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DESIGNING MOBILE AUGMENTED REALITY TO ENHANCE VISUALIZATION SKILLS IN LEARNING ABSTRACT CONCEPT IN CHEMISTRY

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1.1 INTRODUCTION

For the last few decades, integrating technology in teaching and learning in the classroom has been an important issue. According to Lee et al. (2013), there are several meta-analyses have been conducted in order to examine the specific modes or educational practices that can enhances the effectiveness of student learning and teaching with technology. The digital technologies that being used now is not limited to the usage of computer only. There are others digital technologies also arise which are the mobile devices, digital media creation and distribution tools, video games and social networking sites (Collins and Halversont, 2010).

The NMC Horizon Report: 2013 Higher Education Edition listed out the six technologies that to highlight emerging technologies with considerable potential in education. One of the technology is tablet computing. The benefit of using the tablet computing relieves the burden of complex IT infrastructure
management and the cost savings on the maintenance of the applications (Chandra and Borah, 2012). Besides the development of technologies, a considerable amount of excitement among academics also generate because of the transformation of traditional learning to tablet (Kim, 2012).

One example of the integration of tablet computing application in education is Augmented Reality (AR). Many researchers believe that this integration can improve student learning and performances (Chen and Tsai, 2012). According to Clemens, Purcell and Slykhuis (2013), AR is a live, direct or indirect, view of a physical, real world environment whose elements are augmented by computer-generates sensory input such as sound, video, graphics or GPS data. The latest technologies in AR are Mobile Augmented Reality (MAR) which AR had been used in the mobile applications (Danakorn et al., 2013). Danakorn et al. (2013), also stated that MAR have make a learning more meaningful and overall participants from the previous study felt motivates, enjoyed and show a positive educational effects on participants. This will improve the engagement in the learning performances of the students. Other than that, to ensure the learning process will create a meaningful learning with the help of visualization tools, there are some principles or guides should be followed in designing the AR in education.

1.2 PROBLEM BACKGROUND

The advanced technology that emerged in education is now being explored in order to solve the problems in the teaching and learning process. This is because the traditional chalk and talk teaching method and the use of static textbooks are failing to engage students and leading to poor learning outcomes. According to McClenny and Greene (2005), the students claimed that every week chalks and talks routine is boring and this lead to the decreasing of the engagement of students to the subject. Technology is one of the solutions to help in solving this problem.
which technology encourages active learning and computers application rarely make the students bored (Marshall, Cartwright and Mattick (2004). Nowadays the energetic generation need challenges and often bored in traditional classroom and they prefer quick interactions with content which required visualization skill (Black, 2009). In addition, Wu, Krajcik and Soloway (2001) also claimed that computerized models can serve as a vehicle for students to generate mental images which then will help the students visualize and understand better.

1.3 DIFFICULTIES TO VISUALIZE THE ABSTRACT CONCEPT IN CHEMISTRY

Chemistry is one of the electives science subject and the core to the others part of sciences which is less interested by student in Malaysia (Phang et al., 2014; Osman, Ikshan and Halim, 2007). This is because the student found it is hard to understand. Chemistry is a science subject that will equip the student with the knowledge that can help them in problem solving, decision making and also will need they think critically and scientifically in order to find a solution. There are many research have been conducted that shows the students are weak in chemistry and they always fall in the misconception problems (Nahum et al., 2004; Daniel, Kang and Sai, 2001; Ozmen, 2004; Duis, 2011). According to Uzuntiryaki and Geban (2005), students have difficulties in understanding most of the abstract concepts in chemistry and hold misconceptions which lead to the prevention of meaningful learning.

Palmer (2010) claimed that misconception among the student has to be taken into account because it can interfere with student’s learning of scientific principles and concepts. There are many research have been conducted in identifying student’s misconception in chemistry (Nakiboglu and Tekin, 2006; Stefani and Tsaparlis, 2009). Thus, the selection of teaching method plays an important factor in avoiding the student’s misconception
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(Palmer, 2010). Chemistry will be the topics that commonly will involve when talking about the problems in the visualization in sciences education. This is because chemistry is a visual science which visualization plays a major role in daily practices (Wu and Shah, 2003). Chemical bonding is one of the examples of basic topic which contain an abstract concept that cannot be directly applied to everyday life. Thus, students face difficulties in understanding the chemical bonding concept (Uzuntiryaki and Geban, 2005).

