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Original Paper

Educational Games in Elementary Education: Unlocking the Potentials

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Abstract

The advent of technology has made big strides in the development of humans' life in different spheres. The integration of technology in education has introduced other teaching methods that could improve and emulate the traditional way of teaching. The use of educational games is a by-product of integrating technology into teaching to enhance teaching methods and students' performance. This study, hence, aims to evaluate the effect of using educational games in teaching mathematics to second-graders in a Palestinian school using a quasi-experimental approach. Thirty male and female second-graders from Al Aqsa Integrated School, Kuala Lumpur, were the targeted sample. The sample was divided into an experimental group and a control group. A selected educational game was used to explain mathematics lessons, namely addition within 99 or 999, to the experimental group. The same content was taught to the students in the control group using the traditional method. Findings showed that teaching mathematics via educational games was significantly effective in improving students' achievement in the experimental group compared to the achievement of their counterparts taught via the traditional method. These findings provide evidence that educational games could substantially improve primary second-grade students' skills in mathematics compared to the traditional teaching method.

Keywords

games, mathematics, education, Palestine, second-graders

1. Introduction

The use of games in humans' life has been attested since time memorial. Plato, for instance, considered games played during childhood as something important that form what people later become as adults (Ifenthaler et al., 2012). Likewise, Aristotle considered games to be learning opportunities in addition to the entertainment element they have. The Romans later used games to decide on the distribution of crops beside their use as a source of entertainment (Ifenthaler et al., 2012). In the nineteenth century, there was a revival of games when Frobel, the founder of kindergarten, made claims about the value of games for education and development of children's abilities (Ifenthaler et al., 2012). As technology was growing, the concepts of educational games and its use into instruction was growing right alongside it. Leading scholars such as Lieberman (1998), Jenkins (2002), Paquin (2002), Gee (2003) and Papert (2008) have emphasized the fact that computer games offer a convincing educational style for children as they can learn better through educational computer games.

Educational games, or alternatively known as game-based learning, are competitive educational activities organized according to rules and restrictions to achieve a specific educational objective (Prensky, 2007; Donovan, 2018). These games are specially designed to teach certain concepts, and improve certain skills. They have different elements like rules, restrictions, rewards, interaction, obstacles, goals, competition, and reviews (Prensky, 2007; Von Wangenheim & Von Wangenheim, 2012). The fundamental aspects of games is that students are better able to focus on learning, increase their competitive potential, and be able to win (Prensky, 2007). Digital games have been established for use on smartphones, computers, and tablet devices, etc. (Mitamura et al., 2012). Adventure, strategy, simulation, action, competition, puzzles and quizzes, etc., are among the most important types of games (Millington, 2019).

Research in educational games shows that children rely heavily on games, which makes their use vital as a tool for education. They stimulate children to learn more and gain a better understanding of the curriculum (Gee, 2007; Squire et al., 2008). Well-prepared digital games can become tools that benefit the educational field by applying them in the classroom in schools or by getting parents to provide them for children at home. As a matter of fact, games have been used in the past few years to promote higher education skills in different fields of knowledge including health and wellness, history, social skills, technical learning, and training (Rodríguez-Cerezo et al., 2014; Calderón & Ruiz, 2015; Soflano et al., 2015).

Educational games are an important gateway to the growth of learners' cognitive, physical, social, ethical, psychological, and linguistic abilities. They require the use of e-learning materials such as video games, computer games or the internet to support a particular educational purpose. These games, according to behavioural theory, are based on a set of psychological and educational foundations whereby the winning aspect in the game is a motivational factor for the learner to master the new intended knowledge and skills. Accordingly, numerous researchers and academics have called for the use of fun in learning (i.e., educational games) because it can provide a fertile environment for growth, motivate learning, and foster active interaction in a realistic atmosphere close to students' sensory perceptions, which thereby makes learning more appealing.

Traditional teaching methods still dominates the educational process in most Arab countries, including Palestine. Likewise, the use of educational games is often restricted to pre-school children and rarely, if ever, goes beyond that stage. That is why many reports have emerged in different Arab countries, including Palestine, calling for the use of technology in education, the use of educational games in particular. The rationale of this study, therefore, is based on such need for using educational games in teaching. It is meant to inspire teachers in the Palestinian educational system to use educational games so that they enhance the learning pace of their students. It is hoped to function as a valuable guide for Palestinian educational institutions and instructional developers to help them learn how to create educational games that promote the interactivity and joy among learners.

