. There are four steps in CAR: plan, act, observe and reflect. These are the simple model of the cyclical nature of typical action research (Kemmis and Mc Taggart, 1988).

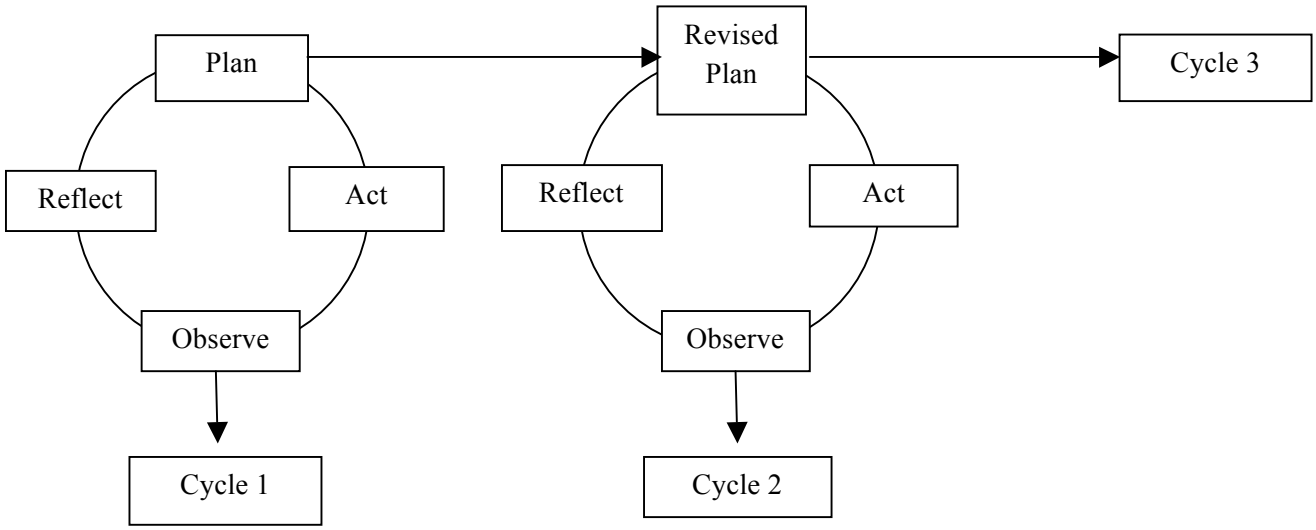

Figure 2: Action Research Model

In giving the elaboration of the simple action research model, Suswam (1983) distinguishes five stages in conducting each research cycle: (1) diagnosis the problem; (2) action planning; (3) taking action; (4) evaluating; and (5) specifying learning.

Figure 3: Action Research Process

In accordance with the cyclical nature of action research, this research was conducted in several phases: (1) Planning. In this stage, the researcher identified the problem in learning Counterpoint at Music Department of ISI Yogyakarta in making two voices invention. There are three problems that found in learning Counterpoint: students spent a lot of time in doing two voices invention by writing on a paper, students did not have enough time doing a variety of exercises, and most of the student did not pay attention to the musical texture of their work. To solve the student's problem in

learning Counterpoint, the researcher took a literature study, reviewing the literature which has the similar topic with this research and designing learning scenario. The learning scenario is to use Sibelius software when making two part inventions; (2) Action. Action means here is a corrective action. Every meeting, the researcher gave the students exercises in making two part inventions. Students did their work on their own laptop with using Sibelius software. The exercises start from 8 bars up to 32 bars length. The researcher assisted the students while they were working on two part inventions; (3) Observe. The observation took when students did their work and the result of their work. Besides that, researcher did the interview with the student. The assessment of student's work was based on how they constructed and combined the vertical and horizontal line with musical texture consideration; (4) Reflection. There are some aspects that we need to consider in order to get the reflection such as analyzing, interpretation and evaluating the research data. After doing observation, the researcher analyzed, interpreted, and evaluated the work of students whether the use of Sibelius software in learning Counterpoint at Music Department of ISI Yogyakarta is successful or not. At this point, if the use of Sibelius software in learning Counterpoint does not work, the problem is re-assessed and the process begins in another cycle. This process continues until the problem is resolved.

The data that were gathered during this study show how to use Sibelius software in learning Counterpoint at Music Department of ISI Yogyakarta and how Sibelius software can shorten the duration in making two voices invention and can improve the student's ability in making two voices invention. The results of this study are shown below:

A. Using Sibelius software in Learning Counterpoint

In learning Counterpoint, with the use Sibelius software student should prepare their own equipment such as laptop and earphone. The student did their work on Sibelius software. They wrote two voices invention on Sibelius. While their work, they can listen to the melody that they made. Of course, they need to pay attention to the construction and combination of a vertical, horizontal and musical texture of the melody. The student can also make a correction easily to the melody that they made if the construction and the combination not required to the basic rules of Counterpoint. This process continues until they have a good construction and combination of the two layers of melody. After they were finished, they sent their work to the researcher in two type of file by email: in the midi file (audio) and the music score (or any relevant graphic file type). The researcher evaluated and gave comments on their work.

Using Sibelius software in learning Counterpoint in Music Department of ISI Yogyakarta is a way to use the technology in a classroom. This is a shifting from manual score writing to digital score writing. Sibelius software is learning media and when working with it, students got real activities which involving their sight and hearing senses. According to Dale's theory, the use of learning media will improve 70% information that we remember. It is meant by using Sibelius software students absorbed the information in learning much more than without Sibelius software.

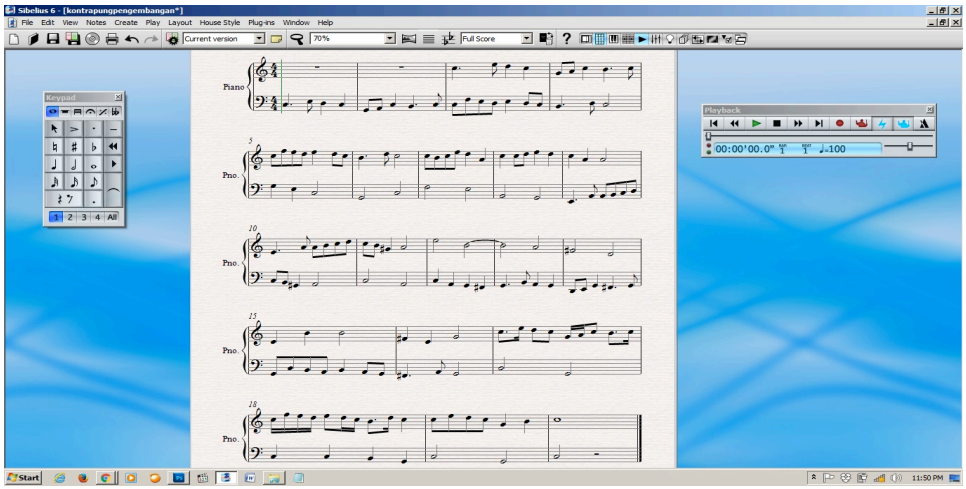

Figure 4: Work sheet of student in making two voices inventions on Sibelius software

B. Sibelius can shorten the duration in making two voices invention and improving student's ability in making two voices invention

Using Sibelius software in learning Counterpoint is proved can shorten the duration in making two voices. Based on the interview, students said when they were writing on a paper they hardly to listen to the melody, they cannot sing the melody by their own voice since there were two melodic lines in two voices inventions, so it took a longer time in order to make a good two voices invention. But, by using Sibelius software, students said that it is very helpful for them because they could hear the actual sounds of their melody while they were worked.