Nahum et al. (2004) stated that from the research conducted around the world, it shows that the concepts associated with chemical structure and bonding, such as molecules, ions, hydrogen bonds, and giant lattices are abstract. These abstract concept will create difficulties that may lead to misconception because of the students have a fundamental misunderstanding. As example in chemical bonding, there is great potential for the formation of alternative conceptions as students try to derive meaning from what is said by the teacher or what is written in the textbooks because the concepts of the topic is abstract (Daniel et al., 2001).

Besides scientific concepts, many scientific ideas and models are also complicated and sophisticated to be taught in schools. Thus, Taber (2001) suggests that school curriculum should include representations of science. There is also research by Kelly and Jones (2008), which found that many students are able to correct their misconceptions after viewing either static molecular visualizations or animations.

According to Mohd Nor and Nur Afza (2010), there are few problems in the study of chemical bonding that lead to the misconception among the students such as students cannot identify the type of bonding and still answering single and double bond, instead of the right answer which are covalent and ionic bond. Besides they also found that the students cannot identify the conditions of every chemical bond that form between the elements. Students also cannot master in drawing the diagram of the electron sequences for the ionic compounds and covalent compounds. Thus,
make the diagram that they are drawn become dysfunctional. Other than that, the problems in the topics of chemical bond that exist among the students are they cannot draw the Lewis structure in the right way. This is because they do not understand the concept and they cannot visualize the abstract concept (Mohd Nor and Nur Afza, 2010).

Thus, effective teaching strategy or new tools to enhance the teaching and learning qualities which can help in the visualization of abstract concept in chemistry for example chemical bond should be developed. According to Campbell et al. (2010), tools or technologies in classroom learning is good to enhances visualization of complex concept and also will eventually facilitate communication and collaboration between the students. Besides the visualization skill can also be improved with the help of technology which has ability to mentally manipulate complex spatial dimensional and 3D figures (Tsai and Yen, 2014). But, according to Wu and Shah (2003), visualization tools should be designed appropriately to make sure that the visualization tools are really relevant to be used by all the students and hence will create a meaningful learning.

1.4 MAR ENHANCE STUDENTS’ VISUALIZATION SKILLS

Horizon Reports from 2004 to 2011 highlighted the potential of mobile devices to be adapted in the future. Thus, AR is now being developed and designed to be integrated in a mobile devices. According to the Martin et al. (2011), the mobile technologies most likely will affected the education fields. Martin et al. (2011) also stated that the current and the most potential mobile technologies that expected will be emerged widely is mobile augmented reality (MAR). MAR provide the user ease which it is not constraining the user to used it in specific areas (Hollerer and Feiner, 2004). Houser, Thornton and Kluge (2012) stated that mobile devices have advantages over desktop PCs because mobile
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devices have the ability to move with the user.

AR is proven can enhance the visualization skills of the student. This is supported by the statement claimed by Kalföken et al. (2011) which they said that AR is a powerful visualization tool for exploring real world structures along with additional contextual information. AR also shows a great potential in visualization which it can also increase the understanding and ease the learning of chemistry for students by visualizing and controlling virtual models of molecules (Maier and Klinker, 2009). Beside the advantages of AR in enhances the visualization skills, AR also shows a positive responses from the participants that experiencing the AR technology.

AR by Burton et al. (2011) shows a result that participants were clearly excited about the potential that this technology has for sharing information and learning about new concepts. The usage of AR using a smartphone also known as mobile augmented reality (MAR) allows learning experience that is linked to the formal classroom, so that students can learn outside of class hours and outside of school limits (Burton, 2011). Future research suggests improving the internet portability in order to facilitate user’s access to the system and students and potential users can use it anytime and anywhere (Lamounier et al., 2010). This will give opportunity to the students to use AR using a smartphone and give them first-hand experiences on how powerful AR can be as a learning tool and the amount of content knowledge they can gained through their interaction with the smartphone activity. This is in line with the development of MAR in education field as reported in the Horizon Reports 2004-2010.

