The Effectiveness of Blended Learning based on digital games in increasing students' motivation toward learning mathematics

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Abstract

This research is action research aimed to reveal the effectiveness of using blended learning based on digital games in increasing the motivation of grade-five students towards learning mathematics. The quasi-experimental method was used with thirty-eight grade-five students in Imam Al-Hassan bin Saeed Al-Sahtani Basic Education School for Boys (5-12) in the Sultanate of Oman. The study used two instruments; an educational program based on digital games and a scale of students' motivation toward learning mathematics. The study found that there were statistically significant differences in favour of the post-motivation scale, in which the mean of the scale in pre-motivation scale was 2.73 and the mean of the post-motivation scale was 4.13. There was a difference of 1.4 in favour of the post-motivation scale. Considering the results of the study, the researchers recommended encouraging teachers to use blended education based on digital games and making various interactive activities for students through instructional digital games.

فاعلية التعلم المدمج القائم على الألعاب الإلكترونية في زيادة دافعية الطلبة نحو تعلم الرياضيات

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الكلمات المفتاحية	الملخص
الألعاب الرقمية، التعلم المختلط، الرياضيات، الدافع.	هدفت الدراسة للكشف عن فاعلية استخدام التعلم المدمج القائم على الألعاب الإلكترونية في زيادة دافعية طلاب الصف الخامس نحو تعلم الرياضيات، استخدم الباحث المنهج الشبه التجريبي. وبلغت عينة الدراسة 76 طالباً من طلاب الصف الخامس الأساسي من مدرسة الإمام الحسن بن سعيد السحتني للتعليم الأساسي للبنين (5-12) بسلطنة عمان. ولإجراءات الدراسة تم اعداد برنامج تعليمي قائم على الألعاب الإلكترونية، ومقياس دافعية الطلبة نحو تعلم الرياضيات. توصلت الدراسة الى وجود فروق ذات دلالة إحصائية لصالح التطبيق البعدي لمقياس الدافعية نحو تعلم الرياضيات، حيث بلغ المتوسط الحسابي للمقياس في التطبيق القبلي (2,73)، وفي التطبيق البعدي بلغ المتوسط الحسابي (4,13)، أي بفارق وقدره (1,4) لصالح التطبيق البعدي. وفي ضوء نتائج الدراسة أوصى الباحثين بعدة توصيات أهمها تشجيع المعلمين على استخدام التعليم المدمج القائم على الألعاب الإلكترونية لما له من دور في تحسين دافعية الطلاب نحو تعلم الرياضيات وكذلك عمل أنشطة متنوعة وتفاعلية للطلاب عن طريق الألعاب التعليمية الإلكترونية، ومن المهم كذلك عقد دورات ومشاغل تدريبية لمعلمي الرياضيات تهدف إلى تطوير ممارساتهم التدريسية.

المؤلف المرسل: أحمد الحضرمي

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1- Introduction:

With the technological revolution that we are living in and the spread of computers, tablets, smartphones, and various game devices, digital games have become abundant in the lives of young and old alike. Digital games spread widely in Arab societies in general and the Arab Gulf in particular as they became part of the child's room Digital game-based learning (DGBL) refers to the learning approach that incorporates educational content or learning designs into digital games. It involves activities that could engage learners in simple tasks or complex problem-solving skills (Chang & Hwang, 2019). Digital games are catalysts that add excitement and motivation which in turn leads to improving learning motivation, which is reflected in improving academic achievement, productivity and fun for students (Toh & Lim, 2020; Moyer-Packenham et al., 2019). Many modern technological methods appeared in the field of teaching (Al Badi et al., 2020), including blended learning. Combining traditional face-to-face instruction with asynchronous or synchronous online learning is what defines blended learning (Vallee et al., 2020). The world was interested in blended education because of its advantages, and the concerns of governments and international institutions became among them (Ma & Lee, 2021). The regional and developed countries were keen to introduce this type of education in their educational institutions. The traditional face-to-face classroom setting and online learning are combined in blended learning (Al Kharusi et al., 2022). Many education institutions around the world are adopting this style of instruction to raise learning standards, boost exam pass rates, add time flexibility, and eliminate barriers due to distance (Kumar et al., 2021). Blended learning is one of the most important types of technology-based learning, as it combines direct classroom learning with e-learning, where the role of the teacher becomes a mentor, guide and facilitator; and the role of the student as a positive interactive learner (Heilporn et al., 2021; Prilop et al., 2021).

