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Game-Based Edutainment Media using Guided Discovery Approach: What teachers say?

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Abstract. Empirical studies over the past half century show that student felt discovery approach had ignored two things, student's interest and cognitive ability. This situation certainly requires teachers to understand the needs and characteristics of students better nowadays. Integrating technology into learning process is an alternative that can be taken by teachers to apply discovery approach. As an effort to overcome these conditions, researchers developed game-based edutainment media using guided discovery approach that can be used in mathematics learning process. The researchers also conducted this study to investigate teachers and postgraduate pre-service teachers' perception related to game-based edutainment media using guided discovery approach in mathematics learning process. Participants included 31 postgraduate pre-service mathematics teachers and 22 secondary school mathematics teachers. This study used a survey method and the data were collected through questionnaires. The questionnaires identified two aspects, usefulness and ease of use. Most participants had positive views, they stated that through game-based edutainment media students would not be afraid to find mathematical concepts independently as they learn through playing game. Nevertheless, both teachers and pre-service teachers also emphasized some difficulties in the application of game-based edutainment media such as, monitoring students' activities and clarity of instruction.

1. Introduction

Learning process becomes one factor determining mathematics students' achievements [1], therefore learning process needs to be emphasized on the transfer process of mathematics material. The transfer process in mathematics is necessary to make students understand the concept being taught [2]. In addition, innovation in learning process also becomes something that must consider to improve students' interest and motivation in mathematics learning [3]. Teachers need to make an innovation in mathematics learning process in which involves three (3) aspects that must be achieved by students, *self-confidence*, *perceived usefulness of mathematics*, and *enjoyment of mathematics as multiple outcomes* [4]. In general, there are two things in which can improve mathematics students' achievement, how to teach the material and how to present the material. For example, students will tend to have learning difficulties when teachers only involve the transfer process without considering students' interest [5].



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Most students will be unable to recall most of the material of typical lecture within fifteen (15) minutes after the end of their class. Students need to understand mathematical concepts not by passively reading or listening but through their own mental efforts [6]. As an effort to teach the material in learning process, it will be more meaningful if students build their knowledge or information independently. Constructivist learning is closely related to students' understanding so that learning through constructivist theory will make knowledge stored in long-term memory [7]. Finally, information or knowledge constructed by students independently will become more meaningful for students. The constructivist view of learning may be best supported by methods of instruction that enable deep understanding of concepts, principles and strategies even when such methods involve guidance and structure [8].

Discovery learning is one method that focuses on constructivist learning [9]. Learning process using discovery learning approach occurs when students are not given information directly but through structured guidance. Finding information independently does not mean that what students find is something really new but discovering solutions from the problems in which they face is something new for them. Discovery learning approach is a component of heuristic learning. It means that discovery learning approach is a learning model designed and oriented to students' activities by involving five (5) main activities, giving stimulus, identifying problems, collecting data, processing data, verifying, and making conclusions [10]. Learning process using discovery learning approach provides opportunities for students to learn actively. By this approach, students are trained to solve problems and make decisions.

Although discovery learning has a major influence in building students' understanding, several studies have shown that many students are afraid and uncomfortable learning through this method. This phenomenon occurs because learning process through discovery is more difficult for less intelligent students but becomes easier for more intelligent students [11]. In other hand, students tend to learn from teacher explanations and prior knowledge of less intelligent students is not adequate to meet skills and understanding in discovery process [12]. In other words, discovery learning will be effective when students have properly prior knowledge. To solve this problem, structured guidance for discovery process are required. As described by [12] that minimally guided instructions ignore two structures that constitute human cognitive architecture. Evidence from empirical studies over the past half-century indicate that minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process.

The second problem is how teachers present the material in order to generate interest and motivation of students in mathematic learning. Both interest and motivation are affective aspects that influence students' cognitive ability [13]. In order to make students achieve effective and meaningful learning in educational environments, teachers should make innovation both in terms of approach and media used.

Many studies emphasize the importance of constant and good-quality support provided for teachers regarding technology used [14]. Today, it is evident that activities leading to learning by actual application and experiencing in instructional processes and learning processes associated with real-life situations can be organized effectively with the support of instructional technologies [14].

Edutainment media is trying to apply existing technology with modern entertainment as media of learning in classrooms [15]. Edutainment media is a learning media that combines two aspects, educational and entertainment content designed in such way to facilitate learning [16]. Edutainment media can help students learn mathematics into something interesting and arouse students' curiosity [17]. One type of edutainment media is a technology-based game [15].