1.1 Literature Review

Children are the source of real wealth, and the hope to achieve a better future. Showing serious attention to their upbringing is thus of great importance across all nations. Likewise, attention given to their education is equally important. Hence, the use of games in their education is an indispensable part of the development and modernization of education to ensure their proper preparation for brighter future. Educators emphasise that children should be prepared to face the problems of life more easily and to adapt successfully with the successive changes as a result of the revolution of knowledge and scientific progress (Lewis & Bedson, 1999).

Children's lives are linked to playing as they learn and gain lots of their life behaviours through games. This leaves a clear mark on the personality of the child and creates a cognitive stock that is related to the child's understanding and thinking. In addition to being a source of fun, games can be an important tool for the child to achieve mental development (Egenfeldt-Nielsen, 2004). After being limited to the traditional tangible games, new tools such as machines and electronic devices have entered the world of educational games based on technology in modern education (Kinder, 1991). Starting in the early 21st century, games have been organized to improve students' abilities in communication, high order problem-solving, and adapting to fresh developments that lead to numerous future advantages in teaching (Gee, 2003).

Educational games have many benefits such as increased teaching performance, interest, encouragement, and a decrease in teacher loads and time for practice (Garris et al., 2002; Prensky, 2007; Wouters et al., 2013; Hamari et al., 2016). They provide learners in the classroom environment with the optimal environment for learning with enjoyment, finding solutions to the problems they face as well as learning from their mistakes through the experiences they go through (Pfahl et al., 2001). Studies also show that using the game properties can create an extremely efficient learning environment (Kirriemuir & McFarlane, 2004; Nacke & Masuch, 2005). Games have been very successful in inspiring fun, and attracting, engaging, and stimulating students (Buckner & Kim, 2012; Kangas et al., 2017; Ibrahim et al., 2018). In recent years, interactive games have been used as a creative educational tool for more effective higher-level learning in various fields of knowledge including mathematics, language, business, education, computing, food, firefighting, and entertainment, etc. (Connolly et al., 2012; Backlund & Hendrix, 2013; Calderón & Ruiz, 2015). It should therefore be an innovative and effective approach to teaching and learning in different stages of education, specifically for children.

1.1.1 Categories of Game Interventions in Classrooms

Historically, learning and knowledge acquisition have been calculated by memorizing facts or figures that lead to the development of skills or steps necessary to solve a complex problem. Through observation and application, these skills or steps will be acquired via one person teaching another (Boulet, 2015). Students these days, however, need more than rote memorization of facts and figures to solve a problem as they have to apply their knowledge in a world appropriate for this century. The set of skills students need should involve problem-solving and the ability to communicate with a wide range of participants when working in teams internally and externally. Teaching such set of skills can be made easier via the use of games in classroom teaching (Hung & Khine, 2006).

As games have become an integral part of digital interventions in classrooms, there has been a growing interest in the effect that computer games can have in students' learning in recent years. Such computer games can provide students with a practical learning approach in which they build their own understanding within the game by self-exploring and solving problems (Whitton, 2011). Although literature appears to group all game learning into one intervention, they can be separated into three different categories with very different applications. These are as follows:

1.1.2 Game-Based Learning (GBL)

This type of intervention is a type of game that has been designed and used to integrate topics with gameplay while enabling the player to remember and implement the subject matter to applications in real-world classrooms (Ritson, 2019). Researchers who use game-based learning intervention build a learning environment that stimulates active and creative thinking rather than passive thinking. They try to create meaningful and interactive experiences that encourage students in the learning process and thus actively involve them (Mehra, 2013).

Game-based learning can provide a variety of learning outcomes from a practice-and-exercise approach to a hands-on learning environment in which students gain experiences in solving problems (Annetta et al., 2009; Chee & Tan, 2012; Chen et al., 2015). Student learning can be scaffolded when using a game-based learning intervention as they move from easy to difficult gameplay tasks while providing students with a safe environment for learning from their mistakes (Stephens & Clement, 2015). Students are working towards an objective, taking their own choices and actions, and along the way learning the consequences of those choices and actions. The game designer could create problem-solving challenges that progress from the starting point in the game to multiple levels of learning. Game play can be complemented by progress tracking where students are winning awards, prizes, or badges, or adding their name to a leader board (Clark et al., 2011; Sadler et al., 2013; Nietfeld et al., 2014; Jong, 2015).

