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Educational Games in Teaching Mathematics among the Pre-Services Teachers

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Abstract

Despite its popularity among students, many teachers are hesitant to use educational games as instructional aids. Addressing the challenges that are causing this reluctance is critical because educational games are backed by learning theory and a growing research basis. The objective of this study is to investigate the use of educational games in teaching mathematics among pre-service teachers and to look into the hurdles to utilizing educational games in teaching mathematics among pre-service teachers. The mixed technique method is employed to carry out the research. With 60 preservice instructors, a convenience sampling strategy was adopted. Data gathered through surveys and interviews was analyzed using descriptive and thematic analysis. The conclusions from the objectives show that pre-service teachers agree that educational games of varying levels of difficulty are essential to include in teaching and learning to make learning more enjoyable. Pre-service teachers, on the other hand, stated that the high cost of resources prevents them from using instructional games in the classroom. Given these findings, a discussion of the difficulties in incorporating educational games is provided.

Keywords: Educational Game, Mathematics Teaching, Pre-service Teacher

Introduction

Mathematics is a subject that is used globally and is found in all human beings. It is a science of structure, organisation, and quantity (Gyamfi, 2022). Mathematics inquiry has been at the heart of every modern civilisation, even the most basic. Less complex societies have less complicated mathematical needs and vice versa (Hom, 2013). In Malaysia, mathematics is taught in accordance with the National Education Philosophy, which aims to build a balanced individual on all levels. This initiative aims to increase knowledge and skills in science and mathematics to benefit the family, society, and nation. To achieve the goal, Malaysian Mathematics Curriculum aims to increase human capitals that can think mathematically and apply it to everyday challenges. Educational games are one way to build mathematical understanding (Castronovo, 2022)

According to the Ministry of Education, every student must be able to comprehend and explain mathematical concepts, as well as apply them. Jan (2013) claims that learning through

games can assist students enhance motivation, mastery of subject, and higher order thinking skills. Finding new ways to engage students is important nowadays. A learning process is able to acquire knowledge and expertise to tackle real-life obstacles. Educational games teach concepts and skills that are retained longer than other methods. It is critical for pre-service teachers to understand what they will be teaching in order to better relate to pupils.

In order to fully comprehend the challenges that pre-service teachers encounter while integrating educational games into their classrooms, it is necessary to examine the existing position of teachers. The lack of time and effort in implementing educational games in teaching and learning is one of the identified challenges. According to Mubaslat (2012), some teachers think educational games are a waste of time and don't use them in the classroom since they are seen as a novelty that doesn't teach anything. Mitton-Kukner (2016) states that time is typically related with school setting, such as an event, and the notion that teachers have many obligations. It is important to incorporate it at the correct time. Due to time constraints, pre-service teachers may not be able to incorporate games into their curriculum.

The dearth of curriculum-aligned teaching resources also hampered classroom integration of educational games. In order for children to achieve academic goals, teachers must follow a curriculum that is coordinated across grade levels. It's difficult to evaluate games as teaching aids, according to Marklund (2016), because we don't know how they're made or how they're used in formal educational contexts. The use of instructional games in formal education is rare in scholarly work (Chee et al., 2014). This is further discussed by (Daria, 2018). The more difficult the educational task, the more "serious" instructional content will be included in the game. The less prepared the student is for the task, the more appealing the game should be to keep his interest.

As a 21st century learning and teaching challenge, absence of classroom management when using educational games Teachers in training acknowledged a lack of support in implementing classroom management practices, which benefits students. Unstable classrooms lead to stress and burnout in pre-service teachers Diana (2010) states that students were more energetic, noisy, and spoke more than normal due to the use of games in class. Less time is spent teaching subjects and giving homework advice when games are used in the classroom (Diana, 2010). So, the instructor couldn't go over everything. Preventive and intervention approaches to improve student achievements include excellent classroom management techniques.

This study employed a hybrid manner of quantitative and qualitative methodologies to answer three research questions, presented as follows
Research Question One: What is the level of difficulties using educational games by pre-service teachers in teaching mathematics?
Research Question Two: What are the effects of the teaching and learning process when pre-service teachers used educational games in teaching mathematics?
Research Question Three: What are the barriers among pre-service teachers of using educational games in teaching mathematics?