2.Problems statement

Fifth-grade students face difficulties in learning mathematics in its abstract form due to students moving from cycle-one school (grades 1-4) to cycle-two school (grades 5-12) and the difference in the method of teaching between the two cycles. Also, the low results obtained by the Sultanate of Oman in the achievement of students in the International Study of Mathematics and Science (TIMSS 2011), TIMSS 2015 and TIMSS 2019 showed an urgent need to search for teaching methods that stimulate motivation toward learning mathematics, which will have a positive impact on academic achievement. Likewise, due to the Covid-19 pandemic, schools in Oman shifted to blended education. The researchers noticed that the remote teaching of mathematics lacks activity and interest on the part of the students. So, it is necessary to use new methods and approaches in teaching, which in turn increases their activity and interest.

The excitement of daily life and the wide spread of technology gadgets among different age groups necessitate technology use in education. The integration of technology in education creates an environment that attracts students' interest in lessons which may have a positive impact in ending teachers' suffering from the lack of various methods that attract students. Integrating technology may motivate students to participate in educational situations and do not limit their role to listening. Mathematics teachers have to search for strategies and modern teaching methods that are appropriate, appropriate to the needs of students, and appropriate to technological progress and the wide spread of digital games in society, or students lose their motivation towards learning mathematics.

Therefore, the researchers decided to use digital games to teach students since teaching at the beginning of the pandemic shifted suddenly from face-to-face classes to abstract online classes which may cause students to feel bored and less active. Hence this study came to reveal the effectiveness of blended learning based on digital games in increasing the motivation of fifth-grade students to learn mathematics.

This action research was guided by the following question : What is the effectiveness of blended learning based on digital games in increasing the motivation of grade-five students towards learning mathematics؟

- ***Significance of the Study***

This study gains importance in that it deals with the issue of students' motivation to learn mathematics. The importance of this study lies in presenting a scientific study on blended learning based on digital games which may help in finding practical solutions to students' motivation toward learning mathematics. It may also direct the attention of mathematics supervisors to the reality of employing mathematics teachers in blended learning and digital games. The study may contribute to providing a clear picture for those involved in preparing the teacher for digital games. It may inform those responsible for preparing the curricula on the importance of blended education based on digital games. Finally, it is hoped, through the results and recommendations of this study, to raise students' motivation in learning mathematics, using a blended learning strategy based on digital games.

There fore, mathematics teachers have to search for strategies and modern teaching methods that are appropriate, appropriate to the needs of students, and appropriate to technological progress and the wide spread of digital games in society, or students lose their motivation towards learning mathematics.