1.1.3 Gamification

Gamification is used to connect learning and game component designs including scoring, rules, competitions, and others (Ritson, 2019). Academics who use a gamification technique try to facilitate the learning of students when they perform a task with rewards or motivators by incorporating elements of the game in a nongame learning experience. In addition to the existing learning system, a gamification intervention introduces a game layer to inspire and engage students in the learning process. Students who use a gamification system will earn badges, rewards, and gradual change of levels as they progress through a series of instructional exercises (Mehra, 2013).

Gamification should not be confused with gaming. Gamification is not just a tournament game or role-playing game. It takes various aspects of concepts and overlays them on learning how to make a game, but it is not a complete experience like a conventional computer game or role-playing game. It draws different aspects such as accomplishment, competitiveness, and rewards. These various aspects are then added to a gamification approach to learning so that players find the learning process challenging; otherwise, they may find it unappealing (Prince, 2013).

Gamification should not just be interesting , but also need to be well crafted (Ritson, 2019). To engage students while they learn and have fun playing the game, the overlay of the game features must be sound and thoughtfully designed (Ritson, 2019). If the game is poorly designed, students might interpret the game as something they are forced to play, and, therefore, not achieve their learning goal (Prince, 2013).

1.1.4 Game Learning (GL)

Game learning is similar to game-based learning, but when researchers apply this type of intervention, they are more concerned with the game mechanics to be used. Games are used here to engage and assess students in their learning process. Kahoot is one such example of game learning. This online game is a learning tool that is used in a variety of settings. Users can play Kahoot with an internet connection on any computer device. In 2017, 51 million students and 3.6 million teachers used this type of game (Isaacs, 2015; Kahoot, 2018). Students are approached with questions and possible answers using this online game learning experience. The students are involved in answering questions within the game environment. As posed questions are answered, their responses, time, and points are all gathered later for data analysis.

1.1.5 Learning Theories

The importance of playing games in children's cognitive development and learning has long been recognized by psychologists. Piaget (1962), for instance, identified playing games as central to the cognitive development of children. Playing games becomes more social, symbolic, and abstract as children grow during various phases of their development. Games work to develop and stimulate the children's knowledge as it gets them out of reality and stimulate their thinking and abilities. Through play, children can imagine any tool as something they love and enjoy such as imagining the eraser as a plane or a chariot, which stimulates their imagination and creativity. This style of behaviour allows children to recognize different versions of the same thing, a skill necessary for abstract thinking growth and makes one of early childhood's most important developments (DeLoache, 1987).

As some educational games can be boring for the children, and, hence, soon after they stop playing the game, excellent educational games are aimed to have some competing elements that make children always win and get motivated in a flow state (Loftus et al., 1983; Czikszentmihalyi, 1990). Likewise, good games aim to be within what Vygotsky (1978) called 'the proximal development zone' of a player. In other words, games should go beyond the learner' average age and above his daily behaviour so the they help in learning new helpful skills.

Dale (1969) provides a visual representation of the correlation between several teaching methods and the outcomes of learning gained from these methods. In contrast to what is seen, read or observed, Dale found that learners maintain more knowledge through learning through games. This type of 'learning through doing' has been known as experiential or action learning. Based on Dale's representation cone, learning information presented by verbal expressions such as listening to spoken words is the least effective approach at the top. The most effective approach, in contrast, involves direct, purposeful learning experiences such as practical experience or real-world experience. Dale's cone displays the average rate of retention for different teaching methods. The further you advance down the cone, the greater the learning is and the better the probability of retaining information is.

The cone also shows that methods of active learning result in retention of up to 90%. when using visual learning styles, for students learn best through the use of sensory-based forms of visual learning. The more sensory sources are available to interact with a tool, the better the chances that more participants might learn the intended skill/content.

Behaviourism

Behaviourism is the school of thought that chooses professional designs based on rules. It is inspired by the psychology of behaviour and motivation, and recognizes all games as engines of challenge, excitement, and reward. Behaviouralists model their games on psychological hooks of opening loops to stimulate and facilitate emotional attachment (Sober, 1985; Filsecker & Bündgens-Kosten, 2012; Watson, 2017). To complete these loops, they use repetitive actions to deliver prizes. The anticipation of the end of a loop and the reward have a powerful effect on the human mind and can give rise to optimistic feelings (Davis, 2018).