Literature Review

According to research, using educational games is a significant technique to increase students' enthusiasm in mathematics study. In prior research, Ke (2008) reported that educational games were found to excite and draw student interest, resulting in higher encouragement and engagement in mathematics learning. Educational games will assist students concentrate on conceptual comprehension and problem solving rather than formulae and structured deviation, which are incredibly important, by including difficult challenges activities that are entertaining to kids and promote their curiosity in exploration (Meletiou-Mavrotheris, 2012). Students can gain vital skills such as creative management, scheduling, interaction, number-usage, group collective decision-making, and data-handling through the use of educational games.

Furthermore, the game's concept is borrowed from a variety of contexts and described in diverse ways in the literature. According to Pilten (2017), gaming is a strategy used by individuals to cope with the environment and serves as the foundation for creation during the school period. This is because the games' abstract reasoning plays a vital part in individual development. Pilten (2017) further stated that any act of intelligence is defined by the interaction of two opposing trends, assimilation, and accommodation. With assimilation, individuals include activities, entities, and events within existing cognitive processes that affect the organizational mental framework. Current forms of thought are merged and reconstructed through adaptation with new facets of the external world. Persons will adhere to the conditions of external existence while maintaining their mental conceptions through the operations of intelligence.

Changes in teaching practices are one of the most important aspects in any educational transition. According to Ke (2008), the goal of the classroom in teaching is to identify locations where students can connect with each other, and the instructor can achieve the goal. Furthermore, as noted by Meletiou-Mavrotheris (2012), a common thread coming from academic practice is the direct association between successful teaching and increasing student achievement in mathematics. Because what an educator knows and can accomplish affects how he or she conducts and teaches, it demonstrates the meaning of these teachings that truly shape what pupils understand and how they learn. An efficient application of instructional games in mathematics teaching is heavily dependent on the teachers' skills, behaviors, and views of the games (Meletiou-Mavrotheris, 2012). As a result, delivering high-quality teacher professional development for educational games is critical for their successful coordination in classroom settings (Hennessy, 2022).

According to Bryant (2009), there is a negotiation between professional teachers and non-teachers that certain children who have a medium level of mathematics thinking skills and an even lower level of subject understanding do not acquire enough mathematics education. In this more technical and economically challenging market, a student's prospects would be limited if he or she lacked sufficient mathematics talents such as content understanding and cognitive techniques. Teachers, particularly pre-service teachers, face a significant challenge in not just developing engaging teaching approaches that attract students, but also in cultivating and fostering a healthy community of mathematical learning (Bryant, 2009). As a result, it is critical that pupils get practical and efficient mathematics learning from future educators' leaders (pre-service teachers) beginning in elementary school.

Usage of Educational Game in Teaching and Learning Mathematics

Educational games have been identified as a pleasant leisure experience with goals, guidelines, and learning needs (Festus, 2012). Mathematical games can be used to introduce or reinforce concepts prior to formal classroom instruction. The importance of good inspiration, commitment, and healthy learning habits has long been recognized. According to Festus (2012), educational games can help develop social intelligence, mathematical interaction, mathematical comprehension, introduce new techniques, and reinforce abilities and strategies. Thus, these instructional games are recommended for curriculum use.

Many researchers have evaluated the effectiveness of mathematical games and explained their application. Teachers describe employing educational games in math classrooms to inspire inspiration, curiosity, involvement, and optimism (Festus, 2012). In his work The Use of Mathematical Games and Secondary School Students' Achievement in Mathematics in Fako Division, South West Region of Cameroon, Nekang Fabian Nfon examined the use of educational games in teaching and learning by assessing student achievement. The responders in his paper stated mathematics is too difficult and abstract and requires special analytical skills. Some of them think mathematicians are nuts and perceive the issues as mysterious and frightening.

Then he summarized instructional resources as elements that may make teaching and learning fun. He also claimed today's effective math teachers can use educational games to explain ideas and engage students. According to Zirawaga (2017), educational games assist kids learn, remember, obey rules, solve problems, manage pupils with attention difficulties, and expand other talents.