Game-based edutainment media can be an interesting way to combine learning with reference to the importance of students' understanding and interest [18]. Game is one popular entertainment and is favored by children, teenagers to adults. This is demonstrated by reports of the *MoboMarket* Indonesia revealing a fact that game the most favorite and the most downloaded applications from smartphone. Well organized game-based activities can play as learning tools. According to Ihsan, mathematic game is something fun or exciting that can support the achievement of instructional goals in teaching

mathematics such as cognitive, affective, and psychomotor aspects [19]. Based on the description, educational games can be used as an alternative in development of learning media.

In this respect, for integrating technology into instructional environments, it is important to determine the types of activities that will help teachers to teach material and present material well. Researchers developed game-based edutainment media designed with guided discovery learning approach. The game certainly contains guided discovery learning steps or processes aiming to attract students, as well as giving students opportunity to construct concepts independently. Development of game-based edutainment media include two important aims; achievement of math skills and students' interest in learning. However, there is a need to know the perception of the mathematics teachers toward the edutainment media because they are one of the users who know their student more than the game developer. Therefore, teachers' perceptions are needed as one of aspects to determine whether this media feasible and can be used in teaching and learning process in the classroom. As a follow up, the purpose of this study is to describe the perceptions of pre-service mathematics teachers and mathematics teachers in secondary school about the use of game-based edutainment media using guided discovery approach in mathematics learning. In line with this overall purposes, the following research questions were directed:

1. What are the problems experienced by pre-service mathematics teachers and mathematics teachers regarding discovery learning used in their course activities?
2. What are the perceptions of pre-service mathematics teachers and mathematics teachers about game-based edutainment media integration into mathematics learning?
3. What are the perceptions of pre-service mathematics teachers and mathematics teachers about game-based edutainment media using guided discovery approach in classroom activities?

2. Method

2.1. Research Method

In this study, which is carried out to reveal the views of pre-service mathematics teachers and mathematics teachers in secondary school about the use game-based edutainment media using guided discovery approach in mathematics learning, qualitative research method is applied. Qualitative research is a study aimed to describe and analyze the phenomenon of beliefs, perceptions and thoughts of people individually or in groups.

2.2. Participants

In process of determining research samples, random sampling method, one of purposeful random sampling methods, was used. Participants in this research included 31 pre-service mathematics teachers and 22 mathematics teachers. Pre-service teachers (aged 24-28 years) selected were mathematics postgraduate student from many different universities experiencing-teaching in school. Teachers (aged 29-40 years) selected were secondary school from several schools with different characteristic. The reason for choosing sample using this method was time limit and ease of access to conduct research

2.3. Data Collection

The research data of teachers' views about the use of game-based edutainment media were collected by questionnaires. The questionnaires contained two sequential phases to determine problems experienced regarding guided discovery use in schools, expectations and suggestions of game-based edutainment media using guided discovery approach in course activities. The questionnaires were developed using Technology Acceptance Model (TAM). TAM used to measure user acceptance of computer technology. This model have high validity and useful to predict technology usage [20, 21]. TAM identifies two user beliefs: perceived usefulness and perceived ease of use, as main determinants for individuals' behavioral intention to use information systems [22, 23].

2.4. Data Analysis

The data collected in the study was analyzed using descriptive analysis based on the qualitative research method. The data were examined in depth within the scope of the themes determined. Analysis of data includes phrases interpretation of the findings obtained. In this respect, the data collected are described at first; the data described are then interpreted; and finally, the findings obtained are interpreted by examining the reason result relationships involved.

3. Result and Discussion

Before discussing the results of teachers' perception analysis, it is necessary to describe the game that has been developed as an illustrations to the game. This game is a platform game that developed through *Construct 2* and can be used both on smartphones and PC. This game is an adventure game that has 16 levels. Each level has a different mission. Students are asked to find coins, aliens or bombs that have a rectangular shape (square, rectangular, parallelogram, trapezoid, rhombus, kite) or triangle from some enemies to open the mystery box at each level. For example, the first level students should look for a quadrangular coin, the second level students should look for a square coin, the third level students should look for a rectangular alien and so on up to level 16. After students can open the mystery box, they will be confronted with some questions which compiled based on guided discovery stage which have main activities, giving stimulus, identifying problems, collecting data, processing data, verifying, and making conclusions. In these situations students will learn independently to seek information related to properties, definitions and formulas of quadrilateral or triangle. Students are not only playing games, but students are also given worksheet that need to be filled. The part of game is presented in Figure 1. (a) (b) (c).

