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DESIGNING INFOGRAPHICS FOR THE EDUCATIONAL TECHNOLOGY COURSE: PERSPECTIVES OF PRE-SERVICE SCIENCE TEACHERS

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Abstract. *Despite the existing research on technology use in tertiary education, there is limited scholarly literature on the use of infographics in education or on the effective design of infographics specifically for educational settings. By employing qualitative research, the researcher attempts to explore the learners' perception of the use of infographics. This research involved the researcher working independently on an in-class research project with 40 third-year undergraduate students. The pre-service science teachers were required to individually create an infographic related to the upper secondary school science curriculum. The findings indicated that the pre-service teachers expressed positive viewpoints about the infographics assignment. When the pre-service teachers were engaged in the learning process, they had a sense of agency and responsibility for their learning. The findings also indicated that this research created a meaningful experience for the pre-service teachers in engaging technology. This research essentially promoted innovations in teaching and learning of the course that encouraged student engagement with technology.*

Keywords: *educational technology, infographic, pre-service science teachers, science education.*

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Introduction

Today's technologies are revolutionising the way people communicate and learn. In the epoch of globalisation, technology appears to be at the forefront of the educational field. The rapid change from teacher-centred to learner-centred instruction in the classroom has contributed to the widening use of technology to enhance teaching and learning in higher learning institutions. The integration of technology equips new generations of learners with meaningful skills to succeed in the 21st century where technology is construed as an important resource. According to Dias and Atkinson (2001), technological integration in tertiary education encompasses the entire continuum of self-directed teaching and learning practice, interactive learning software, online assessment, accessibility to online information, communication and publication. Akinde (2016) suggests that the integration of technology is driven predominantly by the current educational technology trends in the educational settings. The significance of the technology-rich learning environment in a higher learning institution has become a required strategy in educational development, as the conventional, teacher-centred instructions are not able to muddle through with the high demands of the digital natives. The concurrent combination of technology, pedagogy and content knowledge in teaching and learning have a great impact on understanding the challenges and opportunities in the teaching and learning in tertiary education (Lye, 2013). In the case of Malaysia, "Malaysia e-learning Policy 2.0" was introduced by the Ministry of Higher Education in 2011 to specifically support the Higher Education Strategic Plan which requires the e-Learning framework that aims to develop quality world-class human capital through the utilisation of information and communications technology (ICT). Hence, higher education should meet the growing demands for knowledge and skills through the implementation of innovative pedagogical tools and methods.

Focus of the Research

The use of innovative technology-enhanced media as a pedagogical tool has been the subject of great interest in education and has remained a prevalent approach in the last few years (Dabbagh & Kitsantas, 2012; Ferreira, Baptista & Arroio, 2013; Potter & Banaji, 2012). Many educators have reported success in attempts to integrate tools such as blogs, wikis, and social

networks into their instructional and assignment design (Ferreira, Baptista & Arroio, 2013; McLoughlin, 2011; Wolf, Beckem & Matias, 2011). In line with the current development, the use of visualisations has increased significantly. Moreno et al. (2001) describe visualizations as the non-verbal mode of representing content knowledge, which includes photos, illustrations, graphics, drawings, maps, animations, simulations, and video. The infographics are part of data visualisation that can present complex information quickly and clearly. Infographics are considered as an effective tool for communication and transfer of information (Ferreira, Baptista & Arroio, 2013; Lamb, Polman, Newman, & Smith, 2014; Lazard & Atkinson, 2015; Smiciklas, 2012). Due to this attribute, infographics have emerged as a popular visual approach to efficiently deliver abstract and complex instructional content to support students' learning (Lamb, Polman, Newman & Smith, 2014; Smiciklas, 2012; Vanichvasin, 2013).