Behaviourists assess all they can about their players, test small changes, and then measure their results (Sober, 1985; Filsecker & Bündgens-Kosten, 2012; Watson, 2017). Nevertheless, this means that behaviouralists continue to be wary about evolving. Generally, the emergence is difficult to measure directly, and anything that cannot be measured, cannot be reliably improved for the behaviourist. Therefore, behaviouralist's tend to be the most pragmatic of all viewpoints creatively. Instead of developing from scratch, they feel it safer to replicate a popular game and improve it, or to adapt another game with a different theme (Sober, 1985; Filsecker & Bündgens-Kosten, 2012; Watson, 2017).

Cognitivism

In the 1960s, cognitivism replaced behaviourism as the dominant paradigm of learning (Ormrod, 2016). Cognitive psychology indicates that learning is based on the mind and its activity, through reflections, thinking, memory and stimuli. Cognitivists assume that learning is an inner method based on the skill, motivation, and commitment of the learner (Craik & Lockhart, 1972; Craik & Tulving, 1975).

Although there are different emphases on cognitivists, such as Piaget (1962) and Bruner (1966), both agree that learning is expressed through a shift in understanding and knowledge. Cognitive scholars describe this change as an amendment to the mental model of a learner. Cognitivists argue that mind, perception, and comprehension mediate the stimulation and reaction defined by behaviourists. That is, while learning can contribute to behavioural change, it is, in fact, a change in assimilation.

Cognitivism is more concerned with the behaviour and style than with the person, and it encourages critical thinking. It centres on transmitting input from somebody who knows something like an expert to students who do not know, as opposed to facilitators. Students take it into their memory, store it, and link available information and ideas. Input is arranged and organized in folders, and it is recovered from memory when required. Through cognitivism, learning is the process of meaningfully and memorably linking pieces of knowledge (Bruner, 1966).

Constructivism

The constructivist model shows that a person designs his knowledge and comprehends his surroundings through thinking and the available experience that he has gone through (Bada & Olusegun, 2015). The concept of the constructivism theory in learning focuses on problem-solving and providing challenges to the learner to solve problems through their experience based on their previous knowledge; it is based on preparing learners for problem-solving in unknown cases to the learner (Bressler et al., 2018). In a sense, the curriculum is embedded in valuable tasks that the instructor presents to the learner. Moreover, from the constructivism perspective, the learner directs himself towards action through "self-motivation" to solve problems with the action constructed hierarchically from general to specific (Cicciarelli, 2007).

Gee's Model

All through his studies, Gee paid special attention to the concepts of learning in digital games. When used successfully, digital games can be used as tools to challenge players (Gee, 2003). They let the player know how to play the game and encourage them to work hard at the same time (Gee, 2016). Such games give an insight into how individuals could create fresh and stronger teaching methods in work, society, and school. Gee (2007) suggested that good education requires applying the constructive learning concepts that good game designers have settled on, whether or not we use a game as a carrier of these principles. Therefore, Gee organized a simplified list of principles of good learning presented below. The study beforehand uses this list of principles as the framework based on which the game used in this study was selected.

Learning and semiotic domains: Learning means understanding semiotic domains at some stage and managing to engage in so-called convergence groups or associated groups at some point. The learning environment is intended to promote positive and active learning via the design and presentation of quasi-random areas. Also, the learning experience requires thinking about the concept of the design and knowing its existence. The essence of the learning experience is considered to be a reciprocal relationship and multiple signalling systems that include artefacts, symbols, words, pictures, procedures, and others.

Learning and identity: Education includes taking on identities and manipulating them into several roles. In an environment where real-world effects are reduced, learners should take risks to enhance their learning and identify their identities. It is seen that virtual reality and delusional characters are more attractive and persuasive to learners, during which they live more comfortably than in the sensory world. The hypothetical factors are established by learning through the capabilities and possibilities available. From the outset, there are intrinsic benefits for learners of all skill levels; these skills are adapted to the degree, initiative, and the mastery of each learner as they aim to signal the ongoing accomplishments of the learner.

Situated meaning and learning: Learners get lots and lots of practice in a setting where the habit is not repetitive. A different way of progressing or moving forward enables students to think about decisions and make a suitable choice, while also exploring alternative styles, signs, and definitions (words, behaviours, things, items, images, documents, etc.) The difference between the learner and the teacher is not clear because learners have to undo their routine mastery at higher and higher levels to adapt to new or modified circumstances. New learning, automation, undoing automation, and new reorganized automation cycles occur as part of the learning process.

