Abstract
This paper presents the use of infographics to support knowledge retention and to draw the links between key concepts. Often, foundational concepts in word heavy texts are not extricated. Hence students fail to see the overview of these concepts. The use of infographics will facilitate the learning process. Ready-made infographics may be presented as semantic summaries of texts that students need to comprehend. Here, Infographics could be embedded in self-study and in-class group activities and are used to summarise the students’ understanding. The different types of infographics and examples of their uses are provided in this paper.

Keywords: Infographics, visual representation, instructional visuals, higher education teaching and learning
Introduction

Infographics are a pictorial representation of information, data, or knowledge targeted at presenting complex information quickly and clearly (Sudakov et al., 2014, p.1). They are designed to make such information eye-catching, shareable and easily digestible. Through this, readers are able better to visualise the ‘big picture’ that might be otherwise difficult to understand. Given that 60% of the world population are visual learners, it is timely to pay heed to use infographics to help learners think visually and to support learning. Because of the complexity of unravelling and recollecting complex information, infographic is also useful for recall. The usefulness for recall has been cited in different studies.

Harrison, L., Reinecke, K. & Chang, R. (2015) have suggested the importance of designing for instant recall and impression, and their research results showed that exposure effect could allow people to form a reliable first recall based largely on the use of colours and visual complexity. Several studies further indicated that aesthetics in visualisations can lead to better engagement and better memory of data as revealed in Borkin et al. (2013).

In another study, Welinske (2012) discussed applying user research, usability testing and visual design techniques to printed publication. Their research discovered students having little or no memory of information found in a text-laden high school booklet. With changes in the layout and inclusion of infographics, students were better engaged and better able to make out the connections between the different topics. This is not surprising since many introductory textbooks or e-textbooks treat topics as a series of discrete topics with little emphasis on how the contents are related. Students typically begin the study without seeing how the concepts fit together. Infographics could be used to have a broader view of concepts across study units.

Increasingly, students are adopting mobile internet access. Coupled with the oversaturation of digital content, students’ attention spans are shorter than ever. Thus, content presented in the chunks of text can be very off-putting for them. The integration of infographics into teaching, thus, becomes important.

The Conceptual Framework

Different infographics can be created to teach different parameters across the different disciplines. This could include definitions, calculations, theories, procedures, concepts, facts, processes, and principles. To this end, we are proposing that these functions could be represented visually, and they could be summarised in Figure 1. The use of infographics could cut across different disciplines. Using real data, it can be used meaningfully in ways that promote learning.
<table>
<thead>
<tr>
<th><strong>Main Parameters</strong></th>
<th><strong>Instructional Visuals</strong></th>
<th><strong>Examples of Infographics</strong></th>
</tr>
</thead>
</table>
| “Ideas.” Definition, Concepts, and theories | Definition | Enable students to integrate term meanings while working through the material. | • Mnemonic visuals to provide retrieval cues for factual information  
• Pictures |
| Theories | Interpretive graphics to illustrate abstract or cause-and-effect relationships. | • Schematic diagram |
| Concepts | Organisational graphics to show qualitative relationships among content elements. | • Diagrams/Charts  
Visual analogies for abstract concepts i.e. examples and counterexamples |
| Statistic Facts | Representational and organisational graphics to illustrate concrete and discrete facts. This could include metrics such as sales, revenue, market research, surveys | • Pictures/Diagrams/Charts  
Mnemonic visuals to provide retrieval cues for factual information |
| Process and Procedures Processes | Chunking and sequencing graphics to show how processes can be applied to real work scenarios in logical steps. This reduces cognitive overload. This could include processes involving manufacturing, customer service, sales funnel, lead generation, supply chain | • Flowcharts/Timelines/Charts  
• Visual analogies to represent abstract processes |
| Procedure s | Transformational graphics to show steps to perform a procedural task Related to real work scenarios. Emphasise transfer of learning | • Flowchart  
• Animated diagram |
| Principles Principles | Interpretive graphics to teach as a theory. Case studies with articles linked, and related course concepts highlighted in the same screen. | • Diagrams/Charts  
• Representational visuals of the job environment  
• Videotaped cases |
| Calculation s Calculations | Relational graphics to calculations | • Equations  
• Charts |
| Chronology Chronology | Chronological graphics showing history, order of | • Chronological graphics |
| Geography | Geographical | Maps showing locations, metrics by region | • Representational maps |
| Compositio n | Compositio n | Charts showing ingredients, components, lists | • Diagrams/Charts |
| Hierarchy | Hierarchy | Organisational graphics showing structure needs assessment | • Organisational graphics |

Figure 1: Instructional Visuals for Different Infographics

In the case example on the teaching of “Customer Relationship”, the communicative function could be expressed below:

<table>
<thead>
<tr>
<th>Key Topics</th>
<th>Functions</th>
<th>Examples of Infographics</th>
</tr>
</thead>
</table>
| Customer Relationship Management and Social Media | Concept | • Mnemonic visuals to provide retrieval cues for factual information  
• Pictures |
| Value of the customer base | Calculation | • Equations  
• Charts/graphs |
| Customer Insight, Dialogue and Social Media | Principle | • Representational visuals of the job environment  
• Links to videotaped cases |
| Interacting with Customers | Process | • Flow charts  
• Interpretive visuals such as visual analogies for abstract processes |
| Britton and Barnes relationship theories | Theory | • Schematic diagram |
| Customer loyalty | Concept | • Mnemonic visuals to provide retrieval cues for factual information  
• Pictures |

Figure 2: Evolution of Relationships with Customers – The Thinking Behind Customer Relationships

An illustration of a specific example of visual mnemonics can be found below in figure 3. In this example, the infographic draw attention to the key points on the use of social media to develop customer relationship.
Infographics could be used to present case analysis. Interpretive visuals such as visual charts and analogies could be leveraged for this purpose. In the example given below, visual chart is used to show the different car hire companies and feedback data given by customers. Hence, at one glance, students are able to analyse and have a macro understanding of the car hire industry and customers’ perception to the different car hire’s services. Mundane statistics can be brought to life when conveyed using interesting visuals.
In another example, visual analogies for abstract concepts or examples and counterexamples are utilised in infographics to capture the main idea and essence of the idea conveyed. The iceberg is used as a useful metaphor to understand the different layers of complaints, part of which is immediately visible and part of which emerges and submerges with the tides, and with the more deeply-rooted ones going largely unknown by management, beneath the surface. Ubiquitous visual symbols or analogies could be used to draw attention to key information. Such analogies allow learners to apply existing knowledge or schema to understand what is new without the need to read a large amount of text.

**The Customer Complaint Iceberg:**

![Image of the Customer Complaint Iceberg]

**Figure 5:** A Visual Analogy of Customer Complaint Iceberg, retrieved from: [http://www.adrianswinscoe.com/not-many-complaints-but-still-losing-customers/](http://www.adrianswinscoe.com/not-many-complaints-but-still-losing-customers/)

Visuals are often used to draw attention to figures given. It encourages visceral comprehension. It creates flashes of insight that engages students to want to discover more and to trigger discussion in the industry with the most complaints.

**Figure 6:** Visuals for Comparison of Complaints
Different Uses of Infographics

At our University, student work with several study media – the textbook, study guide, chunk lectures, and slides. There are altogether six study units per course. The use of infographics will facilitate the learning process by highlighting key concepts and connections. From the instructor’s point of view, such infographics can be recreated as an assessment of students’ conceptual understanding. For example, an infographic is created as a form of self-assessment towards the end of a lesson. See figure 7.

![Figure 6: Infographics for Self-Assessment](image)

Infographics could also be presented as semantic summaries of texts that students need to comprehend. They could also be integrated with other class activities conducted, and the activities could include:

- Brainstorming
- Case studies and analysis
- Debates

As we move into 21st century, knowledge construction, problem-solving and knowledge integration using more innovative approach becomes more important. There is also a need to find better ways of engaging 21st-century learners through more effective visuals such as 3D infographics and using apps and other forms of communicative technologies.

Infographics Online Apps

There are numerous free tools and online apps available to create beautiful infographics. Some of these free tools or apps have restricted access to graphics content. Most of them operate on a subscription model for individual use or corporate use and some comes with 3D vector for creating 3D infographics.
Table 1: Infographics Online Apps/ Software adapted from “Tools - Cool Infographics” (http://www.coolinfographics.com/tools) and “The 6 best tools for creating infographics (http://www.creativebloq.com/infographic/6-best-tools-creating-infographics-21619)

**Video or Animated Infographics**

As we move into 21st century, students have come to relying more on communicative technology for knowledge construction, problem-solving and knowledge integration. In an attempt to address this, there is a gradual shift towards the use of animated and dynamic infographics. In animated infographics, information, data and statistics are presented through a blend of images and words, with added motion, audio tracks or even music and voice over. They help make content interesting which might otherwise come across as mundane.
To make narratives or large complex information set more meaningful, the following techniques are often used:

- Using motion graphics to depict a story line or present a narrative
- Using interactive content to depict information from different angles, multiple steps or components, which viewers can self-navigate.