Krum (2014) defines infographics as graphic design that combines data visualizations, illustrations, text, and images together into a format that tells a comprehensive description. This definition is close to the definitions presented by Toth (2013) and Lamb and Jhonson (2014). Toth (2013) defines infographics as materials created as a combination of visuals and texts that are prepared in order to provide easy and understandable information about a subject to their readers. Lamb and Jhonson (2014) describe infographics as a visual presentation of information, which is prepared for readers to visualize the information that is normally difficult to understand. Infographics provide information to be a part of a certain flow (Krum, 2013). This way, information can be efficiently presented with a minimum explanation, and at the same time, the relationships of the content can be provided, as mentioned by Lester (2011). In other words, infographics offer new ways of engaging a logical sequence in order to present the content in an interesting way (Abilock & Williams, 2014; Lamb & Jhonson, 2014; Yildirim, 2017). Since infographics can easily present extensive information, they can be used to serve other purposes such as reminding the available information, showing the relationship between concepts, transfer of processes and events, presentation of course content and summarizing the information obtained (Meeusah & Tangkijviwat, 2013; Yildirim, 2017). Lamb et al., (2014) and Smiciklas (2012) explain that infographics should encapsulate sufficient details in one visual while still being clear and precise. Davidson (2014) and Lamb and Jhonson (2014) propose the basic features of infographics including infographics should be simple, be able to present complex information quickly and clearly, integrating visuals and texts for the presentation of information, self-explanatory and attractive for readers. Therefore, in order to create an engaging infographic, students may develop critical thinking, analysis and synthesis skills of designers and it can lead the students to acquire innovative instructional design skills (Hart, 2013; Yildirim, 2017).

In view of the fact that infographics are widely accepted and used as a device for efficiently delivering content, it needs to be precise, and clear in delivering an abstract, complex, and dense instructional content (Dunlap & Lowenthal, 2016; Siricharoen & Siricharoen, 2015). Despite all the existing research on new technological use in the higher education classroom, the literature on using infographics in teaching remains limited at best. Studies on the best practices in teaching that make use of infographics either as an information-sharing tool or as a method of evaluating students' work are difficult to find (Dunlap & Lowenthal, 2016; Siricharoen & Siricharoen, 2015). It is important for educators to understand how students process the information contained in infographics since infographics can provide a way to reach students with varied learning styles, particularly visual learners (Lankow et al., 2012; Smiciklas, 2012). Furthermore, Davis and Quinn (2013) suggest that effective and well-prepared infographics can work as useful learning materials to support the development of students. Similarly, Lazard and Atkinson (2015) state that infographics consisting of text and visuals have a positive effect on the growth of the readers. The purpose of the present research is, therefore, to explore the pre-service science teachers' perceptions about creating infographics for the teaching and learning of an educational technology course. This research focuses on the following research question: What are the pre-service science teachers' perception about creating infographics for the teaching and learning of an educational technology course?

Methodology of the Research

General Background

By employing the qualitative methodology, the researcher attempted to illuminate how incorporating a graphic design assignment into the coursework encouraged and challenged the students' scientific content and technological literacies. The research was designed to be used in an educational technology course associated with the Bachelor of Science with Education at a public research university in Kuala Lumpur, Malaysia.

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Participants

This research involved researchers working independently on an in-class research project with 40 third-year undergraduate students (17 male, 23 female) for one semester (14 weeks). The students ranged in age from 21 to 22 years old. The course, Technology in Science Education focuses on assisting these pre-service science teachers in integrating existing and new expanding technologies into science education which are based on learning theories. At the end of this course, the pre-service teachers should be able to create hypermedia learning environments that will be able to incorporate stimulating and interactive lessons in the teaching and learning of science in school.

Procedures and Data Collection Technique

This research involved pre-service science teachers working individually in creating an infographic by utilizing various tools for creating infographics that were available online. They had the autonomy to create a content-rich infographic on a topic of their choice. The topics, however, must be related to the scientific content from the secondary school science subjects (Biology, Physics or Chemistry). The pre-service teachers must be able to demonstrate the subject-specific knowledge about the topic. This task was used as part of their continuous assessment with a weightage score of 25 percent.

There are a number of free infographic makers that can be employed to create infographics; some are more user-friendly than others. The pre-service teachers were introduced to tools such as Canva, Piktochart, Venngage and Infograms at the beginning of the course, but they were required to explore it further and choose the most suitable tool to use in creating their individual infographics. Hence, some students went on to explore, use and combine other tools such as Adobe Photoshop to generate their infographics. Their willingness to explore further related tools supported Saat et al. (2016) and Grieve, Padgett, and Moffitt's (2016) arguments that current students no longer hold negative perceptions about using technology in teaching and learning. To facilitate the students, all the information regarding the tasks was posted to the course e-learning portal (refer Figure 1).