1.5 PRINCIPLES FOR DESIGNING VISUALIZATION TOOLS IN CHEMISTRY

Designing is important part in developing a multimedia tools for teaching and learning. Every tool that developed should be followed and considered certain criteria to make sure that the
developed tools really make sense and then achieved the objectives. Rio, Sabrina and Guan (2012) stated that designing learning materials and pedagogical aspects of teaching and learning should be taken into consideration before the development process. AR is one of the learning materials which will act as visualization tools that may help in the teaching and learning process. Thus, it is important to design properly before developing the AR. In this research, AR is used as MAR that will be used as a visualizations tool that helps in learning chemical bond. The designing of MAR in chemical bond should consider a lot of things to make sure that the learning process on the topics will be smoother. This is because the ability of the student in visualization is differences.

Therefore, Wu and Shah (2003) listed five principles that should be taking into account when designing visualizing tools in chemistry. The principles are listed as below:

1. Providing multiple representations and descriptions
2. Making linked referential connections visible
3. Presenting the dynamic and interactive nature of chemistry
4. Promoting the transformation between 2D and 3D
5. Reducing cognitive load by making information explicit and integrating information for students.

These five principles also will be applied in designing MAR for teaching and learning because AR is one of the visualization tools that highlighted had a potential enhanced visualization skills as stated previously. To make sure the designed MAR created a meaningful learning to the students, these 5 principles will be applied. Table 1.1 shows the detailed on how the MAR designed that developed based on the principles by Wu and Shah (2003).
Table 1.1 The MAR for learning chemical bond that designed based on Wu and Shah (2003) principles.

<table>
<thead>
<tr>
<th>Principles</th>
<th>MAR designed</th>
</tr>
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<tbody>
<tr>
<td>1 Providing multiple representations and descriptions.</td>
<td>Provide other representation such as audio and text rather than just learning by using visual only for a better understanding due to the differences of student ability to visualize (see Figure 1.1).</td>
</tr>
<tr>
<td>2 Making linked referential connections visible.</td>
<td>Provide a hint by highlighting the electron that will transfer or shared with differences color from the others electrons in the atoms. Therefore, the students will understand that there is something will going on the highlighted electrons.</td>
</tr>
<tr>
<td>3 Presenting the dynamic and interactive nature of chemistry.</td>
<td>Provide a visual that are dynamic and the atoms are represent in differences color and in 3D images (see Figure 1.2).</td>
</tr>
<tr>
<td>4 Promoting the transformation between 2D and 3D.</td>
<td>Provide both 2D and 3D simultaneously. The 2D images/visuals will be display in the minibook while the 3D will be visualized using the MAR. Thus, the students will be able to see both representations simultaneously.</td>
</tr>
<tr>
<td>5 Reducing cognitive load by making information explicit and integrating information for students.</td>
<td>The content of the information’s that being delivered by MAR is followed the syllabus of KBSM on the topic of Chemical Bonding. So, the syllabus will be definitely already considered the cognitive load to make sure that it can be understand by the students.</td>
</tr>
</tbody>
</table>

Table 1.1 shows that every principle that is applied has their own functions enhance the students’ visualization level. This is important to make sure that every student will understand and having a meaningful learning by learning using the visualization tools.
Figure 1.1 The examples of visual, text and sound on MAR

Figure 1.2 The examples of the differences colors and 3D images on MAR
1.6 CONCLUSION

Mobile phone or tablet computing professed high degree of comfort and familiarity with the affordances available with the technology which it enhances portability compared to laptops. From the above discussion, it’s proven that technology especially AR really can be used in order to enhance visualization skills. It also may help the students to encounter the difficulties in visualization of abstract concept in chemistry. However, the designing of the visualization tools includes MAR is important to make sure that the learning process is meaningful. When the designing take place, the interactivity of the visualization tools will be increased and also will let the students to interact more with the visualization tools as how it been designed. The designing process also important in helping differences level of students in understanding the information delivered by the visualization tool. So, it is crucial to take into account the design of the developed visualization tools in order to enhance students’ visualization skill. Other than that, MAR should be explored more to discover the potential that exist for improving the process of teaching and learning.

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