1.1.6 The Educational Situation in Palestinian Schools

Many studies have shown that students consider the study of science and mathematics and associated applications as difficult and complex (Ware, 2018). Students of the basic stage complain about the difficulty of learning, which means that the student has a certain difficulty in understanding, thinking, attention, and conducting arithmetic operations due to the immobility of the courses. According to the Palestinian Ministry of Education and Higher Education, the difficulties and disabilities that the students face in the learning process are increasing due to immobility in the traditional educational system, and, hence, it is vital to create, improve, and employ new tools and techniques to improve the whole teaching-learning process (JadAlluh, 2017). Similarly, studies conducted by the Palestinian Measurement and Evaluation Centre on second and fourth-grade students in the academic year 2015/2016 reveal that the level of student achievement was low. The overall achievement for second-grade students reached an average of 43 out of 100 with a success rate of 39.3%, while the overall achievement in science for fourth-grade students reached an average of 36 out of 100 with a success rate of 28% (PMEC, 2017).

The International Ranking (IEA) conducted a study titled “Trends in International Mathematics and Science Study” with the participation of 49 countries and different educational systems from all over the world, including 13 Arab countries of which Palestine was one. The study aimed to provide a database of educational data on students’ achievement in science and mathematics in the educational systems worldwide, and to provide a database of contextual data related to academic achievement (Mullis et al., 2016). The study adopted a standard scale for the average marks (500) and a standard deviation of 100. The average achievement of Palestinian students in sciences was 404, which is lower than the international average. Palestinian students ranked 43 out of the 49 participating countries (Mullis et al., 2016). The performance of Palestinian students in science showed that 1% only reached the international advanced level while 46% of the Palestinian students did not reach the international low level (PMEC, 2017).

Due to such low performance in the achievement of Palestinian students, there is an urgent need to find an alternative to the traditional way of teaching to ensure better performance. By the same token, as previous studies have proven that the use of electronic educational games in the educational process contributes to improving the achievement of students, and makes teaching materials more fun, interesting, and attractive, the problem statement of this study has emerged as an attempt to improve the method of teaching in the primary stage of Palestinian schools. To that effect, the study beforehand attempts to explore the effect of using educational games on the performance of Palestinian primary second-grade students in mathematics, and the value of using games in teaching compared to the traditional way. It is hoped that this study will benefit teachers in the lower primary level by drawing their attention to the importance of using electronic games in teaching as well as curriculum designers to develop the lower primary level curricula using electronic game software. It is also hoped that the study will inspire teachers to employ the game used in this study in their classrooms, and to encourage them to produce new educational online games that help motivate students to learn, and thus improve their performance.

2. Method

The study used a quasi-experiment to measure the effects of using games in teaching mathematics to second-graders at Al-Aqsa Integrated School (AIS), a Palestinian school in Kuala Lumpur, Malaysia. Al-Aqsa school uses the same Palestinian education system and contains approximately 200 students distributed in different grades from grade one to grade nine. Two subject groups were used in the study: an experimental group and control group. Both the experimental and control group consisted of fifteen male and female students each, making the total of 30 students. Students in the experimental group were taught summation using the digital educational game. Students in the control group, on the other hand, were taught summation using the traditional way of teaching. Two independent variables, gender (males/females) and teaching method (educational games/ traditional teaching), were investigated in the study. The dependent variable is the academic achievement of students targeted in the study. A pre-test on mathematics was conducted before intervention to both the experimental and the control groups. Upon application of intervention to the experimental group over five lectures, a post-test was conducted to both groups. The following figure illustrates the research design of the study followed by Table 1 showing the distribution of the study sample.