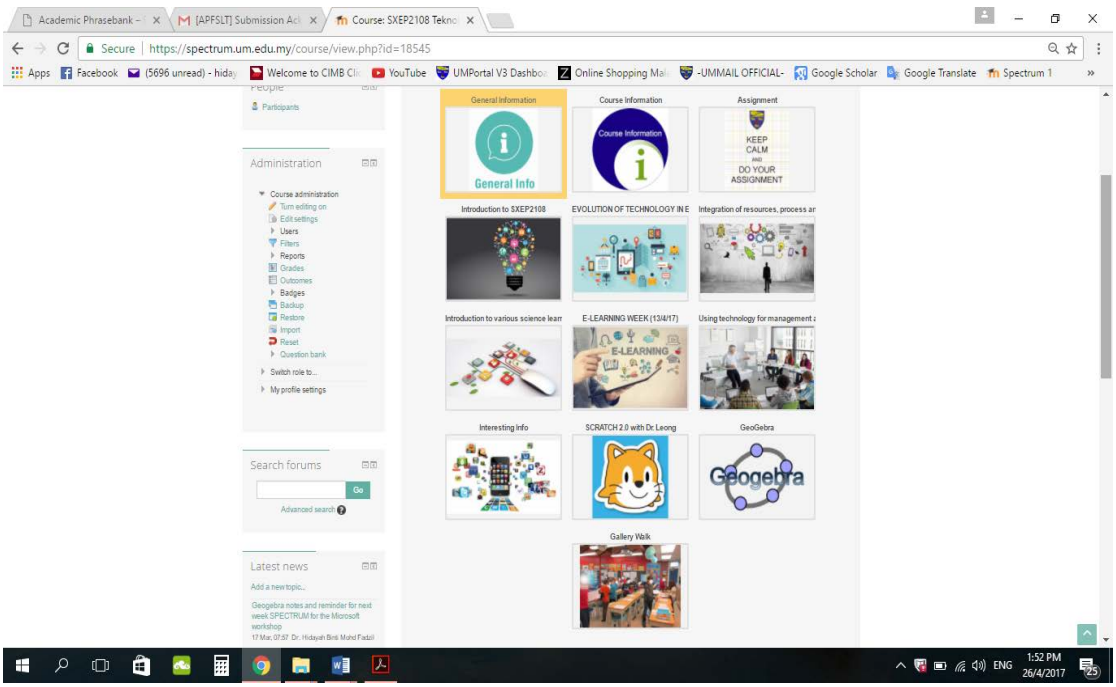

Figure 1: Snapshot of the e-learning platform for the Technology in Science Education course.

The nine-step process in creating the content specific infographic Krauss (2012) was employed to guide the pre-service teachers during the research (refer Figure 2). The researcher observed and facilitated the pre-service teachers during the duration of the course. The pre-service teachers were instructed to share their infographics

through a gallery walk activity at week 7 which marked the course's mid-semester break. At the end of this task, they were required to submit their reflection pertaining to their experience in creating an infographic and uploaded it at the course e-learning portal.

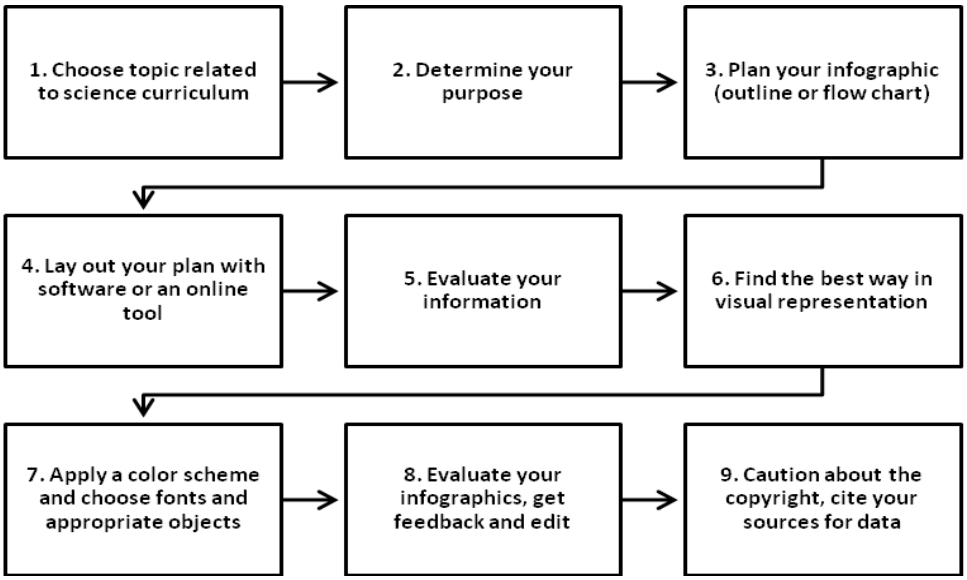

Figure 2: Nine-step process in creating infographic (adapted from Krauss, 2012).