The Effect of Teaching and Learning Process When Using Educational Games

Teachers are now routinely regarded as vital components of successful game-based learning. The instructors are vital to the game's effectiveness in terms of instruction, interaction, and group discussion, as well as establishing a sense of social learning (Groff et al., 2010). Students spend up to 20,000 hours in academic institutions, therefore their observations and responses are vital (Afari, 2012). According to Afari's research, the learning environment influences students' performance and attitudes by influencing cultural, physical, cognitive, and pedagogical factors. The Afari experiments found that games improved students' attitudes toward mathematics and their perceptions of specific aspects of the classroom environment. Students' experiences can boost instructor's motivation, engagement, personal importance like fulfilment, and instructional efficiency. Also, allowing students to connect and work together in an educational game allows them to create important social ties while learning arithmetic (Afari, 2012). Gamification, according to Gozcu and Caganaga (2016), is a learner-centered technique. As Gozcu and Caganaga point out, games reshape teacher-student relationships and encourage students to take an active role in their learning As a result, instructional games can help pupils study independently. From an educational perspective, Gozcu and Caganaga emphasize that educational games provide a meaningful framework for mathematical applications. Teachers can create learning settings that allow students to learn naturally since their focus is not on the games but on the lesson. The issue of comprehensive learning through games persists. For example, games encourage individuals or apprentices to perform tasks they have little prior experience with, but these perceptions are nevertheless linked to the belief that learning should be difficult and that

learning without suffering is not real or useful information. Furthermore, unless designed for very young children, games are often considered as a waste of time and resources (Cojocariu and Bonghian, 2014).

The Barrier in Using Educational Games in Teaching Mathematics

Teachers are considered as a great resource when implementing information changes in the classroom, but they are also seen as a huge hindrance. Experiential learning and willingness to use educational games are important factors of utilizing educational games, according to (Egenfeldt-Nielsen, 2004). Many research were conducted to determine the common challenges faced by teachers. For people who never use games in the classroom, Faria and Wellington (2004) stated that preparatory time is crucial. The study of Faria and Wellington also revealed a lack of simulation understanding and a lack of course matching. Also, 'never users' are 'familiar' or 'somewhat familiar' with educational games.

According to Sam (1999), bad math conduct prevents students from pursuing mathematics as a major. Mathematics-hatred and pessimism impact general actions and beliefs (Gezahegn, 2007). Mathematical discontent is perpetuated by emotions and behaviours that stifle interest.

The Ministry of Education advocated the use of educational games in learning, but there were no clear policies on implementation, which resulted to a lack of instructional game content, poor teacher training, and little administrative resource for adaption, according to (Koh, 2011). Other typical educational challenges include tight curriculum, lack of funds, and inadequate hardware resources. Deficient game compatibility with teachings and statutory mandates is often cited as a key issue by teachers.

Unreliable game content, lack of reference materials, negative gaming impact, expensive costs, licensing and technology issues; unable to determine gamification learning (Razak, 2012). Regarding teacher-related hurdles, studies show that teachers' lack of or inability to play games is not a substantial barrier (Sandford, 2006). Sandford (2006) also points out that teachers' ability to play games is less important than their knowledge of the curriculum, employment experience, and current teaching abilities.

Methodology

The researcher employed cross-sectional survey research as a quantitative strategy. Surveys are used to obtain data from a targeted demographic sample at a given period. The researcher can compare and analyze various samples using the cross-sectional survey method. Closed-ended questions, which occur in many forms but have clear possibilities for a response, were employed to perform this quantitative research. Because a quantitative technique presents the response honestly and accurately, the researcher can forecast the conflict when conducting research.

The researcher employed interviewing techniques with pre-service teachers to determine the use of educational games in mathematics teaching. In a certain period of time, a random sample of the targeted population is chosen to collect data. Using this qualitative method, the researcher may explore the meanings and actions of sociological phenomena from the

respondents' perspectives (Palmer and Bolderston, 2006). Open-ended questions and one-on-one interviews are used to collect useful data.

This study's population is all final year students (pre-service teachers) from UiTM Puncak Alam's Faculty of Education. The researcher chose this target cohort to identify pre-service teachers' use of educational games in teaching mathematics.