3.LITERATURE

3.1. Digital games-based learning in mathematics

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Motivation is an important factor in the learning process, and educators face a significant challenge in supporting students' motivation in mathematics. Educational technologies, such as digital games, have the potential to increase participation in mathematics learning activities (Fadda et al., 2022). According to Dayo et al. (2020), students learn problem-solving through the digital games-based learning approach because problems are integrated into games. Many students perceive mathematics to be dry and difficult; however, through digital games-based learning, students remain interested and motivated to learn mathematics problem-solving without becoming anxious or frustrated. Previous research studies have investigated digital games' positive impact on motivation. Alkan and Korkmaz (2021) investigated the design and educational aspects of digital games available on Steam (Digital Game Sales Platform) using the qualitative case study design. In the analysis of the games, the universal design model and principles, educational and game mechanics were used. The Deconstructing method was used to examine the games. They found that game mechanics are more diverse than learning mechanics in games. In game design, it is also thought that entertainment is more important than educational use. It was discovered that question-and-answer mechanics are more commonly used in game learning mechanics. Furthermore, "instant feedback" was defined as another important game mechanic. Furthermore, it was discovered that in-game rules, levels, and awards facilitate learning and increase motivation. Also, Zabala-Vargas et al. (2022) conducted a quantitative study as part of a design-based research project. The goal was to see how game-mediated teaching strategies affected mathematics instruction in first-year engineering students. Eighty-one (81) students from the Differential Calculus course took part in the study. There were twelve (12) didactic units created. The Synthesized Instructional Materials Motivation Survey (SIMMS) was used, which had been modified to record the categories of Attention, Relevance, Confidence, and Satisfaction (Keller's motivational model). The importance of the pedagogical strategy and the various categories of motivation was confirmed, as was the importance of collaboration and motivation. Skala (2019), in addition, did a study to see how digital games affected students' engagement and motivation. Two classes of seventh-grade students in grade-level mathematics were the subjects of this study. For the eight weeks of the study, digital review games and paper-and-pencil reviews were alternated weekly. Students completed Likert scale questionnaires, on- and off-task counts and behaviours, a teacher reflection journal, and a final student questionnaire were used to collect data. Students were more behaviorally engaged during paper-and-pencil style reviews, but more emotionally and cognitively motivated during digital games, according to the findings. Manginas and Nikolantonakis (2018) did a study to look at how a special education program that includes online digital games affects students with mild intellectual disabilities' understanding of basic

mathematical concepts. Four students (one girl and three boys) with mild intellectual disabilities were divided into two groups : experimental (combined intervention) and control (standard intervention). The students' performance was evaluated prior to the intervention program, immediately following the program's conclusion, and two weeks later. According to the findings, students in the experimental group performed better in the intervention areas than students in the control group. Students in the experimental group continued to outperform those in the control group.

4.METHOD

4.1. Data collection

This Classroom Action Research (CAR) aims to overcome the low motivation towards learning mathematics by applying the word-wall math activities. After reviewing previous studies and literature related to the subject of the current study, the scale of motivation toward learning mathematics, which was prepared by (Abed, 2012), was used. The scale consisted of (20) items, which dealt with situations that express students' motivation towards learning mathematics. The rating range for each item ranges from (1-4), as it is formulated in both positive and negative directions. The scale includes (16) items with a positive direction and (4) items with a negative direction. The scores of the positive item are distributed in points : Rarely =1 point, Sometimes =2 points, Mostly=3 points and Always =4 points. To determine the time required to apply the scale, it was applied to a survey sample consisting of (15) students from grade six students at Imam Hassan bin Saeed Al-Sahtani School (5-12). When calculating the mean of the time that these students took to answer the items on the scale, it was fifteen minutes. The motivation scale was applied as a pre and post. The data analysis technique used statistical descriptives and Paired Samples t Test to see an increase in motivation after the implementation of math wordWall activities as in figure 1.

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Figure N• 1
Word Wall gamed-based math activities

4.2. Sample

Thirty-eight grade-five male students at Imam Al-Hassan bin Saeed Al-Sahtani Basic Education School for Boys (5-12) in the academic year (2020/2021) participated in this study. Study objectives were presented to the participants. Participation was voluntary and participants were allowed to withdraw at any moment without consequences.

4.3. Study design

Classroom Action research is a concept and technique of study that is typically employed in the social sciences. Action research is concerned with resolving specific classroom or school problems, enhancing practice, and assisting in decision-making at local levels. The goal of action research is to equip teacher researchers with a mechanism for problem-solving in schools to increase both student learning and teacher effectiveness. The current study used the descriptive procedural approach, which is based on defining the problem, organizing the work plan, collecting information, analyzing it, and describing it.