Data Analysis

The students' infographics were analysed using an infographic rubric that assessed the suitability of the chosen topic, content, objects, data visualization, fonts, organization of information and citation of sources used in the infographics. The reflections of the pre-service science teachers were analysed using constant comparative data analysis technique (Glaser & Strauss, 1967). This data analysis technique was utilized to answer the research questions posed by this research. It involved the process of coding, categorizing and developing themes from the information that emerged from the collected data, which can best describe the phenomenon under research. This is in line with the view that refining the thematic framework of the research involves a logical and intuitive thinking in making sure that the research objectives are being addressed appropriately (Ritchie & Spencer, 1994). The researcher observation notes during the gallery walk activity and throughout this research were also used as a triangulation method to support the findings of this research.

Validity and Reliability

While designing a qualitative research, validity, and reliability are two issues that a researcher should be concerned about (Golafshani, 2003; Patton, 2002). Qualitative researchers need to ensure the rigor without sacrificing the relevance of the qualitative data. In this research, the themes identified during the data analysis were evaluated through the peer review process. Peer review is regarded as one of the techniques used to enhance the credibility and trustworthiness of qualitative research through the use of external peers. The process of peer review in this research involved two experts from the field of educational technology and qualitative research in science education. The experts were asked to independently review the emerging themes from the findings and provide constructive comments and feedbacks. Another approach implemented in this research was triangulation. Triangulation is one of the strategies for improving and enhancing the internal validity of research in order to control bias. According to Bryman (2006), triangulation refers to the use of more than one approach to the investigation of a research question in order to develop confidence in the ensuing findings. Triangulation should support the findings by showing corroboration or a confidence interval, as claimed by Greene, Caracelli and Graham (1989).

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Engaging multiple methods such as observation, the use of reflection notes, and analysis of infographics will lead us to more reliable, accurate and trustworthy findings and they may reduce the uncertainty of the interpretation.

Ethical Considerations

Prior to commencing the research, ethical clearance was sought from the pre-service science teachers. All the participants volunteered to take part in the research and were assured of their confidentiality and privacy. They were also required to fill an online informed consent form as a proof of their acceptance.

Results of Research

The findings illustrated that most of the pre-service science teachers in this research were able to independently produce an informative, well-structured and visually appealing infographic (for example refer Figure 3 and 4). Three themes also emerged from the analysis of the pre-service science teachers' reflections and the researcher's observation notes. The themes were: (i) the infographic assignment created a meaningful experience for the pre-service science teachers, (ii) the infographic enhanced the pre-service science teachers' conceptual knowledge and (iii) the attributes of a good infographic should be accredited to the pre-service teachers.

Meaningful Experience in Creating the Infographic

This theme was concerned with the manner in which the pre-service teachers described how their participations in the innovative assignment had created a meaningful experience for them. The finding shows that when the students were engaged in the learning process, they experienced a sense of agency and responsibility for their learning efforts. They generally expressed positive feelings towards the infographic assignment even though all of the pre-service teachers admitted that this was the first time they were introduced to the infographic maker tools. Student 14 described developing infographic as "*the most exciting and interesting activity, compared to the common report-based assessment and classroom presentation".*

The pre-service science teachers explored different tools in creating an infographic and decide on the infographic-maker of their choice. For instance, one of the pre-service teachers explained that she tried using Canva and Piktochart to compare both tools and decided to use Canva as it was user-friendly and had many choices of free templates. Student 4, on the other hand, admitted that he learned how to use Canva by viewing YouTube tutorial videos and even tried other tools such as Piktochart and Venngage but found that after comparing the three, Canva was the easiest to use and navigate. Therefore, based on the pre-service teachers' feedbacks on creating an infographic, it was verified that this assignment might promote independent learning through multiple resources such as YouTube videos, tutorial videos on the particular infographic website and blogs.