They students also said that they had an opportunity to do some more exercises in order to get more skillful in making two voices invention. By using Sibelius software students can do more two-part inventions exercises because they were doing the exercises easily and in short duration time. Doing more some exercises full equip students with the skill in making two voices invention, so they can improve their ability and get fluent making two voices invention.

The result shows that using Sibelius software in learning Counterpoint brings the advantages for the students. The problems that found by the researcher in learning Counterpoint at Music Department of ISI Yogyakarta also solved by using Sibelius software. As a learning media, Sibelius software should be interpreted as a way to solve the problem in learning and brings efficiency and effectiveness.

Conclusion

Using Sibelius software in learning Counterpoint at Music Department of ISI Yogyakarta is done successfully. It gave the advantages for students in doing two voices invention and also a problem-solving in learning Counterpoint. Sibelius software also makes learning Counterpoint become more efficient and effective. The improvement of student's ability in making two voices inventions is the significant result of this research, and it makes the goal of the Counterpoint's course content achieved, that is students can make two voices inventions.

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Contact email: orianatioparahitangl@gmail.com

Teaching English Academic Writing Skills through the Flipped Classroom Model and Team-Based Learning

Wan-lun Lee, Fu Jen Catholic University, Taiwan

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Abstract

In recent years, there has been increased interest of flipping the classroom, a student-centered instructional model that makes classwork done at home via lecture videos and homework done in class. The ultimate goal of the flipped classroom is to enable students to spend more face-to-face class time working with the teacher or peers on creative, interactive, and higher-order learning activities. On the other hand, team-based learning, also a student-centered pedagogical approach that has received considerable attention, shares the same goal of making the best use of class time by asking students to read preparatory materials outside the classroom.

This paper describes a project that combined these two approaches in the teaching of an English Composition course to help students develop their academic writing skills. Feedback from students collected through anonymous questionnaire surveys and their reflective writing suggests that most of them thought positively of this new format of learning and found the lecture videos made by Evercam, the in-class Q&A session using QuizMaker, and the individual quiz via Zuvio, very useful in helping them get familiar with different academic writing modes and skills. However, since they still had to spend time writing their own academic essays, some of them felt that flipping the class made the whole learning process even more time-consuming. It is hoped that the practice and outcome of this project will provide EFL teachers with a feasible framework or effective pedagogical model to integrate the flipped classroom and team-based learning in academic writing instruction.

Keywords: flipped classroom, team-based learning

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Introduction

Since I started teaching an *English Composition* course with a particular focus on academic writing, I have been looking for a more effective pedagogic model to increase students' engagement and interest, promote active learning, and attain better learning outcomes. Students taking this one-year course are second-year English majors, most of whom are not familiar with academic writing and find it very difficult and even intimidating, partly because it is so different from what they wrote in their previous English composition classes, and partly because they are required to follow principles of academic writing in English to complete six research-oriented writing assignments, including extended summary, article review, argumentative essay, synthesis essay, research proposal, and research report. To help these students get familiar with academic writing quickly, I first used traditional instructional paradigm, where students listen passively to my lectures on academic writing skills and modes in class and write their assignments at home. However, although this paradigm did enable me to deliver the course content and material efficiently to my students, many of them still felt confused and disoriented when they tried to use what they had learned in class to write their assignments and thus had to turn to me for help by asking me to explain the key concepts or principles to them over and over again. When I thought it was time to give up this pedagogic model that simply did not work, I heard about the flipped classroom approach and decided to redesign this course around this new instructional framework to make it possible for students to preview and review the course content at their own pace, at their own time, and according to their own needs.

The flipped classroom model, which inverts "where and when students acquire basic content ('lecture') and practice applying concepts ('homework')," has been gaining increased attention in recent years, especially in the higher education context (Wallace, Walker, & Braseby, 2014, p. 254). Though not looking exactly the same, most flipped classrooms follow a formula that requires students to "view a video or PowerPoint Presentation in preparation for follow-up activities in class" (Muldrow, 2013, p. 28-9). Since face-to-face lectures are made into digital video tutorials, flip teaching makes class time more productive and gives students "more opportunities to develop higher-order thinking under teacher guidance and with peer support as needed" (Hung, 2015, p. 82). As Goodwin and Miller also point out, one of the benefits of flipped classrooms is that they "alter the nature of homework by having students practice and apply their learning in the classroom, under the watchful eye of the teacher" (2013, p. 79). Thus, the success of a flipped classroom depends not on whether the pre-recorded lecture videos are good or bad, but on whether the precious class time freed up by the use of videos is used to increase students' active learning experiences in class (Brunsell & Horejsi, 2013).

To promote active learning and maximize the benefits of the flipped classroom model both in and out of class, Wallace, Walker and Braseby (2014) suggest that team-based learning (TBL) be integrated into the flipped classroom framework to create a more dynamic, student-centered learning environment for students to use the knowledge and skills acquired from lecture videos to work actively and collaboratively on the learning tasks and activities in class. By definition, TBL is "a teacher-directed method that promotes application of knowledge using small groups in a single venue" (Tan et al., 2011). TBL requires students to read preparatory course material prior to class

(Phase 1), take an Individual Readiness Assurance Test (IRAT) in class to assess their understanding of the knowledge and concepts in the material content before each student is assigned to a group that will complete a Group Readiness Assurance Test (GRAT) (Phase 2), and then work together to assignments that allow them to use what they have learned from the course material (Phase 3). Like the flipped classroom, TBL asks students to learn course content before class, but it "goes further by prescribing a specific structure for what happens during class," which is why it should be used as "an effective in-class, instructional strategy" to ensure greater success of flip teaching (Wallace, Walker & Braseby, 2014, p. 263).

This paper describes how the flipped classroom and TBL were integrated and implemented in my teaching of an *English Composition* course as well as what my students thought of this new model of learning English academic writing.

Research Methodology

This study aimed to design an instructional framework combing the flipped classroom model and TBL for my teaching of academic writing skills in *English Composition* class and then investigate university students' perceptions of and attitudes toward this new format of learning academic writing.