Majid (2018) defines sampling as selecting a statistically representative object from a population. It is a subset of the targeted population chosen to represent the complete population based on survey results. For this reason, the researcher recruited a sample of pre-service teachers from four programs: Bachelor of Science Education (Hons.) Biology, Bachelor of Science Education (Hons.) Physics, and Bachelor of Science Education (Hons.) Chemistry. This study's sample includes 60 survey respondents and 4 pre-service instructors interviewed.

Because not all respondents had an equal chance to participate in the research, convenience sampling was used. It is a type of non-probability sampling where participants are chosen based on realistic criteria such as easy accessibility, geographical proximity, availability at a certain time, or ability to participate.

The researcher collects data using a questionnaire in quantitative research. Questionnaire taken from Teachers Surveyed on Using Games in the Classroom (https://www.teacherswithapps.com/teachers-surveyed/). The questionnaires are broken into two parts: Part A asks about demographics and Part B asks about pre-service teachers' understanding and use of educational games in mathematics teaching. Part B uses symmetric Likert scale items that range from 1 to 5. This segment has four sections: Pre-service teachers from UiTM Faculty of Education use educational games to teach mathematics to improve student learning. Section A identifies whether pre-service teachers use educational games to teach mathematics to improve student learning.

The researcher employed semi-structured interviews for qualitative research, allowing the interviewees some discretion and flexibility while keeping the session structured. In this section, you'll find two sections of interview The first portion seeks to identify respondents' demographics, while the second half focuses on instructional games and has nine questions. Thus, the interviews are done to explore the use of educational games in teaching mathematics, their difficulty level, their impact on the teaching and learning process, and the reasons why pre-service teachers avoid utilizing them in the classroom.

Findings

The following findings are presented to address the research questions listed in the preceding section.

Finding 1: The Level of Difficulties Using Educational Games In Teaching Mathematics By A Pre-Service Teacher.

Table 1
The Level of Difficulties Using Educational Games in Teaching Mathematics By A Pre-Service Teacher

	N	Mean	Std. Deviation
I always use educational games that familiar with the students.	60	3.77	.75
I think that the content can be deliver of although without direct instruction.	60	3.70	.72
I think all the students are able to participate in same educational games although in the different level of class.	60	3.88	.78
I think my students are always attracted in educational games although in the different level of difficulties. *	60	4.15	.66
I am able to tell what students have learned through their game play in whole class discussion. *	60	3.98	.68

According to Table 1, pre-service teachers find it challenging to teach mathematics through educational games. One of the items on the difficulty scale for instructional games was rated by pre-service instructors. Most pre-service teachers (mean=4.15, SD=0.66) think their kids are always attractive in educational activities. They think all students can participate in same educational games regardless of class level (mean=3.88, SD=0.78), and pre-service teachers always use educational games that students are familiar with (mean=3.77, SD=0.75). Content can be delivered without direct instruction, as rated by pre-service instructors (mean=3.70; SD=0.72). That is why no matter what level of difficulty is chosen, pre-service teachers find educational games appealing.

This is further supported in the interview session.

I : *How and when you are use educational games in learning? (ex: simple lesson, deep explanation of concept, once a week or every class)*

R1 : *Usually, I just did educational activities to the students just for a simple lesson but not too simple. It is just like moderate because if it is too simple, the students can easily understand. If it is too hard, it makes students no idea how to complete the activities.*

R2 : *Basically, I use educational games on every occasion. For example, I like simple lessons or I want to explain deep understanding concepts as well .*

R3 : *I use it sometimes when I finish up teaching the mathematical concept. I use it because I want to attract the students and at the same time to know whether they are understanding about the topic or not.*

R4 : *I use it by online gamification which is Quizziz. I always use that when we already finish up the topic or at the beginning of the topic to help students to more understand the concept of that chapter. So, from that I will know that my students understand or not about that chapter.*

Finding 2: The effects of the teaching and learning process when pre-service teachers used educational games in teaching mathematics.