The integration of technology-based assignment in creating the infographics has also contributed positively to pre-service science teachers' attitudes about technology. As a result, these teachers became more exposed to technological use and innovations. The following excerpt, for instance, illustrates Student 39's reflection regarding the integration of technology in this research:

> *I got the chance to familiarize myself with the infographic maker that was available online to make my teaching and learning stimulating. I realized that technology could be very beneficial to us especially in the educational field (Student 39)*

The pre-service teachers also shared their interest to transfer the skills in creating infographics in their future career as science teachers, as mentioned by Student 7 in the following excerpt:

> *This knowledge of creating infographics was beneficial as it works as alternative approaches to teach the scientific concepts to my digital natives' students. I can integrate the skills in creating infographics and scientific knowledge to come out with interesting infographics for the science subject that I have to teach in the future (Student 7)*

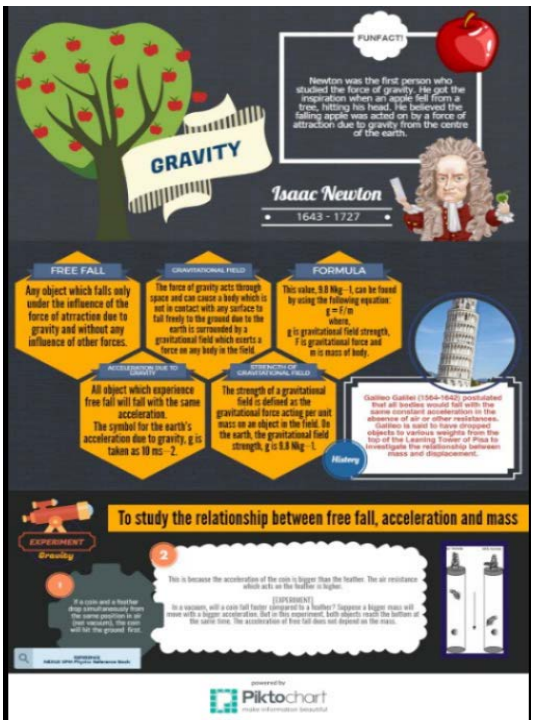

Figure 3: Student 13 infographic.