The participants of this study were 15 second-year English majors taking my one-year English Composition course at a Taiwanese university. They all had learned English for over ten years. The results of a simulated Test of English as International Communication (TOEIC) showed that they were all intermediate English language learners. None of the students had any flipped classroom experiences prior to the study, but they did not find TBL a brand new way of learning because they had been asked to complete various learning tasks or projects in pairs or groups since they entered the university.

The context, for which the instructional framework combining the flipped classroom model and TBL has been designed, is a one-year *English Composition* course aiming to teach students six academic writing modes: extended summary, article review, argumentative essay, synthesis essay, research proposal, and research report. The first three writing modes are taught in the first semester and the other three in the second semester. The students are required to submit one essay for each mode, and each essay has to be revised at least twice. The third draft of each of the first five essays has to be 1000 words long while that of the last one, research report, must be 2000 words long. The class met weekly for two 50-minute class periods during each of the 18-week semester.

As for the procedure, the digital lecture videos, all of which were narrated PowerPoint videos made with the help of Evercam, were put on the website called "powercam.fju.edu.tw" for the students to watch in advance of class. During class, the IRAT was first conducted by means of Zuvio, an online teaching platform allowing teachers to develop multiple choices and open-end questions and students to use digital devices like smartphones and tablets to answer questions immediately. Then, the GRAT was conducted using QuizMaker, a quiz builder software. After the students took these individual and group tests to check and show their understanding of the knowledge and skills acquired from the videos, they then put what they had

learned into practice by working collaboratively with their group members to complete application activities and problem-solving exercises on the course content and help one another get prepared for the essay writing process. Finally, they started to write the first draft of the essay individually outside of class and used the feedback from their peers to write the second draft.

Two instruments were used to collect both qualitative and quantitative date for this study. First, at the end of each of the two semesters, the students were asked to fill in an exit questionnaire on the platform Survey Monkey, an online survey service. Data from the two questionnaires were then analyzed and compared with the help of Survey Monkey. The second set of data came from the students' reflective writing about their learning experiences and was analyzed with the help of NVivo, a qualitative data analysis computer software package.

Results and Discussion

Feedback from students collected through questionnaire surveys and their reflective writing showed that most of the participants thought positively of the implementation of this new instructional framework in the writing course and expressed high levels of learning satisfaction at the lecture videos made by Evercam, the use of technological tools Zuvio and QuizMaker, and the process of cooperating and interacting with their peers to complete team-based learning activities in class. Besides, the lecture videos, as well as the in-class quizzes and activities, were all considered very useful in helping them get familiar with different academic writing modes and skills and increasing their confidence in writing academic essays.

Interestingly, some participants admitted that at first they did not like the idea of flipping the class, either because they were too busy to watch the videos at home, or because they believed that they would learn better from face-to-face lectures; however, their attitude gradually changed in the learning process, and at the end of the second semester, only one of them still insisted that the course should follow traditional teaching procedures, and that only face-to-face lectures help her learn well because she would like to get answers from the teacher immediately whenever she had questions about the course content.

It is also noteworthy that in their reflective writing, some students complained that flipping the class actually made the whole learning process even more time-consuming because they had to spend more time watching the lecture videos and writing their essays at home. Some of them also mentioned that their team members did not always remember to watch the videos in advance of class, which made it difficult for them to work together as a team to do well on group quizzes and complete classroom activities effectively.

Conclusion

Although flip teaching has received a lot of research attention, there are still very few studies that examine the use of the flipped classroom model in the second and foreign language-learning context, not to mention the use of TBL as a flipped class pedagogical approach (Engin, 2014). The strength of this study is its instructional design in relation to the flipped classroom model and team-based learning, together

with the use of technological tools. It is hoped that the pedagogical design and practice, as well as the findings of the study, will help expand the application of the flipped classroom model and team-based learning to English writing instruction and encourage English language teachers working in similar contexts to adopt this new instructional framework, together with applications of available technological tools, in their academic writing courses to transform their students' learning experiences.

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The Development of a Model to Promote Predict, Observe, Explain Strategies for Teaching about Electric Circuits in Virtual Environments

Parinda Phanphech, King Mongkut's University of Technology Thonburi, Thailand
Tanes Tanitteerapan, King Mongkut's University of Technology Thonburi, Thailand

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Abstract
The paper presents a virtual model to promote Predict, Observe, Explain (POE) strategies for helping students overcome misconceptions about electric circuits. Vocational educational students preparing to be electric technicians often have misconceptions about electric circuits. Yet, knowledge of such circuits is basic to their training. This paper outlined a model that relies on PDOE strategies, we added DO in second process that involve students predicting results, doing a virtual simulation of the prediction, observing the results and subsequently explaining any difference between what they predicted versus what they observed. Such models exist for high-school and university students but not for vocational learners. Furthermore, the challenge with using POE strategies in the classroom is providing students with opportunities to observe scientific phenomenon in a way that is real, authentic and, most importantly, safe. The models do not provide an opportunity to "do" because it is often not feasible or possible to carry out experiences in the real classroom. This paper demonstrated a PDOE model developed specifically for vocational students and that operated in a virtual environment. Such environments rely on technology such as simulations to do experiments that are not possible in the real classroom.

Keywords: POE strategy, virtual environment, vocational education, electric circuits, misconceptions, PDOE model

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Introduction

The purpose of this paper is to present a model to promote Predict-DO-Observe-Explain (PDOE) strategies in a virtual learning environment for helping students overcome misconceptions about electric circuits. Predict-Observe-Explain (POE) strategies are considered as constructivist-oriented strategies (White & Gunstone, 1992) that help students put forth and test hypotheses (Kibirige, Osodo & Tlala, 2014). POE strategies are also useful for helping teachers identify students' misconceptions (Boo & Watson, 2001; Kibirige, Osodo & Tlala, 2014). Teachers need to recognise students' misconceptions and modify their strategies to adjust (Kibirige, Osodo & Tlala, 2014). The strategies can help teachers find out about "learners' prior knowledge and thought processes" which they can then use to "find sustainable solutions to overcome such misconceptions" (Kibirige et al., 2014, p. 301). Misconceptions can take the form of incorrect understandings (Martin, Sexton, and Gerlovich, 2002) and may be resistant to change (Eggen and Kauchak, 2004). For example, Kibirige et al.'s (2014) study showed how POE strategies had "a positive effect on learners' misconceptions about dissolved salts" (p. 305) and helped students to improve. The use of the strategies also provided an opportunity for teachers to identify new misconceptions.

