Development of students’ creative thinking skills in chemistry using Mobile Game-Based Learning (M-GBL) with integrated creative problem-solving

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ABSTRACT: This study explored the development of creative thinking skills by using a Mobile Game-Based Learning (M-GBL) media chemistry using the topic of ion equilibrium in salt solution. The M-GBL media used in this research has been validated regarding chemistry content by educational experts, while the pilot study has been validated by experts, students and teachers. The research was conducted in three chemistry classrooms of three secondary schools. Data were collected through participant observation using interviews, observation, a reflective journal and a questionnaire. The research quality standards included prolonged engagement, persistent observation, progressive subjectivity and member checking. The interview results show that the students developed their creative thinking skills in flexibility to find ideas in different ways, original ideas, fluency in generating ideas and elaborative thinking. The results concluded that in learning chemistry, especially in the topic of ion equilibrium in salt solution, M-GBL had a positive effect and can also develop students’ creativity.

1 INTRODUCTION

Mobile technology is very popular among today’s users, including students. The advent of mobile technology is changing students’ learning, including mobile game-based learning. This is because mobile game-based learning is a unique way that can be used by learners anywhere and at any time (Ally, 2009). Mobile technology can improve communication significantly and can be used in learning (Imran, 2007), as it has roles in attracting and motivating students toward learning and engagement (Scott et al., 2015). Teachers can develop mobile game-based learning assessments, considering the factors affecting students, including motivation (Shin & Han, 2016). Based on studies, there is a statistical difference between teaching with a mobile game-based approach and traditional media (Nouri et al., 2014). Learning using mobile game-based learning media can improve student learning outcomes and independence (Cahyana et al., 2017). Additionally, the education system based on student’s needs is easily adopted and very promising in improving student learning outcomes and independence (Hwang et al., 2013).

Mobile and web-based learning have a positive influence on creative thinking ability (Lin, 2014). Learning, based on mobile approaches, also has a significant effect on students’ attitudes and other soft skills such as creative thinking skills, group work collaboration and sharing information in group activities (Cavus & Uzunboylu, 2009). Students who receive creative thinking teaching through mobile game-based learning reveal higher performance in their creativity than those receiving conventional teaching (Lin & Wu, 2016).

Students’ problem-solving and creative thinking skills can be developed by designing a learning environment integrated the mobile game-based and the creative problem-solving the model. Based on a Global Creativity Index study in 2015, Indonesia has a low creativity index (0.202), ranked 115 of 139. The results of the creativity index were based on three indicators
(technology, talent and tolerance). Therefore, teaching using mobile game-based learning with integrated creative problem-solving models can develop students’ creative thinking skills in the chemistry topic of ion equilibrium in salt solution.

2 METHOD

This research was conducted in three schools in Indonesia during the 2017/2018 academic year. There were 36 students from class XI using the Mobile Game-Based Learning (M-GBL) media that had been validated by experts and tested by students and teachers. Data were collected through observation, interviews, a reflective journal and a creative thinking skill questionnaire. The research quality standards included prolonged engagement, persistent observation, progressive subjectivity and member checking. The analysis will explore how M-GBL helps students to think creatively, covering each aspect of creativity (flexibility, fluency, originality and elaboration).

3 RESULTS AND DISCUSSION

3.1 The analysis of students’ creative thinking skill of flexible thinking aspect

Creative thinking skill in the aspect flexible thinking means that students are able to produce many ideas and have different ways of thinking, that be seen when the students given by a problem so they can thinking many kind of way to solve the problems. In this research, the effort is to use the M-GBL media, so the analysis concerns the effect of using M-GBL media on students’ creativity in the aspect of flexibility.

From Table 1 and Table 2, it can be said that the students have positive answers in relation to the use of M-GBL media as their way to get some ideas, both in learning and solving problems. This indicates that the students’ creative thinking skill in flexible thinking aspect is caused by learning using M-GBL as an alternative way that helps them produce ideas. Students’ spirit can make them produce many ideas and participate actively during learning. It is due that they are given the opportunity to convey and provide ideas in their own way, besides the material is considered easy for students, learning activity is not monotonous, they can provide ideas different ways, and learning resources that not only use the book. The features contained in M-GBL also attracts the attention of students so that they are more enthusiastic in participating in learning chemistry. This result is in accordance with Chiang, Yang, and Hwang research in 2014 which found that the use of M-GBL improves students’ motivation in the dimension of attention and satisfaction. This is because of the ease of using the media.

<table>
<thead>
<tr>
<th>No</th>
<th>Statements</th>
<th>Results (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Strongly agree</td>
</tr>
<tr>
<td>1</td>
<td>I use the M-GBL media to solve problems on ion equilibrium in salt solution matter</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>When the teacher explains about ion equilibrium in salt solution, I find out more about it using the M-GBL media</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>When the teacher gave a problem, I can’t think of any solution nor the way to convey the solution idea</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>The use of M-GBL media makes me complete my own assigned tasks</td>
<td>30</td>
</tr>
</tbody>
</table>
and its interesting appearance, as well as the additional features such as games and animation. The existence of game features also attracts students to learn more deeply. Various types of games, which are contained in this media, provide many choices for students. In the quiz section, there are several levels that can test the level of student understanding, along with the discussion which will allow students to better understand the question answers. The animation feature, which contains experimental videos, also increases students’ understanding of self-learning using the media.

Based on this aspect result, which shows that the use of M-GBL media is an effective way to produce ideas, students participate in giving ideas and provide concepts in different ways. These results are supported by Cavus and Uzunboylu’s (2009) study, which suggests that learning with M-GBL has a significant effect on students’ attitudes and other soft skills such as positively influencing student creativity, developing a collaborative attitude in work and sharing information in group activities.

