Designing Game-Based Learning Kit with Integration of Augmented Reality for Learning Geography

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Abstract—The development of education is changing in line with the development of current technology, and these developments have influenced many innovations in teaching and learning methods. Many technology-based games have been introduced in the market; however, not all games are suitable for student learning. This is because the features of a game must have an impact on education; it is essential to choose a game based on appropriate criteria for education. Therefore, this paper describes the integration process of game-based learning features outlined by Alaswad and Nadolny (2015), which are goal, interaction and feedback. The three features are designed in a learning kit called the "Kit Pengembara" for learning the topic of "Wind Direction" and "Bearing Angels", the subject of Geography Form 1. In addition, this Kit Pengembara also integrates the UniteAR application for user to complete a given task using augmented reality. Therefore, this paper can provide an overview to educators in the form of their educational innovations that integrate technology to increase student engagement.

Keywords—game-based learning, augmented reality, geography

1   Introduction

The use of information and communication technology (ICT) in education has rapidly grown around the world, including in Malaysia. ICT in education is not a new concept; it has been implemented in the field for a long time. According to [1], the development of education today has changed in tandem with technology development. Thus, the world of educational technology has now integrated various technologies in education, such as websites, online applications, virtual reality and augmented reality. This is because learning methods will become more interesting with the advent of technology like this. According to [2], augmented reality technology increases learning effectiveness and learning interest among students with real-world scenarios. Cai et al.

[3] stated that augmented reality technology could easily help students understand abstract concepts and improve students' learning and cognitive abilities. The study conducted by [4] proved that the students' learning performance levels increased after students learnt using augmented reality in learning Science subject. Thus, it can be said that this kind of technology provides many benefits to students as well as helping and facilitating teachers in delivering learning content.

In addition, the selection of the appropriate type of technology and approach when applying technology during teaching and learning sessions is critical to ensure that the technology can be a medium to deliver learning content. One of the appropriate approaches to use is game-based learning. Game-based learning is an integrated process guided by continuous progress driven by optimal challenge and cognitive engagement of students [5]. Past studies have stated that game-based learning produces many positive effects on student learning, such as motivation, achievement and students' perceptions of learning [6]. Therefore, teachers need to implement game-based learning in the classroom so that students have the opportunity to showcase their potential and talents [7].

Moreover, good technology design can also increase student engagement and achievement, this is because student involvement in the classroom affects students' performance. Licorish et al. [8] stated that student involvement in the classroom is important to stimulate learning and low levels of engagement are associated with poor performance. Nowadays the use of digital ICT such as augmented reality integrated with game-based learning is benefit to increase student engagement. According to [9], the augmented reality with the integration of game approach can improve not only students 'attitudes towards learning, but it also improves their learning performance. This approach can be used in a variety of subject areas in education by setting the game missions and add other learning materials according to the suitability of the subject [10].

The combination of ICT facilities and game-based learning approaches can help students in learning a skill. Thus, it can be concluded that using teaching aids that use technologies such as augmented reality and game-based learning approaches is very important in the student learning process. This is because the method is effective in helping to deliver learning content and can improve student achievement.

2   Background of problem

Technology development has brought many changes in education especially Malaysia. The use of technology in teaching and learning has a good impression if it is appropriately designed. The findings from the study of [11] shows that computer games do not significantly impact student learning and do not affect student attitudes towards computer science. This means that ICT implementation in the classroom cannot be seen as additional material but should be accompanied by purpose and meaning through the teacher's pedagogy [12].

In addition, the findings by [13] illustrate that student generally have less cognitive loads, strong motivation and a positive attitude towards the experience of reading augmented reality books. Meanwhile, the feedback from the research conducted by [14] shows that contextual collaboration with augmented reality tools is interesting, motivated and helping students get deep and long-term knowledge. The data obtained by [15] reveal that an average student perception score on teaching and augmented reality simulator is higher than 4.0; this indicates that students have a positive perception of augmented reality. These studies suggest that the use of such technologies can positively impact student learning if they are well-designed.