POE strategies help "students to support their predictions through benefiting their existing knowledge and experiences of similar events that they encountered in their daily life" (Ayvaci, 2013, p. 549). These strategies involve learner-centered teaching that "acknowledges the social construction of knowledge" (Kibirige et al. 2014, p. 304). Karamustafaoğlu and Mamlok-Naaman (2015) explained that POE strategies typically involve three tasks. In the first task, students are given a physical situation for which they should predict "the result of a specific change to the physical situation" and explain their prediction (p. 924) or use if-then logic "IF the system behaves as expected IF...THEN my Prediction (my logical expectation) is that…will happen and…will be observed" (Rusbult, 2013). In task two, students must describe what they see as they conduct a physical experiment (Rusbult, 2013). In the final task, they must explain the contradiction between what they predicted versus what they observed. These tasks can help students engage in inquiry and critical thinking, enhance conceptual understanding and informal reasoning skills, and develop students' independence, motivation, interest and ability (Perver, 2015).

POE strategies and technology

The challenge with using POE strategies in the classroom is providing students with opportunities to observe scientific phenomenon in a way that is real, authentic and, most importantly, safe. Kearney (2004) used multimedia with POE to provide students with opportunities to observe "difficult, expensive, time consuming or dangerous demonstrations of real, observable events" (p. 427). Banky and Wong (2007) described advantages of use of simulation software in terms of the capacity to let users observe outcomes without harm and without the inconvenience of equipment failure. Kearney (2016) summarized the advantages of assigning POE tasks for completion in a computer-based environment. These include opportunities for small-group work, computer scaffolding, student pacing and autonomy, opportunities for discussion and reflection. In addition, Kearney noted that computer-based

demonstrations "can reveal interesting science phenomena that… go beyond our temporal,
perceptual or experiential limits" (p.427).

Paper purpose and objectives

In spite of the value of using technology for this purpose, there are few examples of use of technology with POE strategies particularly at the post-secondary level. Hussain et al. (2013) used virtual simulations with POE strategies in an undergraduate basic electric circuits course. The authors explained that the topic is abstract therefore simulations can help students visualize these abstractions. Kearney and Wright (2002) used a computer program to help science teachers build and photographic, sound or video-based (digital) demonstrations. However, this study did not take place at the post-secondary level. There are few studies of use of POE strategies with technology for post-secondary learners. Our review of the literature did not uncover any studies of POE strategies and models using technology with vocational learners. This may be partly because, in general, POE models exist for high-school and university students but not for vocational learners. Vocational educational students preparing to be electrical technicians often have misconceptions about electrical circuits. The high-school models typically emphasize theory. University-based models tend to emphasize activity without theory. What is first needed in order to use POE strategies in a technology-based environment with vocational students is a model of such learning. This paper will demonstrate a model developed specifically for vocational students that can operate in a technology-based, virtual environment. The presentation will also include some implications for practice and for research.

Methods

To develop the model for vocational learners at the post-secondary level, we completed the following steps:

1. Identify previous models of POE;
2. Identify the common misconceptions related to electric circuits;
3. Create a model to promote PDOE strategies for teaching about electric circuits in virtual environments

Objective 1. Identify previous models of POE

The POE strategies were redesigned from the Demonstrate-Observe-Explain (DOE) strategy (Champagne, Klopfer and Anderson, 1979). DOE is about real-world situations or real-world experiences. The strategy involves formulating a question for prediction of the results of situation and then observing the effect of the change and explaining results. Champagne, Klopfer and Anderson (1979) used this strategy to assess students' understanding of force in first year physics students. The advantage of DOE strategies includes a reduction in the quantity of verbal description and a reliance on open-ended questions which provide data to make inferences about students' conceptualizations (p. 25). White and Gunstone (1992) redesigned the DOE strategies and developed the first POE model in elementary science. According to their model, students must first predict the outcome, justify their prediction, describe

their observation and then reconcile contradictions between what they predicted and what they observed.

More recently, Ebenezer et al. (2010) used Prediction-Explanation-Observation-Explanation (PEOE) strategies for constructing and negotiating ideas after student predictions. The PEOE is practiced by the teacher to promote students' conceptual understanding and make teaching plans. Costu, Ayas and Niaz (2012) developed the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) model to investigate students' understanding of science. This strategy involves motivating students' prior knowledge and solving the contradiction between their beliefs and observations. Hilario (2015) developed the Predict-Observe-Explain-Explore (POEE) model which is designed to stimulate students' interest and curiosity between their knowledge of Chemistry and their life. Sales (2015) developed Predict-Explain-Observe-Explain strategies (PEOE) for exploring metacognitive awareness of students to improve conceptual understanding and problem-solving skills also in Chemistry. The PEOE focuses on students' explanation. The difference between PEOE and POE is that students have to explain both after their prediction and again after their observation.

There are very few virtual POE models. Kearney (2004) focused on the use of POE tasks in a technology-based multimedia environment with peer conversation to probe students' understanding in science. His model used student motivation with digital video clips in a physics' lesson on force. The computer-based digital video clips replaced real experiments. Kearney, Treagust, Yeo, and Zadnik (2001) found three affordances of multimedia-based POE tasks. First, students can control the pacing of POE tasks and control the presentation of video-based demonstrations. Next, the student can make detailed observations of physical phenomenon in using digital, video-based demonstrations in the observation phase. Last, students must describe the virtual, real-life physical setting in the video-clips. The advantages of using computer-based video clips are that students can control and observe experiments as many times as they want. In addition, the virtual video clips provide content for the "reflective discussions" that take place during the observation step of the model (Kearney, 2004).

Objective 2: Identify common misconceptions related to electric circuits

Electric circuits are fundamental to the study of electricity and must be known in depth. If knowledge is lost in a particular session or class it will lead to misconceptions. Because electricity is abstract, intangible and difficult to understand, many students form incorrect understandings and fail to grasp the concepts (Frederiksen, White & Gutwill, 1999). The body of knowledge on electric circuits is a broad, focusing on current, resistance, voltage, series and parallel-circuits (Duit & Von, 1997). However, those who study about the circuits must deeply understand the properties, specific characteristics and behavior of the circuits. In addition, students sometimes rely on intuitive conceptions to understand electricity and electric circuits (Ding et al, 2006; Duit & Von, 1997; Kollöffel & Jong, 2013).

Turgut, Gurbuz and Turgut (2011) conducted a study in Turkey with 10th grade students. They found that the most common misconceptions were that students thought that current does not flow and none of bulbs are lit when the switch is closed. A study of high-school students in Romania found that they believed that current decreases when it passes through the bulb which is a misconception (Korganci et al.,

2015). Similarly, Engelhardt and Beichner (2003) in the USA found that students misunderstood that a battery provides a constant source of current. Other common misconceptions are as follows:

1. Current decreases when it passes through the bulb.
2. Light bulbs use up current.
3. The current is stored in the battery/generator.
4. Resistance is the force applied to the opposite direction of the electric current.
5. Resistance is the obstacle applied to the electric current.
6. Potential difference is a force.
7. The battery always supplies the same current to the circuit.
8. The brilliance of the bulb that is far from the battery is less than the brilliance that is close to the battery.
9. Current which passes on a simple electric circuit is partially consumed by the bulb.
10. A battery provides a constant current source rather than a constant voltage source.