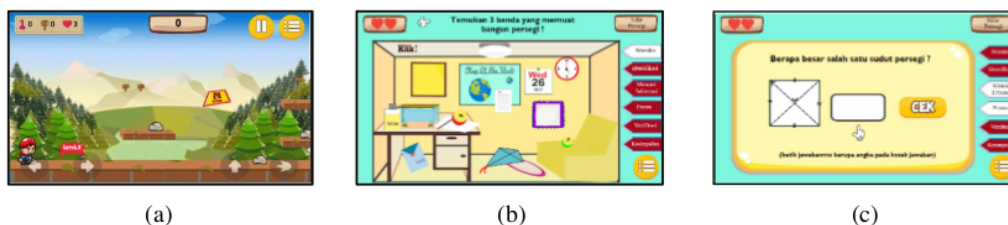


Figure 1. Example of game-based media.

Fig. 1(a) describes a game that must be skipped, at this stage students need to avoid some enemies to get game missions and open the mystery box. In addition, at this stage students through the stimulus stages of discovery learning. Because of students need to recall and distinguish the quadrilateral and triangular shapes that must be found. When students can unlock the mystery box, students will come across a series of questions gradually. For example, at second level, students learn square related. At the stimulus stage as in Fig. 1(b) students are asked to find objects that contain square. If students successfully answer, they are allowed to continue the next activity. At the identification stage, students will be given some information that should be observed and used as a guide to answer some questions related to the nature of the square. Fig. 1 (c) is the process of searching for information and data processing. Students go through this stage several times, because through this process students will be able to infer what properties the square possesses. Finally, students can return to the game to continue the next mission.

To answer research questions, the researcher developed a questionnaire into two phases. The first phase was structured to describe teachers' views about guided discovery approach, the questions. While the second phase of the research was developed to describe teachers' views towards game-based edutainment using guided discovery approach.

Researchers also reviewed experiences of teachers creating discovery-based learning. The data show that 83% of participants, including 31 pre-service mathematics teachers and 22 mathematics

teachers have used interaction-based discovery in the mathematics learning process. Some of main reasons why participants used discovery learning are summarized as follows:

1. Providing opportunities for students to involve in the learning process actively.
2. Providing opportunities for students to engage in meaningful process.
3. Encouraging self-learning behavior for students

Although most participants have used the guided discovery approach, our data show that the intensity of use of approach in mathematics activities is still low. Data can be seen in Table 1.

Table 1. Intensity of teachers in applying the guided discovery approach.

<i>Do teachers often use guided discovery learning approach in mathematics learning ?</i>			
Every time	Frequently, in about 70 % of the chances when teacher could have	Occasionally, in about 30 % of the chances when teacher could have	Never
Percentage	Percentage	Percentage	Percentage
0 %	28,3 %	54,7 %	17 %

The first phase questionnaire shows one reason for the low of teachers' intensity using the guided discovery approach. This condition is caused by experiencing difficulties of most teachers when applying guided discovery approach in mathematics learning activities [8]. Data can be seen in Table 2.

Table 2. Teachers' views about the difficulty of applying guided discovery approach.

<i>What is the difficulty level in applying discovery/guided discovery learning approach in mathematics learning?</i>	Very Difficult	Difficult	Neutral	Easy
	Percentage	Percentage	Percentage	Percentage
	17 %	81,1 %	1,9 %	0 %

Although teachers believe that the use of guided discovery in mathematics activities gives students opportunity to learn meaningfully there are still many difficulties and obstacles. Analysis of the second question in the first phase will explain the difficulties teachers got. There are various factors that are problematic for teachers causing difficulties in applying guided discovery approach such as learning planning and student conditions [8]. Overall, the difficulties come from the teachers themselves and also from the students. Table 3. presents problems experienced by teachers regarding guided discovery approach used in class.

Table 3. Problems experienced by teachers regarding guided discovery approach use in class.