Table 2
The Effect of The Teaching And Learning Process When Pre-Service Teachers Used Educational Games In Teaching Mathematics

	N	Mean	Std. Deviation
It give an effective learning to students. *	60	4.22	.64
Its promote collaboration between the students. *	60	4.32	.57
It can promote student's knowledge retention.	60	3.67	1.05
It can encourage students be more on active participation. *	60	4.18	.70
The students cannot understand well about mathematical concept.	60	2.88	1.04
The teaching and learning process will be more interesting.	60	4.22	.61
I will be more excited to use another educational game in the next class.	60	4.12	.72
I think that educational games make me to be more productive in teaching.	60	4.08	.77

Table 2 shows the impact of using educational games in mathematics teaching by pre-service teachers. Pre-service teachers rated eight items on the influence of teaching and learning process scale descriptively. The pre-service teachers believe that educational games can foster student collaboration (mean=4.32, SD=0.57). They thought it could help students learn more effectively (mean=4.22, SD=0.64), make teaching and learning more fun (mean=4.22, SD=0.61), encourage students to participate more actively (mean=4.18, SD=0.70), and make pre-service teachers more excited to use educational games in the future (mean=4.12, SD=0.72). Pre-service instructors gave the lowest rating to “students do not understand mathematical concepts” with mean=2.88 and standard deviation=1.04. As a result of the teaching and learning process, educational games can enhance student collaboration when utilized by pre-service teachers in teaching mathematics.

This is explained from the interview with Respondent 4.

I : *What your students says about the game?*

R4 : *Most of my students are full of commitment and always participate in my educational games and most of them said that it is an interesting game and give them more understanding about the topic. I believe this method can deliver higher thinking skills and gain their self-motivation toward learning. (students from upper class)*

Finding 3: Barriers among pre-service teachers of using educational games in teaching mathematics.

Table 3
The Barriers Among Pre-Service Teachers in Using Educational Games in Teaching Mathematics

	N	Mean	Std. Deviation
I fail to manage time in class when involving educational games. *	60	3.23	.89
I need to use high cost to use educational games. *	60	3.32	1.08
I am not sure where to find the quality games.	60	3.15	1.07
I am not sure how to integrate games into instruction.	60	3.05	1.06
It's hard to find the games that fit with the curriculum. *	60	3.23	.98
I am unable to finish up the syllabus.	60	2.83	.91
I think that the use of educational games makes me failed to manage the class. (Ex: keep students organized, facilitate, enhanced learning, etc)	60	3.18	1.21

Table 3 shows pre-service teachers' attitudes about adopting educational games in mathematics classes. The pre-service teachers' ratings on seven items on the obstacle faced scale were descriptively analyzed. Pre-service teachers must employ instructional games at a considerable expense (mean=3.32, SD=1.08). They believe that using educational games makes them fail to manage the class (mean=3.18, SD=1.21), they are unsure where to find quality games (mean=3.15, SD=1.07), and they are unsure how to integrate games into instruction (mean=3.05, SD=1.06). A mean of 2.83 and a standard deviation of 0.91 was given by pre-service teachers to the item “I am unable to finish the syllabus”. The results show that pre-service instructors are reluctant to use instructional games in mathematics classrooms due to the high expense involved.

The findings are further elaborated from the interview session. Respondent 1 mentioned that the time is the main barriers to have educational game in teaching and learning as shown below.

I : *Is there any barrier that can prevent you from using educational games in class?*

R1 : *The first one I mention the duration period given to me is not sufficient. The second one, the students do not really show their understanding but they enjoy doing the activities. The third one is the materials to be used to conduct the activities are costly since we are not being provided with any expenses to organize the educational games. Then, if the school has conducted any program, it takes my time and cannot conduct the activities to finish the syllabus on time. Those things also make me refuse to conduct the activities in the class.*

Secondly, Respondent 2 and 4 has mentioned that inadequate facilities and hardware support is also one of the barriers to have learning via educational game.