The focus of Standard-based Curriculum for Secondary Schools (KSSM) for lower secondary students is more than the basic knowledge mastery [16]. Geography is one of the compulsory subjects for lower secondary school students as well as other subjects. Ahmad (2016) [17] states that geography is a compulsory subject for all form one to form three students, and teachers who teach geographic subjects need to increase knowledge and skills on current issues, use the 21st-century teaching methods and have excellent ICT skills. This is important to produce students who can use various geographical ideas and principles and make judgments on specific issues.

Wind Direction and Bearing Angels are the first topic in the form one syllabus and are one of the titles under the geographical skills that need to be mastered by students. Geographical skills enable students to review and connect in space organisations as well as focus on skills in the use of basic tools such as compass, measuring instruments, atlas and globes [16]. As this topic is the foundation of geography knowledge and skills, students must acquire it before moving on to the next topic. If this topic is taught only using a map, the students are likely to misunderstand and unable to accurately determine the direction, which will affect their mastery of other learning topics [18]. If this problem is not immediately attended, the students will continue to make the same mistakes [18].

Therefore, the Kit Pengembara that uses a game-based learning approach that integrates augmented reality technology has been developed. The details of the development of the Kit Pengembara and the integration of the game-based learning approach are discussed in the next section.

3 The design of *Kit Pengembara*

Kit Pengembara that integrates game-based learning features has been developed for students to learn Wind Direction and Bearing Angels which are the topics in the Form 1 Geography syllabus. Kit Pengembara uses a situation in the zoo as a place that requires students to play while learning by solving some of the given problems (Refer to Figure 1).
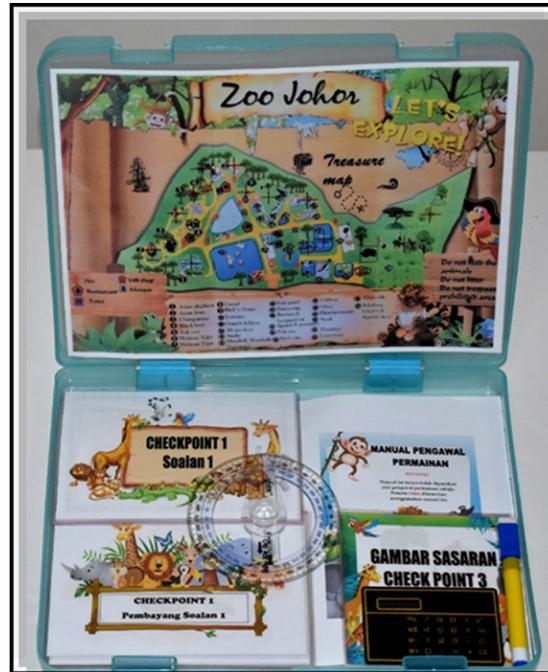
Fig. 1. Kit Pengembara

This Kit Pengembara is a game-based kit that has a quiz at every checkpoint. The number of checkpoints in this kit is seven checkpoints covering some subtopics found in Wind Direction and Bearing Angels. At each checkpoint, students need to answer quizzes as assignments. They can move on to the next checkpoint if they have completed or answered the quiz. Out of seven, only four checkpoints (Checkpoint 3, 5, 6 and 7) involve students using UniteAR to complete the quiz given. Apart from that, the game in the Kit Pengembara is controlled by a game controller, in which the game controller's role is to give instructions to players in every checkpoint game, provide hints if the players give wrong answers, and respond to answers given by the players. The description of the activity at each checkpoint is described in Table 1 below.