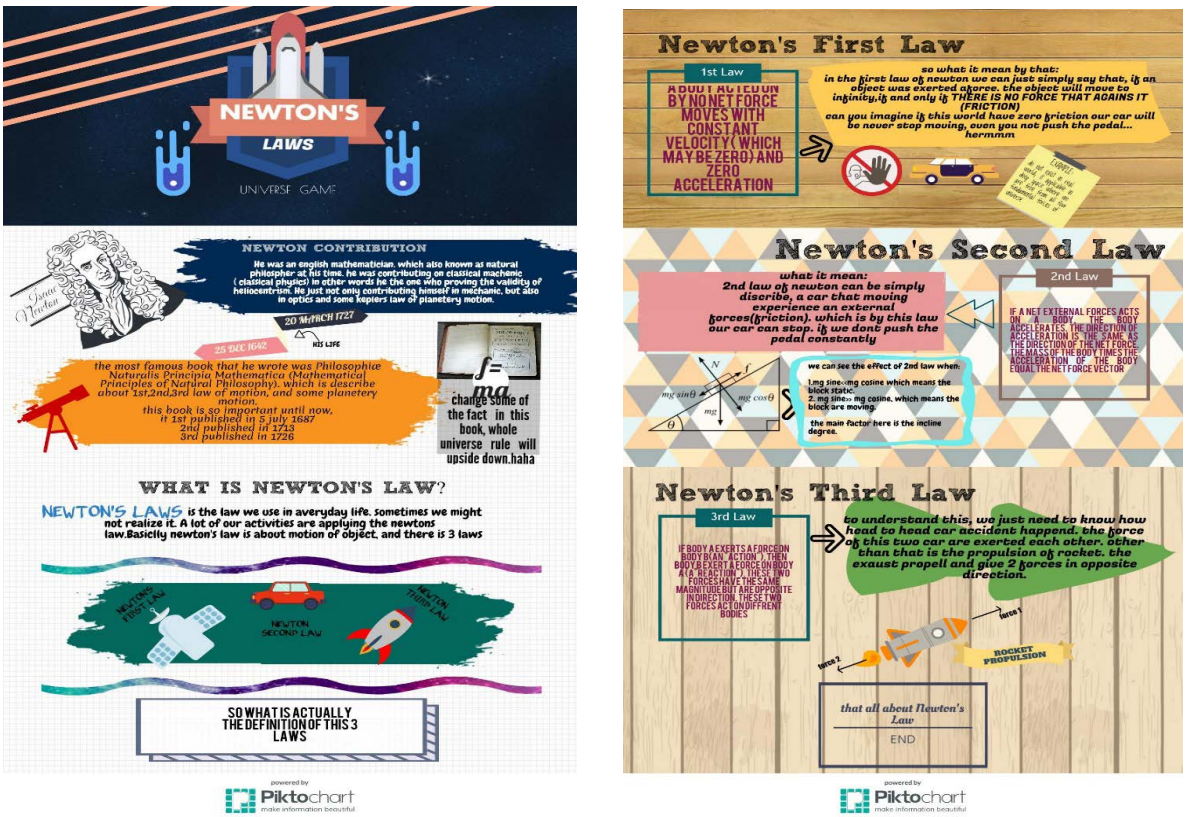

Figure 4: Student 25 infographic.

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Infographic Enhance Understanding of Conceptual Knowledge

The second theme that emerged from the findings was concerned with the manner in which the pre-service teachers explicated that this innovative assignment enhanced their understanding of conceptual knowledge in science. The infographic exposed the pre-service teachers to scientific concepts that were not related to their major courses. The pre-service science teachers in this course were majoring in Physics, Biology or Chemistry. However, they needed to teach the general science subject later in school. Thus, these pre-service teachers were expected to comprehend general scientific concept and theories that would enable them to teach science in secondary school. Student 36 explained that, "*I have gained much knowledge from Biology infographics. I did not take Biology subject during my secondary school thus I have a limited knowledge of this subject*". Student 34 who was a Biology major also shared his interest in learning Newton's law and the application of the law from his friend's infographics during the gallery walk activity.

The pre-service teachers also agreed that the infographics can enhance their understanding of scientific concepts and that the process of creating an infographic was "*especially great for displaying unexciting or complex data in a way that is more visually engaging and easy to understand*" (Student 12). Infographics provided a way in explaining the scientific concept in an interesting manner. Student 4 explained that "*the infographics incorporated pictures and diagrams related to the scientific concepts, which makes the topic easy to understand especially for secondary school students and visual learners*". Another student commented that, "*in order to deliver the basic concept of science and technology, I realised that infographics create a platform that improvise a concrete conceptual scientific content into a graphic representation that describe the complex information efficiently with minimum explanation*" (Student 3). The pre-service teachers also reflected on the need to highlight some information over others.

Attributes of a Good Infographic

The third theme that emerged in this research explicated the attributes of good infographics based on the perspective of pre-service science teachers. An engaging infographic should not only be graphically stimulating, but it should also include appropriate structure, accurate content and appropriate depth of information. In this particular research, Student 5 explained that "*I had seen a variety of infographics presented by my course mates. I realized that when constructing an infographic, the most important thing that we must consider is how to get the information across effectively. The visual elements used in the infographic should also be able to support the information given*". Student 9 also "*realized that good infographics should convey the right message*".

Student 14 described that the information in an infographic should be well-arranged and systematically presented in order to ease the reader's understanding of the topic. Another student opined that an infographic needed the creator to exercise creativity so that it is easy to understand and aesthetically pleasing. At the same time, it should be able to provide graphical contents and useful information (Student 9). Almost all of the pre-service science teachers expressed their appreciation of the opportunity to observe their course mates' efforts and creativity in creating the infographics during the gallery walk activity. The following excerpts illustrated the pre-service science teachers' responses regarding their course mates' efforts in creating the infographics;

> *I got the chance to observe my friends' efforts and creativity. I believed this is the first time for everyone (in creating infographics). (Student 12)*
> *I observed how my friends interpreted their idea creatively and reflected it graphically in their work. (Student 16)*
> *I got so much information from my friends, and I realised how creative my friends were. (Student 40)*
> *I am amazed by my course mates' creativity in developing infographics. (Student 25)*

Challenges in Creating Infographics

The fourth theme was concerned with the manner in which the pre-service teachers described the challenges in creating their infographics. Most of the pre-service teachers explained that creating the infographics was time-consuming. Student 19 explained that "*I managed to come out with a good infographic even though it was time-consuming, and I am proud of my product*". Student 23 described her experience as challenging and time-consuming since she was not digitally savvy but she "*felt very pleased, and this was a great experience for me*".