I : *Is there any barrier that can prevent you from using educational games in class?*

R2 : *Sometimes yes if the educational games need to use internet access. Sometimes when we are dealing with the internet, it might drag our time to proceed with the lesson if that day we have bad internet connections.*

R4 *Yes of course. For example, the facilities and student's participation. Some schools do not have good or enough facilities and some students do not have their interest toward participating in our lesson. Maybe some of them dislike us or feel like our teaching is boring.*

Conclusion

The findings in this study were indeed insightful. Preservice teachers believe that pupils are always attractive in instructional games, regardless of difficulty level (Table 1). A lot of research and reports assume educational games are fun and hence good for learning. As stated by Dickey (2005), educational games are commended for their motivational power due to their complexity, sensitive character as well as their diversity and preference. As a result of this, students will be able to make learning more fun and engaging (Westera, 2015).

Interviews revealed that most pre-service instructors utilized basic educational games to analyze or explain complex ideas. Berg According to Marklund (2014), educational games are ideal for teaching a wide range of subjects in a hands-on and engaging manner. They also employ educational games to assess students' grasp of topics in assignments or homework. Educational games can be quite effective for students who struggle with traditional learning methods (Sosnik, 2014). An instructional game can assist low-level students grasp subjects like arithmetic and science, according to the Joan Ganz Cooney Center. It illustrates that tailored content and the freedom to experiment without fear of judgement may encourage a diverse spectrum of students.

As shown in Table 2, most pre-service teachers believe that using educational games to teach mathematics can help foster student collaboration. Collaboration occurs when two or more people share knowledge and work together to solve an issue (Meij et al., 2011). Collaboration, according to Van der Meij et al (2011), improves articulation and logical arguments, which are important for gamification learning. According to Selvi and Cosan (2018), performing games can increase student motivation, promote active involvement in class, and foster good attitudes, making the classroom more entertaining.

The interviewees agreed that using educational games in the classroom can help kids learn better than using traditional techniques. Selvi and Cosan (2018) agree that educational games provide students with a developed experience that allows them to learn about what they do rather than who they are. Aside from that, students in this study said educational games can help them focus in class, have fun, improve thinking abilities, and increase self-motivation to learn. In order to encourage students to think critically and explore multiple options, educational games include a decision-making feature in which the learner's game experiences are impacted by the actions they do when playing the game (Hussein et al., 2019).

As shown in Table 3, the pre-service teachers agreed that the high expense of using educational games in the classroom is a deterrent to using them. Because in Malaysia, pre-service teachers are not reimbursed for using instructional materials during practicum. So, if

educational games are needed in teaching and learning, the respondents in this study feel burdened.

Educators' knowledge and skills are also vital. Insufficient time, problems with student participation, expensive material costs, and a lack of resources were highlighted as barriers to adopting educational games in mathematics teaching by pre-service teachers interviewed. Marklund (2014) states that educators must be prepared to plan game play sessions quickly. To reinterpret the game materials in topic teaching or vice versa, educators must know how to reinterpret the game materials and have a comprehensive grasp of the activities to monitor student progress across the curriculum (Marklund, 2014).

Moreover, most pre-service instructors felt that educational games are not a burden on their profession but must be limited for non-collaborative students. Because pupils can play for fun but not learn correctly. Educators should consider the games they employ, when they should be utilised, how they link to the curriculum, textbook, and most importantly, how they are useful (Gozcu and Caganaga, 2016).

Educational games have been shown to help both teachers and pupils. It also enhances the instructional and motivational efficacy of game-based learning for learners (Shah and Foster, 2015). But teachers with pedagogical knowledge must be able to incorporate games into classrooms. Educators training in educational games is a new field of study with few pedagogical methods to support teachers in using games to educate, according to (Shah and Foster, 2015).

Choosing educational games might be based on their ability to teach specific information, behaviors, or abilities, and focusing on games that have been proven to be effective (Van der Meij et al., 2010). It is important to recognize educational games as many genres that cannot be interpreted from a single point of view of learning, according to the researcher. Since many of the subjects that are important in educational games, like encouragement, have facets relating to any of the areas addressed, omitting them will result in an inadequate comprehension of the games and their learning capacity (Plass et al., 2015).

Finally, a mostly socio-cultural viewpoint often neglects design factors from cognitive and emotional backgrounds that would ensure the educational games design's suitability to fulfil its purpose. For students with varying levels of difficulty, the researcher recommended and demonstrated how educational games might be integrated to drive conceptualization and development of learning processes that enhance cognitive participation emotionally in favour of learning objectives.

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