There are numerous tools that support animated infographics. Some are designed using HTML5 or Flash. Examples of software embedded with HTML5, Flash, CSS3, SVG or Javascript to help develop animated infographics are given below:

<table>
<thead>
<tr>
<th>Software</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infogram</td>
<td>This tool is useful for creating data-centric infographics. The infographics can be embedded into its websites, be read off mobile phones, tablets, and desktops and they are responsive and interactive. Several templates are available to choose from, and they are easily shareable on social media.</td>
</tr>
<tr>
<td>Bokeh</td>
<td>A Python interactive visualisation library that targets modern web browsers for presentation</td>
</tr>
<tr>
<td>Charte.ca</td>
<td>It helps to create free interactive charts created online in seconds</td>
</tr>
<tr>
<td>Chartle</td>
<td>Chartle.net simplify the complexity of online visualisations - offers simplicity, ubiquity and interactivity instead.</td>
</tr>
<tr>
<td>ChartsBin</td>
<td>ChartsBin is a web-based data visualisation tool that allows everyone to create rich interactive visualisations with data</td>
</tr>
<tr>
<td>Flare</td>
<td>Flare is an ActionScript library for creating visualisations that run in the Adobe Flash Player</td>
</tr>
<tr>
<td>SandDance</td>
<td>SandDance experiments with a new genre of visualisations, where every data element is always represented on the screen, to help people explore, understand, and communicate insights in their data (Tools - Cool Infographics, n.d.)</td>
</tr>
<tr>
<td>Silk</td>
<td>Silk creates interactive visualisations — charts, graphs, grids and tables</td>
</tr>
<tr>
<td>amCharts</td>
<td>It adds interactive map functionality to your web pages and JavaScript-based applications</td>
</tr>
<tr>
<td>Maps</td>
<td></td>
</tr>
<tr>
<td>Tableau Public</td>
<td>Tableau Public is free for anyone who wants to tell stories with interactive data on the web.</td>
</tr>
<tr>
<td>Visme</td>
<td>With Visme, you can turn your infographic into an interactive infographic with built-in animations. The infographic could be shared as a URL. Web visitors can see the animated infographic upon visiting and as they scroll down the page depending on the animations set. This is useful if you have a teaching site. The infographic can be locked-down with a</td>
</tr>
</tbody>
</table>
password if it is to be shared it online with a target audience. This is a useful feature if you are working remotely and need to share it with the team before the infographic is shared publicly. (The 6 best tools for creating infographics, Creative Bloq, n.d.)

| **Adobe Illustrator** | It is a program used by graphics designers and artists to create logos and digital images. |
| **Adobe After Effects** | It is the industry-standard tool to do digital visual effects, video compositing, animation and motion graphics design. It is used in the post-production of filmmaking. |
| **Adobe Animate CC (formerly Flash)** | It can be used to create animated content ranging from animated cartoons, games, advertisements across platforms. This includes HTML5, Flash Player & Air, Web GL and Snap SVG. |

Table 2: Tools supporting animated infographics production, adapted from “Tools - Cool Infographics”.
http://www.coolinfographics.com/tools

Over and above the paid licensing of Adobe, free online video makers for making infographics are also available in the public domain. The two popular ones are www.animaker.com and www.biteable.com, and they come with readily made templates.

In the example presented below, students may prepare an interactive map showing the customer increase or decrease in a franchise case study of a coffeeshop. The size of the customer base and the positive/negative trending are represented by the size of dots and the colours. When one hovers his or her mouse over the location of the chain represented by dots, the number of customers each franchise receives automatically appears. The colouring red represent a fall in numbers compared to previous year while a green colouring represents an increase in customers. Students are able to visually see the track customer base across the different coffee outlets in Singapore and to do trend analysis.

Figure 7: A dynamic map showing customer base in *Bedok* branch
The purpose of this dynamic map is to help students organise the knowledge that they bring to the course and to be used as a tool for applying that knowledge to investigating causes and problem-solving a case. Increasingly, there is need to learn how to create interactive infographics. In Multimedia classes, ICT students can be taught to write a simple Java program to present interactive infographics for their lessons, group presentation or as part of their assignment.

In recent years, we also saw infographics presented using augmented reality. Marxent Lab in the US built Augmented Reality (AR) Animated 3-D Infographics for its clients. It is an AR viewer app that allows one to hover over Augmented Reality markers to start an interactive 3D experience.

**Conclusion**

From our experience, we note that the instructor would certainly benefit if they are actively conducting interdisciplinary research. Infographics are believed to be a useful and effective tool in the educational process that would increase interest in learning within different disciplines. In summary, the collection of infographics promotes the incorporation of theory, concepts, principles and formulas, and disseminates critical applications to students. This kind of integration, in turn, strengthens the understanding and applications of the discipline studied. While infographics are commonly encountered in advertisements, they are lesser known for use in teaching, and their potential is still under-explored. We would like to suggest that there is much potential for their use, especially in light of the more recent developments in 3D or animated infographics.
References


Progress in developmental research (pp. 169-200).


Smiciklas, Mark (2012), a. Infographics Inside the Organisation; b. The Power of Infographics; c. The ROI of Infographics