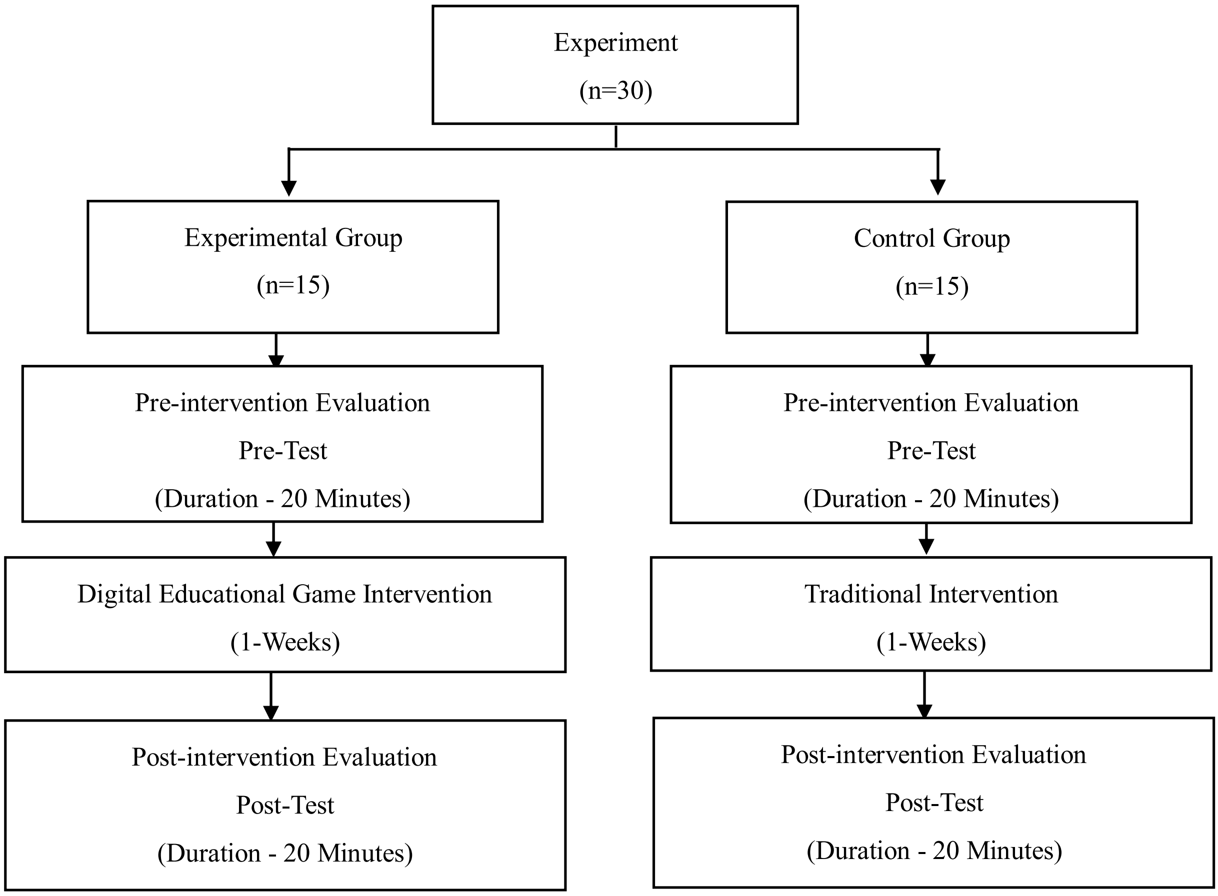

Figure 1. Research Design

Table 1. Study Sample Distribution

Gender	Control group	Experimental group	Total
Males	8	11	14
Females	7	4	16
Total	15	15	30

Teaching mathematics to the primary second-grade in the academic year 2017/2018 was chosen to be the focus of the study. The teaching material (summation) consisted of one lesson comprising 13 pages from the first part of the mathematics subject for the primary second grade in the Palestinian curriculum (PCDC, 2018). The summation or addition lesson contains summing two numbers within 99 or within 999 with the choice of whether to sum with the rest (with the load) or without the rest of the summation (without the load) as well as summation in vertical and horizontal formula.

Since Gee's (2016) model is the framework based on which this study is conducted, the 'Second Grade Math App' game was used in teaching the selected educational material (see Figure 3).

Figure 2. Game Icon

This game was selected in consultation with the teachers of mathematics for the primary stage. Used in the Palestinian educational system, this android game was developed by FlashToons (2017). The game uses Arabic language as medium of instruction and covers all the mathematic operations that students in primary second grade learn including addition or summation.

In order to capture students' attention and provide good motivation for them to play it, the game has attractive content including multimedia elements like text, sound, videos, graphics, and 2D-animation. The game also interacts with students' answers in order to provide reinforcement of learning behaviours. For instance, when students answer correctly, a piece of encouraging music plays and a green correct sign image is presented with a kind voice saying 'good job'. When students answer wrong, however, a piece of encouraging music plays and a red wrong sign image is presented with a kind voice that says 'try again'. These forms of interaction encourage students to keep playing and do their best to answer the questions properly.