Some of the pre-service teachers admitted that this assignment was quite challenging as they were required to

explore the infographic-maker first before they can decide which tool suited their needs. Then they were required to master the skills of using the infographic maker, in order to create their own infographics. They completed all these through online tutorials, as previously explained. The following excerpt explained Student 26's challenging experience in creating his infographic;

> *I decided to use Canva. At first, I did not realize that we can put shapes or lines on top of the text and that we can insert frame at the images, so I just did basic things like insert background, text and upload images. When I saw my friend edited his work in Canva, I asked him to teach me the new skills. So, I need to adjust and modify the background, the content arrangement, font and colours, which took me more than 4 hours. The most challenging part was to make the word or text appear clear. I needed to re-adjust the font and colour of the text and background (Student 26)*

The third challenge was the limitation of the free infographic maker itself. Most of the free infographic makers had limited features. For example, Student 27 explained that "*I used Piktochart as the tool to design my masterpiece. Pikochart is a very useful software but the limitation of this tool is that you cannot save your work as a PDF document. You have to pay a certain amount of money to be able to use that feature.*"

Discussion

This research explored pre-service science teachers' perceptions about creating infographics in the teaching and learning of educational technology course. Infographics have become one of the new trends in today's learning approach since they included visualization of information which enables knowledge to be presented in different visual forms (Ferreira, Baptista & Arroio, 2013; Lamb, Polman, Newman, & Smith, 2014; Lazard & Atkinson, 2015; Smiciklas, 2012). The research indicated that technology-based projects were believed to have a positive influence on the pre-service teachers' active learning and allowed them to independently create infographics as products of their learning. Meyer, Haywood, Sachdev and Faraday (2008) suggested that the key to their concept of independent learning was the shift of responsibility for the learning process from the instructor to the learner. These required the learners to acquire an understanding of their learning process, to be motivated to learn and to collaborate with instructors to structure their learning environment. This finding is also in line with the research by Artun (2016).

In this research, the pre-service teachers were enthusiastic about the opportunity to take complex scientific concepts and displayed them in a visual form. They described how their participation in the innovative assignment had created a meaningful experience for them. As they engaged in this activity, they were developing skills related to the critical processing of key content from the scientific concepts that they had selected. They identified their intended audience and decided on the best information that should be included in their infographics. The skills in the filtering of information are considered as one of the important digital literacy skills (Artun, 2016). Thus, the infographic assignment permitted the pre-service science teachers to apply vital skills necessary for the educational technology course, such as content curation and content production.

Content curation is the process of sorting through vast amounts of content on the web and communicating it in a meaningful and systematic way (Artun, 2016). The work involved scrutinizing, organizing and arrangement of information around a specific issue. It can thus be deduced that the infographic assignment required the pre-service science teachers to acquire a variety of skills which included cognitive skills, technical skills, digital skills, skills related to the communication of information and innovative instructional design skills, as suggested by previous studies (e.g. Artun, 2016; Hart, 2013; Yildirim, 2017). This research has demonstrated how a graphic design assignment could be incorporated as part of the challenges that the students had to overcome to complete the assignment and subsequently encouraged their visual digital literacies. The findings exhibited that the infographics assignment contributed positively to the pre-service science teachers' viewpoints about technology. These findings were in agreement with those obtained by Reed (2007), Chan Lin (2008) and Sasova (2011). As a result, the pre-service science teachers admitted that they had become more open to technological use and innovations in the teaching and learning of science.

The second theme that emerged from the findings was concerned with the manner in which the pre-service teachers explicated that the infographics enhanced their understanding of the conceptual knowledge in science. Thus, it will be beneficial for pre-service teachers to acquire the skills to create engaging infographics to facilitate students' understanding of science. Based on the research conducted by Sacopla and Yangco (2016), teachers