4.5. Study procedures : The study procedures were as follows :

- Determine the educational units and the targeted educational objectives from the student's book and activity book for mathematics for the fifth grade.
- Determine the educational content (lessons - concepts - exercises - digital games) that will be presented to the target group.
- List of websites that contain digital educational games suitable for the target group.
- Determine the digital games that will be used for each educational goal and the time of their application.

- Apply some of the selected games to an exploratory sample to detect the students' ability to use and practice them, identify the difficulties they face, and calculate the time required to conduct each game.

- Prepare the appropriate learning environment for the application of these digital games.

-administer the pre-motivation scale

-Teach this group of students using blended learning based on digital games for 3 weeks, with 5 lessons per week, the duration of one lesson is 60 minutes (figure 2), that is15 lessons.

- Administer a post-motivation scale

- Analyze the results from the pre- and post-motivation scale.

Figure N• 1
Example of a lesson plan

5. Action plan for development

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This study aimed to increase the motivation of grade-five students towards learning mathematics by using digital games after the researchers noticed that there was a decrease in their motivation towards learning mathematics and their complaints about the difficulty of mathematics increased. In light of this, the researchers developed a procedural plan to solve the problem and it consisted of four stages :

- *Stage one : After reviewing the relevant literature and previous studies, the researchers developed a general plan for the implementation of this study. They defined the objectives of the study, the target group, and the requirements of tools and resources. The general plan was modified based on the instructions of some colleagues who reviewed the plan.*

- *Stage two : It was important, before starting the study, to identify the study units and topics that could be taught using some digital games. Four topics were identified from the topics prescribed for grade-five students. These topics are probability, decimals and unusual fractions, fractions. Equivalents, fractions and division. These topics were chosen based on the possibility of designing digital games for them and based on the availability of these games on online websites. During this stage, the appropriate educational environment was provided to implement this study and prepare students and know their skills in using technology. There were some problems with some students in their use of electronic devices, which was solved in cooperation with the IT teachers in the school. students were trained in the required skills to use these devices.*

- *Stage three: This stage is the stage of implementation and application. At the beginning of this stage, the pre-motivation scale toward learning mathematics was carried out. Then, the specific lessons were taught and the use of the previously specified math digital games.*

- *Stage four : In this stage, the post-motivation scale was carried out. Then, the pre- and post-motivation data were analyzed and compared. Then, recommendations and suggestions were made.*

During the implementation of the previous stages, there were some changes made by the researchers in the previously established plan for each stage. There was a change in the specified time because the implementation of this study required a lot of time in the beginning due to the students' unfamiliarity with using technology despite being trained by the IT teacher. However, during the last weeks of the implementation of digital games in the math lessons, things were easier and more fun. the students showed enthusiasm and a positive interaction towards these digital games. They compete with each other during the lessons.

Also, one of the reasons that led to changing the time specified for each activity is the sample size which was 38 students. The sample size was rather large which required

more time to follow up and give them feedback after each digital game activity as immediate feedback must be given to all students in the right way to avoid making the same mistakes later.

6.RESULTS AND DISCUSSION

This study aimed to examine the effectiveness of blended learning based on digital games in increasing the motivation of grade-five students towards learning mathematics. To fulfil this objective, the means and standard deviations of the students responses on the mathematics motivation scale were analyzed for the responses of grade-five students in the pre and post-motivation scale as shown in Table 1.

Table N°1

Responses of grade-five students in the pre and post-motivation scale (The Paired Samples t Test)

Motivation scale	Mean	Std. deviation	f	t	Sig.
pre	2.73	1.03	37	3.862	0.002
post	4.13	0.83			

It is clear from table 1 that there are statistically significant differences in favour of the post-motivation scale toward learning mathematics. The mean of the scale in the pre-motivation scale was 2.73 and the post-motivation scale was 4.13. A difference of 1.4 was in favour of the post-motivation scale. this was attributed to the fact that the integrated learning method based on digital games had a significant impact on increasing the motivation of learners. This method led to an increase in students' desire to learn mathematics because games in general attract students. Also, the students are more attracted to learning the material. They were eager to start the lessons to take part in the digital math activities and compete with their peers. The educational environment provided by blended learning made the student learn in an atmosphere of fun and enjoyment, which led to an increase in their motivation towards learning mathematics.