Objective 3: Create a model to promote PDOE strategies for teaching about electric circuits in virtual environments.

To create a model we first relied on POE strategies as outlined by Champagne, Klopher & Anderson (1980) and by Gunstone, Champain and Klopfer (1981) to promote conceptual understanding (Tao & Gunstone, 1999). We added one step to conform with the needs of vocational learners. Vocational learners need more than theory. They need opportunities for hands-on, real experiences. In normal models, the actual enactment (the doing) of the scenario is not possible or feasible in a real environment because it might be dangerous or costly. However, in a simulated environment, the enactment of the scenario (the experiment) is possible. Therefore, we added DO process to the model to make it PDOE. Thus, instead of only POE, our model relies on Predict, Do, Observe, Explain (PDOE).

Figure 3 outlines the model. The PDOE model includes a virtual environment in which the student acts as an electrician. As in Kearney's (2004) virtual model, this model also relies on a technology-based environment with peer conversation. The conversation takes place using CHAT boxes. The technology is specifically simulations. The centre of the model shows PDOE as a four-step process. Corresponding with the Predict step, students will see a web-based interface that offers them ten different scenarios. These scenarios correspond to 10 common misconceptions. An example of a choice is as follows:

Please choose one of the following scenarios and make your prediction using the CHAT box:

If I have three circuits as below, then which bulb is brightest (same battery)

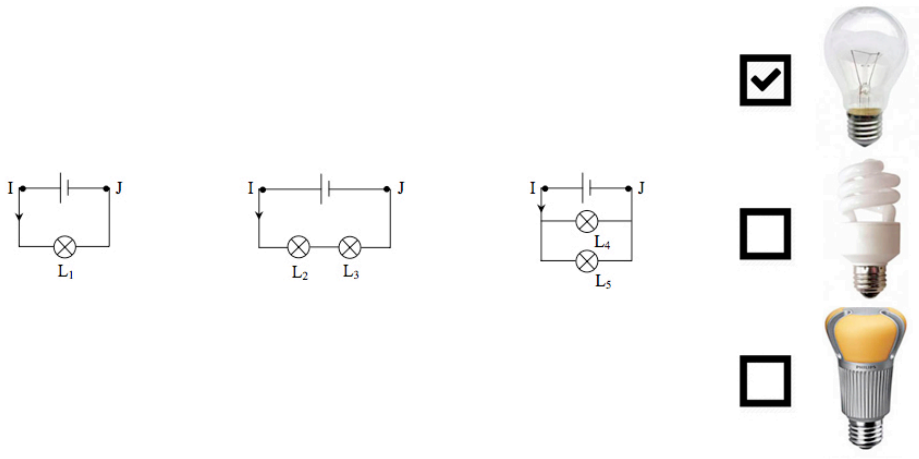

Figure 2: Example of an if-then scenario

In step 1, students have to predict using an if-then scenario. They use an interactive CHAT box to input their choice. The CHAT element reflects Piaget's (1936) and Vygotsky's (1978) emphasis on social interaction, constructivism and conversation as a means of learning. The content is automatically available to the teacher but students can choose to make it available to other students. After they complete their prediction, they automatically move to a second interface (Step 2). In this DO step, students are given the opportunity to carry out a simulation of the scenario. For example, if the student selects the above scenario, the current decreases when it passes through the bulb. The student will be able to simulate connecting the battery either in series or parallel circuits with bulb. Then, they can select a type of bulb such as an incandescent bulb to compare the brightness.

Next (step 3), the student can observe the result (i.e., in this case, which bulb will be brightest). The virtual simulation can demonstrate for easy observation the direction of the flow of current in the wire. In this scenario, the most common misconception is that students think that L3 and L5 will not light (see figure 2) because they believe that current decreases when it passes through the bulb. However, in actual fact, every bulb has equal brightness except that L3 is dimmer. This is because of the current divider and voltage divider are in series and parallel circuits. The student will use a CHAT box to describe what he/she observed. The student can then move to the following step 4 of Explain where he/she can once again use the CHAT box to explain why there was a difference between the prediction and what actually occurred. Each students' input into the three different chat boxes (predict, observe, explain) can all be stored for future viewing by the teacher. The teacher can then comment and the student can view and respond to their teacher's comments.

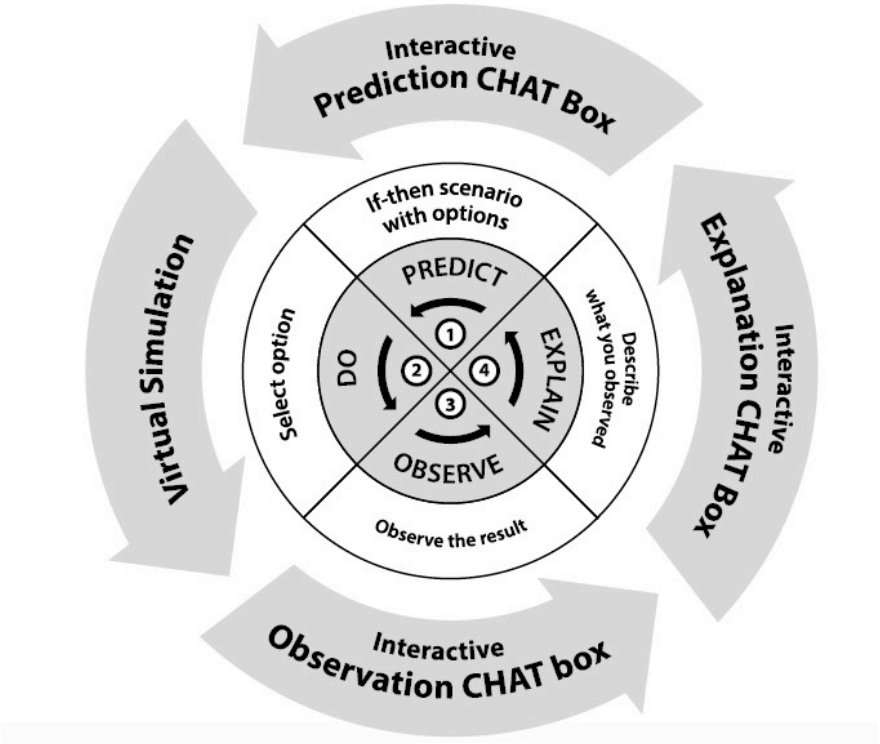

Fig. 2 PDOE model in virtual environment

Conclusion

The paper presented a virtual model to promote Predict, Do, Observe, Explain (PDOE) strategies for helping students learn about electric circuits. Vocational educational students preparing to be electric technicians often have misconceptions about electric circuits. Yet, knowledge of such circuits is basic to their training. This paper outlined a model that relies on PDOE strategies that involve students predicting results, doing a simulation of the prediction, observing the results and subsequently explaining any difference between what they predicted versus what they observed. Such models exist for high-school and university students but not for vocational learners. The high-school models typically emphasis theory and do not provide opportunities to carry out experiments. University-based models tend to emphasize activity without theory. This paper demonstrated a PDOE model developed specifically for vocational students and that operated in a virtual environment.