3.2 The analysis of students’ creative thinking skill of original thinking aspect

Creative thinking skill in the aspect original thinking means giving unusual answers, different from others or answers rarely given by most people. Student behavior, in the aspect of originality, is seen when students are able to think about problems or things that others never think of.

Table 3 and Table 4 show a good result for their creative thinking skill in the originality aspect, which indicates that students made a good effort to create new ideas and were capable of thinking in different ways than others. From the overall data above, some students were
shown to be able to produce new ideas. Problem-based learning, contained in the games on mobile devices, uses various ways to help students understand concepts and resolve various issues. Some researchers believe that the teaching materials and techniques are not as good as having children learn via games by having fun and being happy (Norman, 1981). Games are easily accepted and used by students (Kafai, 1995). Furthermore, games can help students develop problem-solving skills (Seonju, 2002; Chuang & Chen, 2009; Lee & Chen, 2009; Blumberg et al., 2008; Shih et al., 2010). M-GBL is presented as an alternative to help students understand chemistry by using games on mobile devices, which can help students to produce new ideas, demonstrating the originality aspect in creativity.

3.3 The analysis of students’ creative thinking skill of fluent thinking aspect

Aspects of fluent thinking refer to the number of ideas produced in an appropriate response. Student behavior, in this aspect, can be seen from students’ ability in answering a number of questions fluently and expressing their ideas independently.

Table 3. Results of questionnaire on original thinking aspect.

<table>
<thead>
<tr>
<th>No</th>
<th>Statements</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>While doing a task, I was able to think of ways that no one else had thought of</td>
<td>16</td>
<td>58</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>I have a different way of thinking than others</td>
<td>19</td>
<td>52</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>I never try to give a new idea after reading or hearing ideas which have existed</td>
<td>2</td>
<td>8</td>
<td>58</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 4. Results of the reflective journal, observation and interview for original thinking aspect.

<table>
<thead>
<tr>
<th>Reflective journal</th>
<th>With using books and the application, I can think of alternative solutions, even my friends could not think of</th>
</tr>
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<tbody>
<tr>
<td>Interview</td>
<td>I like when the teacher gave freedom in answering, from a lot of learning sources including the application, so I can think of new ideas because of many learning facilities provided</td>
</tr>
<tr>
<td>Interview</td>
<td>The teacher commands to think of alternatives from any point of view, and find different original solutions from our own minds</td>
</tr>
<tr>
<td>Observation</td>
<td>Many students are trying to find an alternative. Students use books, mobile learning applications and the Internet</td>
</tr>
</tbody>
</table>

From the overall data above, the students are capable of producing and providing their ideas independently and answering questions fluently. This result is accordance with Zan’s (2015) research that suggests that the use of mobile media in chemistry learning can build students’ positive attitude and make the learning process easier than another learning methods. The study shows that students who receive creative thinking teaching in a mobile based approach reveal a higher performance in the creativity of fluency, flexibility, uniqueness and elaboration than conventional teaching. It proves that mobile and web-based creative thinking teaching could stimulate students’ creation potential (Lin & Wu, 2016).
The analysis of students' creative thinking skill in the elaborative aspect

Aspects of elaborative thinking refers to students’ ability to develop, add and detail an idea. Detailing in this case is that they can explain details about an object or idea so that it is more interesting. Students’ behavior in this aspect can be seen from their ability to develop or enrich other people’s ideas and add or specify an idea.

Based on the data, it can be assumed that the use of M-GBL media makes students capable of adding to and detailing an idea. This is marked by the behavior of students who think of other ways by using learning resources including the M-GBL media and who are capable of taking steps to complete the task. Students’ elaboration ability can also be seen from their ability in developing or enriching the idea of others. Developing or enriching other people’s ideas can be done with high student participation in learning, where students frequently ask...
opinions or questions and also respond to questions. It can be seen by the students’ behavior, who are working on their tasks, by thinking of other ways of using learning resources including the M-GBL media and are capable of taking steps in accomplishing tasks and being active in learning, as well as brave in asking and answering questions. This result is in accordance with Cavus and Uzunboylu (2009), who suggest that learning based on mobile approaches also has a significant effect on students’ attitudes and other soft skills such as creative thinking skills, group work collaboration and sharing information in group activities. Lin and Wu (2016) suggest that mobile and web-based creative thinking teaching could stimulate students’ creation potential. Students who receive creative thinking teaching using mobile based approaches reveal higher performance in creative fluency, flexibility, uniqueness and elaboration than conventional teaching.

4 CONCLUSION

In the process of learning chemistry, the use of M-GBL media has a positive effect in improving student creativity. Students are not bound by time and space. They can learn, not only in the classroom but they can also study outside the classroom, depending on the student’s individual conditions. The learning material contained in M-GBL is interesting as it comes with games, animations and learning videos. The students’ creative thinking ability in the flexibility aspect showed good results, in that the use of the M-GBL media is an effective way to produce ideas, and can make students participate in providing ideas and presenting concepts in different ways. The aspect of originality shows that students are able to provide new ideas. For the fluency aspect, it shows a good result in that by using the M-GBL media, students are able to produce and express their ideas independently and answer questions fluently. For the elaboration aspect, it is shown that by using the M-GBL media, students are able to add and detail their own ideas as well as others. It can be seen by the students’ behavior who can solve the problems on other ways using many learning resources including the M-GBL media, capable to make steps in accomplishing tasks, being active in discussion, and also brave in asking and answering the questions.

REFERENCES