To find out the students' motivation towards learning mathematics after applying the game-based blended learning, the means and standard deviations of the students' motivation scale in the post-motivation were extracted. The following scale was adopted to analyze and interpret the results : Very low=1-1.8, Low=1.8-2.6, Medium=2.61-3.4, High=3.41-4.2 and Very high=4.21-5. Table 2 shows the post-motivation scale means and standard deviations.

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Table N°2
Means and standard deviations of post-motivation scale

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	Statement	Mean	St. Deviation	Decision
1	I think learning math is useful for me.	4.87	1.09	Very high
2	I enjoy learning math.	4.73	1.04	Very high
3	I think learning math is important for life.	4.68	1.24	Very high
4	I feel good at math.	4.67	1.19	Very high
5	I need to be able to do mathematics.	4.66	1.08	Very high
6	I think math is important.	4.61	0.74	Very high
7	I do my best to study mathematics.	4.58	1.05	Very high
8	Math is fun for me.	4.50	0.65	Very high
9	Mathematics can be described as fun.	4.38	1.13	Very high
10	I think math is valuable to me.	4.27	1.03	Very high
11	I can learn mathematics.	4.26	1.29	Very high
12	I feel like I can master math after studying it	4.23	1.08	Very high
13	I feel good at math.	4.21	1.17	Very high
14	I am satisfied with my achievement in mathematics.	3.99	0.87	High
15	I feel happy doing math exercises.	3.77	0.82	High
16	I don't try hard to study math.	3.56	1.30	High
17	I work hard to learn math.	3.56	1.02	High
18	I don't put my energy into learning math.	3.46	1.33	High
19	Math doesn't interest me at all.	3.40	1.15	Medium
20	Math is boring for me.	2.38	1.30	Low
	Total	4.13	0.83	High

Table 2 shows the mean of the level of motivation towards learning mathematics in the post-motivation scale. The overall mean was 4.13 with a standard deviation of 0.83. the means of the statements ranged between 2.38 and 4.87. The statement states "I think learning math is useful for me" came in first place with a mean of 4.87 and a standard deviation of 1.09. which is considered a very high level. This was attributed to the fact that the educational games that were used in blended learning were linked to the student's daily-life situations. Students did math game activities that contained situations they encountered originally in their lives. The statement which states "I enjoy learning math" was in second place with a mean of 4.73 and a standard deviation of 1.04 which is considered a very high level. This can be attributed to the attractiveness and suspense

in the use of digital games as students at this stage tend to use digital games in general, and when they were linked to mathematics education, it was attractive to them.

However, the statement "Math is boring for me" came in the last rank with a mean score of 2.38 and a standard deviation of1.30 which is considered as a low level. The researcher attributes this to the fact that the blended education based on digital games created an atmosphere of fun and entertainment for students, which was noticed by the teacher through the students' eagerness for the math class and their repeated requests for additional math classes. this statement got the lowest mean confirmed for the first and the negative statements. It has in meaning the second largest mean which explained the positive motivation that the students had after studying through the blended education based on digital games.

7.CONCLUSION

Despite the existence of so-called blended learning for many years in some educational systems around the world, the current period of Covid 19 pandemic and the interruption created by this pandemic in education systems made blended learning appear more as one of the best alternatives to confront the pandemic. It was one of the alternatives that various countries resorted to limit the spread of the Coronavirus among school and university students, as the idea of blended education is based on integrating e-learning in its various forms and traditional education to increase the effectiveness of education (Vallee et al., 2020). Blended learning incorporates online learning experiences and aids students in learning meaningfully through adaptable online information and communication technologies, a decrease in the number of students in crowded classrooms, and planned teaching and learning experiences (Kumar et al., 2021).