In terms of implications for research, future research can involve the design, development and testing of a virtual PDOE environment with vocational students based on this model. Instructors and designers can experiment with new technologies especially those available online for free such as Android or IOS apps that students can use to observe the actual “do” phase. These apps could be used in combination with social media such as Facebook groups or other such tools to engage students in conversation with others about their predictions and observations.

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Contact email: parinda.fon@mail.kmutt.ac.th
tanes_kmutt@yahoo.com

The Competency Development in Practical Skills by Hand-on activities for Industrial Education Students (Electrical Engineering Learners)

Tanapon Tamrongkunanan, King Mongkut's University of Technology Thonburi, Thailand
Tanes Tanitteerapan, King Mongkut's University of Technology Thonburi, Thailand

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Abstract
This study was aimed to develop learning competency in practical sessions by using Hand-on activities. The tools used to collect data were a questionnaire, assessment test and Delphi technique. The purposive sampling of this study were 80 senior students in Electrical Engineering Education from King Mongkut's University of Technology Thonburi. The Delphi technique sampling groups were selected from 10 experts as the mainstream vocational education. The research finding were the student samples had insufficiency of knowledge, skills and attitudes for competency's need of vocational education. The results of Delphi technique found that the basic competency can divided to 3 domains; cognitive, affective and psychomotor. The factor of these are consist of basic electronic (design circuits by computer, testing circuits and electronic instrument skills). Hand-on activities modules were design as lesson plan by job analysis and contain with knowledge and skill in the basic of electronic including to do PCB electronic board, soldering and coil wiring transformer.

Keywords: Hand-on activities, job analysis, competency

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Introduction

Education which is knowledge based economy is important especially in these current economic situations. National Economic and Social Development plan for No.11 B.E. 2555 to 2559 (draft),Factor of Consideration of planning for curriculum development, Office of the national economic and Social Development surveyed analyzed and presented the issues about The challenges and opportunities of Thailand is a result of the region Economic concentration affected the connection of International economic in the region is increasing and expand the asia economic rapidly. Global economy will change the center to the Asia and also the advancement of electrical technology electronics and computer with the human living that is Thailand has to prepare curriculum to be ready for the changing by manage knowledge systematically, develop and Create new knowledge as well as the application of appropriate technology in the current status and the future follow by the university context including the regulation from National Education Act of B.E. 2542.It caused Education reform to develop the capacity of both teachers and Education Personnel such as being Educational reform leadership, creating and developing curriculum, classroom research promotion etc. and Quality Assurance. Due to the important of this problems, researcher who is the part of graduate producer, have to develop teachers and Education Personnel to be on top of the vision for economic change, so the purpose of this study was to study the properties of vocation knowledge, vocation ability, vocation attitude and Capacity

Research Methodology

1. Objectives

1. To study on the problems, obstructions and development of Electrical instructor competencies requirements.
2. To build competency in part of knowledge, skills and attitudes.
3. To develop practical competencies, according to teacher professional required (Electrician).

2. Scope of the Study

2.1 In part of studying on the problems, obstructions and development of Electrical instructor competencies requirements. The sample groups were selected from Electrical teacher who had been teaching at least 2 years in technical colleges.

2.2 In part of learner's test by through competency from knowledge, skills and attitudes.

2.3 In part of development of practical competencies, according to teacher professional requirement (Electrician). The sample groups selected for this study comprised 3 sections of Electrical technology education student, King Mongkut's University of Technology Thonburi 5th grade.

3. Research Instrument

3.1 A questionnaire on the problems, obstructions and development of Electrical instructor competencies requirements

3.2 A questionnaire on development of practical competencies, according to teacher professional requirement (Electrician).

4. Research Methodology

Data Collection, Researcher used a questionnaire with the sample groups were Electrical teacher, as follows

4.1 Practical competencies requirement study. a questionnaire of value of expert opinion about the problems, obstructions and Electrical instructor development competencies requirements (Delphi Technique) to summarize the opinion and the main issue.

4.2 Course structure was determined by base separation

1. Group meetings (Focus Group) and create a suitability of development of practical competencies, according to teacher professional requirement (Electrician) questionnaire by divided to Knowledge skills and Attitude.
2. Design base competencies, Hand-on activities modules were design as lesson plan by job analysis
3. The sample groups practice in practical part to develop competencies

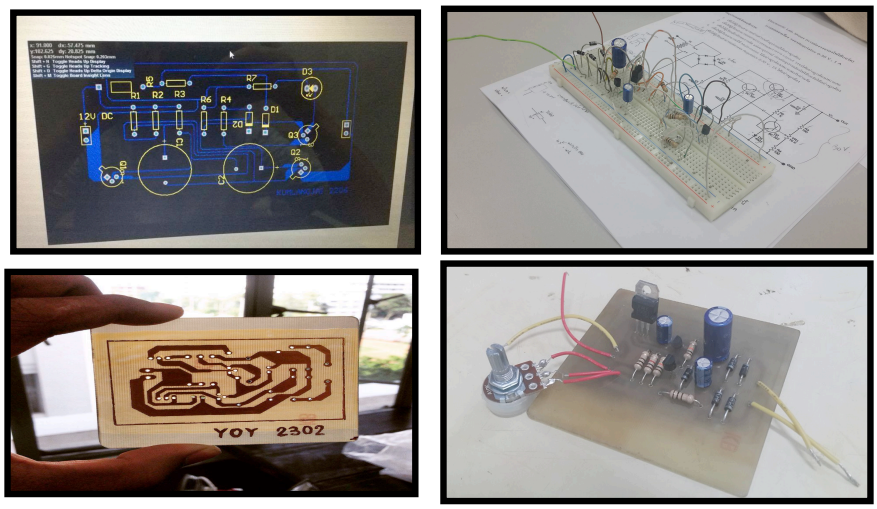

Figure1. Develop practical competencies, according to teacher Professional required (Electrician)

5. The data analysis

The data were analysed by percentage, mean, standard deviation using Delphi technique to analysis and also correlation (median and interquartile range)

6. Results

1. The problems, obstructions and Electrical instructor development competencies requirements

1.1 Vocational Knowledge Problems

First of vocational knowledge problems is measurement knowledge($\bar{X}$ = 3.82, SD. = .85) second problem is electrical and electronic devices knowledge problem ($\bar{X}$ = 3.78, SD. = .86) designing and drawing by computer knowledge problem ($\bar{X}$ = 3.73, SD. = .89) Device testing knowledge problem ($\bar{X}$ = 3.71, SD. = .90) Mathematics for Industry knowledge problem ($\bar{X}$ = 3.70, SD. = .78) English Language knowledge problem respectively ($\bar{X}$ = 3.70, SD. = .86)