Table 1. Description of the activity at each checkpoint

Checkpoint	Subtopic	Activity Description
Checkpoint 1	Wind direction	Students need to label the four main Wind Direction in the diagram by arranging the answer choices given on the question cards provided. If they answer incorrectly, they are given hints to help them get the correct answer. After they get the correct answer, they are instructed to the next *checkpoint*.
Checkpoint 2	Wind direction	Students complete the *'jigsaw puzzles'* provided. Students who answer the questions are given hints to help them get the correct answer. After they can answer correctly, they are instructed to go to the next *checkpoint*.
Checkpoint 3 (UniteAR Integration)	How to determine the wind direction using the sun	Students watch a video related to how to determine the direction of the wind using the sun and arrange the steps to determine the direction of the wind guided by the sun on the question card provided. If they answer incorrectly, they are given hints to help them get the correct answer. After they get the correct answer, they are instructed to the next *checkpoint*.
Checkpoint 4	How to determine the wind direction using the sun	Students fill in the blanks with the correct answer to the question. If they answer incorrectly, they are given hints to help them get the correct answer. After they get the correct answer, they are instructed to the next *checkpoint*.
Checkpoint 5 (UniteAR Integration)	How to determine the wind direction using the sun	Students look at the diagram related to how to determine the wind direction using a compass, and later they find a way to use the compass in the correct order as in the question card. If they answer incorrectly, they are given clues to help them get the correct answer. Once they get the correct answer, they are directed to the next *checkpoint*.
Checkpoint 6 (UniteAR Integration)	Bearing angles	Students watch a video related to bearing angels and match the angle with the wind direction on the diagram given on the question card. If students answer incorrectly, they are given hints to help them get the correct answer. After they get the correct answer, they are directed to the next *checkpoint*.
Checkpoint 7 (UniteAR Integration)	Bearing angles	Students watch a video on how to measure bearing angels, and then they measure the bearing angels for given locations. After they get the correct answer, they are instructed out of the zoo.

Next, the Figure 2 below illustrates the flow of game using Kit Pengembara.
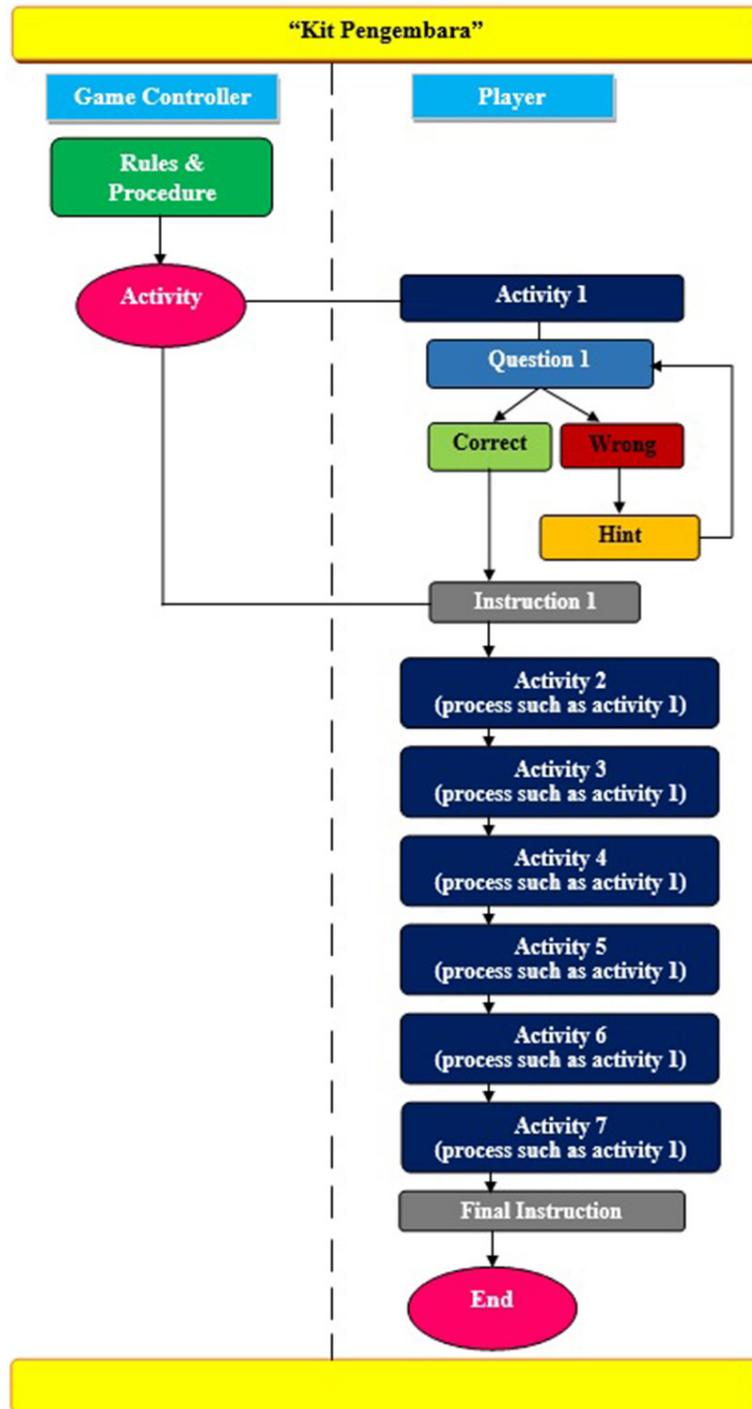