In light of these events, the idea of this action study emerged. The study aimed to reveal the impact of the use of blended learning based on digital games in increasing students' motivation toward learning mathematics. Mathematics in its abstract form. The researchers chose the use of digital games as a teaching method during this study from among many e-learning methods, because these games add excitement, motivation and suspense to education, which leads to an increase in students' motivation towards learning mathematics (add ref here Motivation and digital games), which in turn is reflected in improving academic achievement, productivity and fun among students.

Before the implementation of this study, it was necessary to determine the educational content that will be used to apply this study correctly. It was necessary to search well for digital games that fit with grade-five students and with the lessons contained in the curriculum. At this stage, the researchers encountered some difficulty in choosing these math digital games due to the lack of websites and applications that

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support the Arabic language in a way that is easy to be used for students. Later, WordWall website was approved as a digital game website because it supports the Arabic language, is easy to use and has many ready-made activities and exercises.

To overcome the problems that students may face, it was necessary to give them clear guided instructions for how to properly play these games on their devices on n a daily basis ; for 3 consecutive weeks. This is among the positive points that the student benefited from accessing math digital games through their computers or tablets.

There are some challenges during applying this study, as most of these challenges are related to digital games. The first change was the scarcity of Arab digital games compared to foreign ones. Another critical challenge was that some students were unfamiliar of how to use devices and deal with internet resources properly. Also, some digital games were complex for grade five students to do. So it needed effort and time for the teacher to explain and the student to understand and implement. Most importantly, weak infrastructure, including equipment and supplies, was one of the major challenges during this study.

However, despite the presence of the previous challenges, the results showed a noticeable increase in student's motivation to learn mathematics. researchers believe that this is due to five reasons. First, the use of digital games contributes to helping students to interact constantly and develop their thinking, which is reflected in an increase in motivation towards learning mathematics. Second, the educational environment provided by electronic games makes the student learn in an atmosphere of fun and enjoyment, which leads to his love of mathematics and increases his motivation towards it. Third, the use of digital games contributed to creating a feeling among students that mathematics is an easy and useful subject. Fourth, digital games created a kind of challenge and excitement among the students. Finally, the students' feeling that they are the centre of the educational process, led to an increase in their motivation toward learning.

8.Future work

To improve this action study in the future and obtain better results, it is necessary to focus on the following points :

• Develop a clear plan for how to apply e-learning instruction in general and learning based on digital games in particular during the school year.

• Create a comprehensive educational e-portfolio that contains all mathematics topics for easy reference in the future.

• Learn digital game design and development programs to design games that suit the math topics, lessons, and students.

• Cooperate with the school administration and other colleagues to create an appropriate environment for this type of education.

This experience in conducting this classroom action research had a great role in developing skills to use technology of all kinds in professional practices, which was positively reflected in teacher's and students' performance in the classroom. This, in turn, positively affected the educational process in general, the researchers and colleagues at school after reviewing the results of the research.

Finally, conducting this classroom action research enabled the researchers to understand the concept of action research and the method of its implementation. It enabled the researchers to apply action research appropriately in terms of planning and implementation, drawing conclusions and analyzing them, making recommendations and writing a research reflection. it also enabled the researchers to adopt the action research methodology as a method for professional development

8. Recommendations

In light of the results of the study, the researchers made the following recommendations :

- Offer courses and training workshops for mathematics teachers aimed at developing their teaching practices.

- Encourage teachers to use blended learning based on digital games because of its role in improving students' motivation towards learning mathematics.

- Do a variety of interactive activities for students through digital games.

- Conduct studies on the effectiveness of blended learning based on digital games and their role in academic achievement and mathematical thinking.

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