Students' Problem	Teachers' Problem
Students' behaviour	Prepare instructional design that leads to GDL
Students' independence is less: students are not accustomed to self-study in guided discovery activities	Guide the students to think creatively in finding concepts
Different cognitive abilities	Difficulty guiding students when their abilities are different
Most of students unlike discovery activities	More time required
Students focus only on finding concepts so that many students fail to solve problems using the concepts	Difficulty in creating the appropriate stimulus
Previous knowledge that has not been mastered by the students	Not understanding the principle or step of discovery learning
Students feel comfortable learning if explained directly by the teacher	The difficulty of creating a learning medium that refers to GDL approach

Students have difficulties understanding the procedures
that must be passed to find the concept

Organize student activities to stay focused

In this respect, researchers try to propose an idea as a solution that can overcome teachers' difficulties. Technology-based learning media can be used by teachers to overcome the difficulties of guided discovery activities. Researchers demonstrate that the media have been developed after giving questions in the second phase to review characteristics of media that teachers need for discovery learning process. Table 4. presents media characteristics by teachers that can be used to facilitate the implementation of guided discovery in learning process of mathematics.

There are many kinds of learning media such as game-based edutainment media. Game-based edutainment media that have been developed by researchers have considered the characteristics of media required by teachers. The most important edutainment media is to provide the discovery processes. The difficulty level on this game is easy. This is made easy so that students will not experience any problem in completing all levels of the game. Game contains clear feedback and guidance on what students should do. The game also contains some exercises to improve students' understanding of the concepts they have learned. As a control system whether the students have completed the game or not, the game is completed with key level system. Students will not be able to go to the next level if students do not complete the previous one. Teachers can add other media such as worksheets as a support system for the use of this game

Tabel 4. Characteristic of Media.

Characteristics of media that can be used in applying the guided discovery learning approach
Can increase student's behavior and interest in discovery activities
Giving non-abstract explanations
Directing clearly what students should do
Gives students opportunities to give ideas during the discovery process
Provide appropriate stimulus for students
The instructions must clear so do not spend much time
Present the material indirectly
Integrating technology

When teachers are given explanations regarding the benefits and use of edutainment media in learning process, most teachers respond positively, this condition is illustrated in Fig. 2(a). Previous research results have also revealed that teachers believe technology-based learning processes has positive impact on mathematics learning, for example : Suzan & Kurt [14], Wahyu [21] and Ardani [24]. Teachers also assume that edutainment media such as smartphone games are considered to be effective in overcoming teachers' difficulties in implementing discovery learning, this condition is illustrated in Fig. 2(b). Jong & Joolingen [25] state that technology-based environment is well suited for discovery learning, the main task learner being to infer, through experimentation characteristics of the model underlying the simulation. On the other hand, prominent in this research is that teachers are aware of the importance of educational technology use in mathematics activities and that they are not yet willing to use such technologies not only due to lack of the necessary of technology use in learning [21] but also due to lack of related support of school administration and insufficient knowledge about use of such technologies in education [24].

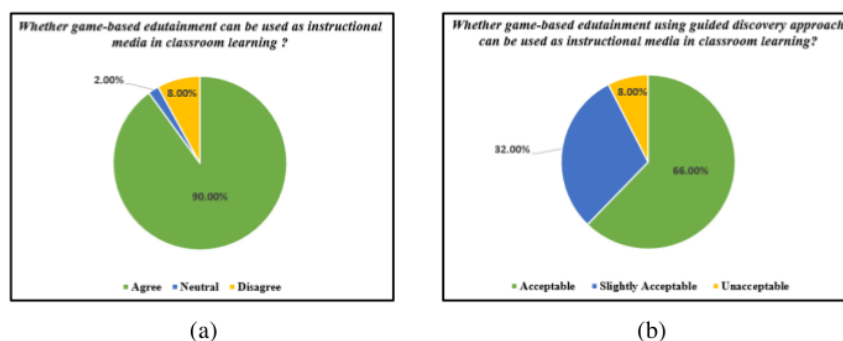


Figure 2. Teachers' respond about the use of edutainment media.

The last question will be able to review the usefulness of game-based edutainment media using guided discovery approach. Teachers' views indicate that game-based edutainment media have an opportunity to support guided discovery learning processes. Based on qualitative analysis, in broad outline there are several reasons stated by teachers why game-based edutainment media is able to become a good media for students such as making innovative learning process for students, increasing student engagement in discovery activities, increasing students' interest and directing students to find mathematical concepts in a more fun way.