1.2 Vocational Skills Problems

First of vocational skills problems is Design and Drawing circuit skill ($\bar{X}$ = 3.75, SD. = .94) Secondly is Using Computer to Process and Collect Data skill ($\bar{X}$ = 3.73, SD. = .91) Measuring and Checking circuit skill ($\bar{X}$ = 3.72 , SD. = .94) Using Technology skill ($\bar{X}$ = 3.66, SD. = .82) Creating circuit skill ($\bar{X}$ = 3.64, SD. = .90) Maintenance devices skill ($\bar{X}$ = 3.59 , SD. = .89) devices testing skill ($\bar{X}$ = 3.58, SD. = .81) Create Project of Industry skill ($\bar{X}$ = 3.57, SD. = .96) respectively

1.3 Good Attitude towards Work Problems

First of good attitude towards work problems is Enthusiasm ($\bar{X}$ = 3.88, SD. = .88) Secondly is Work Success Oriented Mind ($\bar{X}$ = 3.83, SD. = .85) Honesty in Work Duties ($\bar{X}$ = 3.81 , SD. = .93) Development knowledge from resources center ($\bar{X}$ = 3.80, SD. = .86) An effort solve problem ($\bar{X}$ = 3.71, SD. = .77) To be consistent in work ($\bar{X}$ = 3.61, SD. = .83) Have reason in to listen idea of colleague ($\bar{X}$ = 3.64, SD. = .95) To Suggest Matter for Consultation ($\bar{X}$ = 3.60, SD. = .89) Punctuality ($\bar{X}$ = 3.60, SD. = .91) To devote time give with work and function ($\bar{X}$ = 3.58, SD. = .94) respectively

2. Comparison of the needed of development of practical competencies, according to teacher professional requirement (Electrician)

Table - 1 Shown the comparison of vocation Knowledge requirement

	vocation Knowledge	Electrical Engineering		Electric Engineering		Computer Engineering		F-test	Sig
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.		
1.	Knowledge of Thai communications in vocation	3.00	1.000	3.90	0.664	3.70	0.984	2.676	073
2.	Knowledge about English	3.00	1.000	3.62	0.590	3.82	0.769	2.711	070
3.	Knowledge about security	3.33	0.577	3.97	0.523	4.21	0.600	4.862	009**

4. Knowledge about mathematics for Industrial technicians	3.00	0.000	3.82	0.573	3.97	0.770	3.490	034*
5. Knowledge about science applications	3.00	0.000	3.80	0.539	3.64	0.603	3.899	023*
6. Knowledge about electrical devices and electronics	4.00	0.000	3.90	0.536	4.18	0.635	3.044	051
7. Knowledge about rules and formulas	3.33	0.577	3.59	0.744	3.76	0.561	0.992	374
8. Knowledge about Device testing	3.33	0.577	3.91	0.657	4.18	0.584	3.679	028*
9. Knowledge about Circuit designs	3.67	0.577	4.03	0.601	4.24	0.663	2.086	129
10. Knowledge about Industry management	3.67	0.577	3.84	0.616	4.09	0.631	2.257	109
11. Knowledge about Electrical technology	3.00	0.000	4.01	0.545	3.85	0.619	5.394	006**
12. Knowledge about Approximate Price	4.33	0.577	4.22	0.510	4.21	0.650	0.068	935
13. Knowledge about using computer to Design and drawing circuit	4.00	1.000	4.17	0.483	4.15	0.712	0.150	861
14. Knowledge about measurement	4.00	1.000	4.18	0.443	4.45	0.564	4.077	019*

Table - 2 Shown the comparison of vocation Skills requirement

Vocation Skills	**Electrical Engineering**		**Electric Engineering**		**Computer Engineering**		**F-test**	**Sig**
	$\overline{X}$	**S.D.**	$\overline{X}$	**S.D.**	$\overline{X}$	**S.D.**		
1. Skills in read and design the circuits	3.67	0.577	4.40	0.515	4.39	0.609	2.688	.072
2. Skills in use computer to Process and Collect Data	3.33	0.577	3.73	0.697	3.97	0.529	2.359	.099
3. Skills in Checking Circuit	3.33	0.577	3.86	0.779	3.73	0.761	0.945	.391
4. Skills in use technology	3.67	0.577	4.21	0.565	4.21	0.781	1.090	.339
5. Skills in Create Tools	3.67	0.577	4.01	0.545	3.82	0.882	1.372	.257
6. Skills in Create Equipment	3.33	0.577	3.96	0.467	3.79	0.696	2.902	.059
7. Skills in Create Project of Industry	3.00	0.000	3.72	0.746	3.73	0.674	1.458	.237
8. Skills in Control Electric Circuit	3.67	0.577	3.98	0.593	4.12	0.696	1.109	.333
9. Skills in Create Circuit	4.00	0.000	4.37	0.569	4.21	0.740	1.221	.298
10. Skills in Maintenance Devices	3.67	0.577	4.29	0.584	4.15	0.712	1.963	.145
11. Skills in Measuring and Checking Circuit	3.67	0.577	4.23	0.697	3.97	0.637	2.525	.084
12. Skills in Practicing	3.33	0.577	3.62	0.823	3.52	0.906	0.325	.723
13. Skills in Basic Electric Industry	3.33	0.577	3.75	0.586	3.75	0.696	0.749	.475
14. Skills in Basic Electronic	3.33	0.577	3.53	0.544	3.64	.742	0.570	.567

Table – 3 Shown the comparison of Good Attitude towards Work requirement

Good Attitude towards Work	Electrical Engineering		Electric Engineering		Computer Engineering		F-test	Sig
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.		
1. Concentrade on work	4.33	0.577	4.41	0.558	4.73	0.452	4.357	.015*
2. Work Success Oriented Mind	4.33	0.577	4.29	0.545	4.58	0.561	3.205	.044*
3. Development knowledge from resources center	4.00	1.000	4.34	0.519	4.18	0.528	1.483	.231
4. An effort solve problem	4.00	0.000	4.14	0.585	4.33	0.479	1.629	.200
5. Maintenance machine	4.577	0.333	.557	0.058	.683	0.119	1.337	.266
6. Cleaning machine/and equipment	4.33	0.577	4.24	0.581	4.15	0.619	0.325	.723
7. To be consistent in work	4.33	0.577	4.25	0.547	4.24	0.561	0.037	.963
8. Punctuality	4.00	1.000	4.30	0.508	4.52	0.566	2.553	.082
9. Honesty in Work Duties	4.00	0.000	4.30	0.508	4.61	0.556	4.952	.009**
10. devote time for work and duty	4.00	0.000	4.28	0.599	4.36	0.603	0.607	.547
11. Show well-mannered with the boss	3.67	0.577	4.22	0.571	4.36	0.653	2.185	.117