Fig. 2. Flow of game in Kit Pengembara

4 Game-based learning integration in the Kit Pengembara

The Kit Pengembara integrates game-based learning features as outlined by [19]: Goals, Interaction and Feedback. These three features are the main features that are often used by other researchers in integrating game-based learning, as reported by [19] from their investigation of 31 articles from 2003 to 2014. The description of every game feature integration is found in the following sections.

4.1 Goals

The first feature of game-based learning is Goals. The main goal in this game is that students have to find a way out of the Zoo because they got lost in the Crocodile Park. To achieve that goal, students need to complete the tasks in the checkpoint seven, namely answering quiz questions related to the topics of Wind Direction and Bearing Angels asked in each checkpoint correctly to enable them to get instructions to exit the Zoo. Once the player achieves the goal of successfully exiting the Zoo, the game controller reads a passage stating, 'Congratulations, you have successfully exited the Zoo… The mission is over' as shown in Figure 3.

Fig. 3. The game controller reads the passage after the player achieves the goal

4.2 Interaction

The second feature of game-based learning is Interaction. The game is played in groups; one group has 3 to 4 members. One of the members becomes the game controller who gives instructions to the players. Players need to work with the group members in completing the tasks to get them out of the Zoo, as shown in Figure 4.

Fig. 4. Players work together in completing tasks

Besides that, players can also discuss the questions received at each checkpoint with the group members to get the correct answer. Figure 5 shows the players are having a discussion to get the correct answer for the question received.

Fig. 5. Players are having a discussion in the group

Players are also asked to use the UniteAR app to scan target pictures provided by the game controller at Checkpoints 3, 5, 6 and 7 to obtain information based on the videos or diagrams related to the topic to help them answer questions correctly at the checkpoints. Figure 6 shows a player using the UniteAR app to scan on a target image.

Fig. 6. Players are using the UniteAR app to scan on a target image

4.3 Feedback

The last feature of game-based learning is Feedback. Feedback refers to the type and information given to students who are the players after they have responded in a game. There are two types of feedback used in this study, namely outcome feedback and process feedback. The outcome feedback refers to the feedback given to the players after they get correct answer in each checkpoint, i.e., the game controller says, 'Congratulations on your correct answer'. When a player gets a wrong answer, the game controller gives a process feedback, i.e., the game controller says, 'Your answer is wrong, please try again'. After that, the players are given hints to help them get the correct answer. Figure 7 shows the game controller providing feedback to the player after the player gets the correct answer, and the figure also shows the game controller giving a hint to the player.

Fig. 7. The game controller gives a hint to the player

5　Conclusion

In conclusion, the key of game-based learning features outlined by [19] have been integrated into the games in the Kit Pengembara. The UniteAR app found in the Kit Pengembara is used at Checkpoints 3, 5, 6 and 7 to help students find the correct answer based on videos and diagrams related to the topics of Wind Direction and Bearing Angels that have been uploaded in the app. This features mobile learning help students to understand the topic well [20],[21] and further increase students' learning outcome [22]. Besides, the used augmented reality as visualization tools can also help students to understand the difficult concept [23] Therefore, it can be said that such software can increase student engagement during the learning process while making learning more meaningful and fun.

6　Acknowledgement

7　References

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