Although the results of this study explain that most teachers have positive perceptions of the use of game-based edutainment media in the classroom, teachers worried if games would give a negative impact for students in learning process. First, clear instructions and clear control, most important issues that teachers face with similar views, are priority for those in the process of using game-based edutainment media. Regarding the sub-theme "Could the game-based edutainment facilitate students to conduct guided discovery", one participant, A1, mentioned the problem will occur due to the process of using game-based edutainment media in the class,

"...how to make teacher supervision and classroom design so that learning goes well. It should be understood that by allowing students to turn on their mobile phone in the classroom, it is possible that the students will use their smartphone for something others, such as opening WhatsApp, IG, browsing and other things that can fool the students' attention". This in line with Ardani [25] that teachers have difficulty monitoring whether the students have implemented the learning process using the game or not. Other participants, A2, also stated "... how to condition students to be really interested in the look and content of the game and coordinate each student in order to *learn while playing*, make sure that students are really learning". Overall, though teachers have a positive outlook they are also afraid that they are unable to create control systems and monitor student activities. It means that teachers feel hesitant to be able to monitor student activity well.

Second, the teachers perceived that elements of entertainment that tucked can make students not focus on learning. In addition learning by using games can hamper the process of learning in the classrooms. Other participants, A3, mentioned that the problem will occur due to the process of using game-based edutainment media in the class, "...the students' focus in learning will be likely to be fragmented because it may be more soluble in his or her game's fun than material understanding".

The last, another reason also conveyed the teacher how to cope if students do not have smartphone. Other participant, A4 stated, "...although today many students seem familiar with smartphone, it should be underlined that not all students have smartphone, especially for students from less fortunate families. Admittedly, this happens also for schools in remote areas and most plenty students from poor families. So we need to find a solution for this condition. One solution that I offer is preparing some smartphones and forming some groups. One smartphone will be enough for a group." In addition, teachers also suggest some solutions to make learning more effective when using edutainment media, as follow :

1. Monitoring the time used for all syntax to work, decisive in determining the time when students use games-based edutainment media and when students are not using game-based edutainment media (when paying attention to teachers, group discussions, paying attention to other groups of presentations).
2. Teachers should have a feature that can control whether students follow learning activities that are conducted using games-based edutainment media or not.

Research conducted by Suzan & Kurt [14] also shows that integration of technology into education can be achieved by establishing a clear interaction between teachers and students to facilitate the use of technology and to give students the opportunity to use technology effectively.

4. Conclusion

Pre-service mathematics teachers and mathematics teachers face difficulties in applying guided discovery learning approach. The difficulties are not only sourced from the teachers' ability but also from the students. Different students' ability is one of many difficulties of applying discovery learning. These conditions will lead to negative impacts on teachers. The teachers will difficult to guide the students, and it will also spend a lot of time.

Pre-service mathematics teachers and mathematics teachers viewed game-based edutainment media integration into mathematics learning as a positive thing. In addition, teachers want to improve students' math skills, teachers also want to provide fun learning environment. When teachers are faced with game-based edutainment media, teachers consider it as one good innovation. Despite the facts that many teachers have limitations in developing technology-based media such as game media, teachers support game-based edutainment media to be used in learning process. According to the teachers' views on game-based edutainment media, this media will certainly provide fun learning for students but there are many things to consider. It needs to be done in order to improve students' ability and attract students' interest.

On the other hand, teachers stated that learning by guided discovery approach becomes something that is not interesting for students. One reason for this is that less intelligent students can not follow the learning process through guided discovery. They will likely think that guided discovery activities is something difficult for them. Guided discovery learning process in which game is applied will unlikely attract the students to follow the learning process. If the game contains clear instructions and appropriate stimulus, game activities are not difficult for students. Learning activities are easily monitored by the teachers through sophistication of the technology, then game-based edutainment media can facilitate the discovery learning process.

4 Recommendation

According to the research findings, the teachers participating in this research emphasized that most of their students will be better do discovery activities when they use technological tools such as game-based edutainment media. In this case, it is an inescapable solution for teachers to help students progress in learning and developing their experiences. Taking into account the positive feedback from the teachers, it is a good sign to integrate technology into classroom teaching and learning. Therefore, the game-based edutainment media using guided discovery approach could be implemented in the classroom in the near future. However, there is a need to do further research involving broader participants from many different demographic backgrounds in order to provide comprehensive findings.

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