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should be encouraged to equip themselves with the skills in designing infographics so that they will be able to address the needs of visual learners to facilitate recall and retention and thus improve the coding skills that lead to conceptual understanding. The findings of the research seemed to be consistent with other research which found visual representations to be one of the most effective tools in the communication of scientific concepts (Cook, 2011; Ferreira, Baptista & Arroio, 2013; Lamb, Polman, Newman, & Smith, 2014; Lazard & Atkinson, 2015; Smiciklas, 2012). Sacopla and Yangco (2016) and Cook (2011) argued that science would be very challenging without the support of graphic representation for some topics that involved concepts that were too small (e.g. cells, enzymes), too large (e.g. solar system, continental drift), too slow (e.g. decomposition), too fast (e.g. chemical reactions), to see with the unaided eye. Infographics were also used to represent processes that were difficult to describe, such as photosynthesis and cellular respiration (Cook, 2012). Therefore, these findings were in line with those of the previous studies which indicated that the use of infographics in teaching and learning of scientific concepts were more effective in improving learners' conceptual understanding as compared to the use of the didactic approach (Cook, 2011; Ferreira, Baptista & Arroio, 2013; Lamb, Polman, Newman, & Smith, 2014; Lazard & Atkinson, 2015; Smiciklas, 2012). This result may be explained by the fact that the content curation processes aided in decongesting the scientific content and eliminating irrelevant information that made the concepts more organized and connected to prior knowledge. The pre-service teachers had critically analysed, explored, evaluated and reflected their work on the chosen scientific topic. Therefore, the results of this research promoted the use of infographics to enhance the conceptual understanding, especially in teaching scientific subjects with complex topics.

The third theme that emerged from this research explicated the attributes of good infographics based on the perspective of the pre-service science teachers. The pre-service science teachers clarified that the infographic should not only be graphically stimulating but it should also include appropriate structure, accurate content and appropriate depth of information. This is in line with Ware (2012) who asserted that an effective infographic communicates the essence or fundamentals of a message without requiring someone to read the associated text thoroughly. In other words, the reader should be able to determine the subject of an infographic at a glance. The infographic creators must think about the logical sequence in order to present the content in an interesting way, whether the decoration is required, or what type of infographic would be appropriate for presenting the main idea (Abilock & Williams, 2014; Lamb et al., 2014; Yildirim, 2017). If a decoration can be an obstacle for the readers to understand the main idea of the infographic, possibly certain objects may need to be removed. The pre-service teachers explained that good infographics should be able to present complex information effectively by integrating visuals and texts for the presentation of information. These findings were in accord with recent studies indicating that infographics should encapsulate sufficient details in one visual while still being clear and precise (Davidson, 2014; Lamb et al., 2014; Smiciklas, 2012; Yildirim, 2017). Even though the pre-service teachers admitted that creating infographics was time consuming as this was their first experience creating the infographics and utilizing an infographic maker, all of them agreed that this assignment served as an excellent experience for them. Kos and Sims (2014) in their research also encountered problems in terms of the limitations of the free online software. Another noticeable learning curve was also detected among less technologically savvy students. Some of the pre-service science teachers took a considerable amount of time to learn how to use the software before they could start creating infographics. These findings matched those observed in earlier studies (Kos and Sims, 2014; Yildirim, 2017).

Conclusion and Implications of the Research

In the light of these findings, it can be concluded that developing infographics promotes innovations in teaching and learning of the course that encourage student engagement in using technology. The research identifies emerging findings from the experience gained through the infographics assignment, and from the pre-service teachers' feedbacks. It can be deduced that infographics can be recognized as an appropriate tool that can enhance the understanding of conceptual knowledge by providing an interesting way to explain scientific concepts. However, it is essential that the pre-service science teachers realized that science cannot be captured or understood through 'key concepts' alone. Producing infographics requires considerable thoughts, and it forces the creator to think about their audience and how best to communicate the key concepts to them. The research also suggested that this kind of creative assignment required the students to practice technological competencies required to participate in an increasingly visual digital culture. The pre-service teachers may in future incorporate infographics in developing instructional materials to reinforce the learning of the science subject to produce scientifically and visually literate students. Despite the inherent limitation of this research due to its small scale and the lack

of generalizability (which is not the underlying aim of this research), the findings of this research, to an extent, indicate the need for an alternative and complementary practice in the educational technology course for the pre-service teachers. To date, there are limited studies conducted to explore the effectiveness of using infographics in teachers' education, particularly for science education. While creating infographics may be considered as a useful approach in educational technology, further investigation is needed in order to determine how infographics should be objectively assessed as it undoubtedly involves some aesthetic elements which are an unfamiliar territory for academics in field of science education.

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