Table – 3 Shown the comparison of Good Attitude towards Work requirement (or)

Good Attitude towards Work	Electrical Engineering		Electric Engineering		Computer Engineering		F-test	Sig
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.		
12. Show well-mannered with the friend and woke-man	3.67	0.577	4.25	0.460	4.24	0.614	1.938	148
13. Work group to create	4.00	0.000	4.30	0.550	4.42	0.502	1.196	306
14. To Suggest Matter for Consultation	3.67	0.577	4.34	0.519	4.42	0.614	2.671	073
15. Have reason in to listen idea of colleague	3.67	0.577	4.33	0.494	4.42	0.614	2.880	060
16. Practicable in order by intend	4.00	1.000	4.29	0.504	4.36	0.549	0.729	485
17. Help associate some time	3.67	0.577	4.15	0.553	4.27	0.674	1.650	196

Table 4 Competency requirement of the teacher (electrical teacher)

Knowledge property in the vocation	Agreement Level		
	$\overline{X}$	S.D.	Agreement Level
1. Knowledge of Thai communications in vocation	4.2500	.50196	High
2. Knowledge of English	4.2188	.54610	High
3. Knowledge of security	4.1641	.55808	High
4. Knowledge of mathematics for Industrial technicians	4.1094	.56449	High
5. Knowledge of science applications	4.0781	.62253	High
6. Knowledge of electrical devices and electronics	4.0859	.53282	High
7. Knowledge of laws and calculating	4.0703	.56378	High
8. Knowledge of devices testing	4.0703	.65428	High
9. Knowledge of circuit design	4.0625	.59855	High
10. Knowledge of Industrial administration	4.0547	.70217	High
11. Knowledge of electrical technology	4.0156	.56099	High
12. Knowledge of estimates	3.9766	.56770	High
13. Knowledge of circuit design by computer	3.9688	.65132	High
14. Knowledge of measuring instrument	3.9544	.57928	High

Skills property in the vocation	Agreement Level		
	$\overline{X}$	S.D.	Agreement Level
1. Ability to read and design the circuits	4.3828	.54874	High
2. Ability to use computer to evaluate and record data	4.3203	.61393	High
3. Ability to test the devices	4.2422	.62426	High
4. Ability to use technology	4.1953	.62819	High
5. Ability to make an instrument	4.1484	.83739	High
6. Ability to make an equipment	4.0078	.62110	High
7. Ability to make industrial project	3.9531	.65037	High
8. Ability to control electrical circuit	3.8984	.54469	High
9. Ability to make an electrical circuit	3.8125	.77103	High
10. Ability to repair the devices	3.7813	.66330	High
11. Ability to measure and check the circuit	3.7031	.72481	Average
12. Ability to practice	3.5859	.68837	Average
13. Ability to operate basic industrial electrical			
14. Ability to operate basic electronics			

Attitude property in the vocation	Agreement Level		
	$\overline{X}$	S.D.	Agreement Level

Attitude property in the vocation	Agreement Level		
	$\overline{X}$	S.D.	Agreement Level
1. concentrate on work	4.4922	.54695	High
2. Result based approach	4.3750	.59339	High
3. Demonstrate to learning outside	4.3672	.55940	High
4. Attempt to solve the problem	4.3516	.54107	High
5. Conserve an electrical device	4.3438	.55327	High
6. Cleaning machine/and equipment	4.3359	.53650	High
7. Attend class constantly	4.3281	.53403	High
8. Punctuality	4.3047	.52585	High
9. Honesty in Work Duties	4.3203	.56028	High
10. Devote time for work and duty	4.2969	.53241	High
11. Show well-mannered with the boss	4.2891	.53466	High
12. Show well-mannered with the friend and woke-man	4.2500	.54700	High
13. Work group to create	4.2422	.59850	High
14. To Suggest Matter for Consultation	4.2344	.50951	High
15. Have reason in to listen idea of colleague	4.2187	.58777	High
16. An effort solve problem	4.2031	.59339	High
17. To help organize or community	4.1875	.55769	High

Results on Competency requirement of the teacher (electrical teacher), first knowledge property in the vocation to total up agreement level high, second skills property in the vocation to total up agreement level high, third attitude property in the vocation towards to total up agreement level high.

Table 5 Competency of electrical teacher

Competency of electrical teacher	Agreement Level		
	$\overline{X}$	S.E.	Agreement Level
1. Mathematics and calculation	4.2812	.61478	High
2. Science	4.1641	.60102	High
3. Basic of electrical and electronic	4.1484	.60301	High
4. Drawing and design by computer	4.1484	.54830	High
5. English	4.1094	.59932	High
6. Basic practical	4.1094	.57202	High
7. Measuring and testing the instrument	4.0937	.62036	High
8. Basic electrical instrument	3.9922	.71226	High
9. Security and Pollution control	3.8672	.50563	High
10. Electrical device maintenance	3.7734	.66237	

Results on competency of electrical teacher, most competency of electrical teacher that is mathematics and calculation, next below is science, basic of electrical and electronic, drawing and design by computer, English, basic practical, measuring and testing the instrument, basic electrical instrument, security and pollution control and electrical device maintenance

Table 6 CORRELATIONS

Competency requirement of the teacher (electrical teacher) Needed			
P-value	Knowledge	Skills	Attitude
Knowledge	-	.749**	.743**
Skills	.749**	-	.802**
Attitude	.743**	.802**	-

Results on correlations between competency requirements of the teacher (electrical teacher) needed. Respondents of correlation knowledge, skill and attitude in problems and obstacles and competency requirements of the teacher (electrical teacher) needed has correlation kind of significant 0.01

Conclusion

The purposes of this research were to Capacity requirement of the teacher (electrical teacher) include vocational knowledge, vocational skills, Good attitude towards work and competency of electrical teacher. The samples student of Electrical technology education department in Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi number 81 person. The Results on Competency requirement of the teacher (electrical teacher), first knowledge property in the vocation to total up agreement level high, second Skills property in the vocation to total up agreement level high, third attitude property in the vocation towards to total up agreement level high. Results on competency of electrical teacher, most competency of electrical teacher that is mathematics and calculation, next below is science, basic of electrical and electronic, drawing and design by computer, English, basic practical, measuring and testing the instrument, basic electrical instrument, security and pollution control and electrical device maintenance. Results on correlations between competency requirements of the teacher (electrical teacher) needed. Respondents of correlation knowledge, skill and attitude in problems and obstacles and competency requirements of the teacher (electrical teacher) needed has correlation kind of significant 0.01

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Contact email: nathwut.kow@.kmutt.ac.th
tanes_kmutt@yahoo.com

The International Academic Forum (IAFOR)
Sakae 1-16-26-201
Naka Ward, Nagoya, Aichi
Japan 460-0008
ww.iafor.org