2.1 Game Features

What distinguishes this game is the presence of certain features that cover a larger and wider scope of the mathematics taught in the primary second grade. These features include:

Figure 3. Second Grade Math App—Game Features Part 1

1) Numbers Conversion: Players have the ability to convert the numbers presented in this game from Roman to Indian forms and vice versa (Classical Arabic language uses the Indian number form).
2) Numbers Scope: Players have the ability to set the scope of numbers to any range between (0 < = > 999).

Figure 4. Second Grade Math App—Game Features Part 2

3) Free handwriting: Players have the ability to use the free handwriting feature in order to solve the equation freely, and facilitate attaining the correct answer.

Figure 5. Second Grade Math App—Free Handwriting Page

4) Teaching Videos: Each division in the game has a few illustrative videos that the user can watch; these videos help the player to understand how to play the game and win.

2.2 Evaluation Tools

The achievement tests (pre-tests and post-tests) were used as means for data collection. Each test consists of two parts; part 1 addresses demographic factors such as gender whereas part 2 addresses students' achievement. As the demographic gender factor is important to identify in relation to the findings, students were asked to specify their gender in part 1 of the test. Both the pre-test and post-test were translated into Arabic. The post-test contained the same questions used in the pre-test but in a different arrangement to ensure that students did not memorise and replicate their answers. The test consists of ten various questions including finding the summation of two numbers within 99 and 999 in a vertical and horizontal forms with and without carrying. It also included questions of choosing suitable numbers to make the correct summation as well as choosing suitable options that lead to the given result.

Both tests were created under the guidance of an expert mathematics teacher of primary second grade. In order to attain helpful and constructive feedback on both tests, they were then presented to a university professor in faculty of education (Prof. Faisal Husein) as well as to two mathematics teachers of the primary second grade, namely Ms. Narjes Fareed and Ms. Sujood Ghawadra. The content of the tests was adjusted according to the opinions of the arbitrators in terms of language drafting until the test evolved into its final form.

2.3 Pre-test and Intervention

The twenty-minute pre-test was conducted on Friday 13 December 2019. The data were then stored in preparation for statistical processing. Three days later, the intervention was applied on the experimental group on Monday 16 December 2019 until Friday 20 December 2019. It was applied over 5 lectures of 40 minutes each.

Students in the control group were taught summation using the usual and prevailing method used by most mathematics teachers in Palestine in accordance with the educational plan prepared by the Ministry of Education. Contrary to the control group, students in the experimental group were taught summation using the Second Grade Math App over 5 lectures as shown below.

Lecture 1 (Watching tutorials and review of the game): Students started by watching the videos embedded in this division. Then they started practicing the summation within 9 in horizontal and vertical form. After that, the teacher increased the scope of numbers to 20.

Lecture 2 (Summation within 99 horizontally and vertically without carrying): The teacher asked the students to start by re-watching the videos embedded in this division in order to refresh their memory. Then the students started working on the summation within 99 vertically without carrying for 15 minutes. After that, the students were asked to start practicing the summation within 99 horizontally without carrying for 15 minutes.

Lecture 3 (Summation within 99 horizontally and vertically with carrying): The teacher asked the students to start by acting on the summation within 99 vertically with carrying for 20 minutes. After that the students were asked to start practicing the summation within 99 horizontally with carrying for 20 minutes.

Lecture 4 (Summation within 999 horizontally and vertically without carrying): The teacher asked the students to start by acting on the summation within 999 vertically without carrying for 20 minutes. After that the students were asked to start practicing the summation within 999 horizontally without carrying for 20 minutes.

Lecture 5 (Summation within 999 horizontally and vertically with carrying): The teacher asked the students to start by acting on the summation within 999 vertically with carrying for 20 minutes. After that the students were asked to start practicing the summation within 999 horizontally with carrying for 20 minutes.

2.4 Applying the Post-test

Upon completion of the intervention by the end of the fifth lecture, the achievement test (post-test) was applied to both groups on Monday 23 December 2019. The test was corrected by giving one mark for a correct answer and zero for the wrong answer; the maximum final score was 10 marks. The statistical packages program (SPSS 24) was used for the Windows platform (SPSS Inc.; Chicago, IL, USA). Chi-square was used to compare between the experiment and the control groups for any significant difference regarding the demographic data (gender). Two-Way Mixed ANOVA was used to determine the effect of the game on the achievement of students in both groups. The effect size was evaluated according to Cohen's d; the small value of effect size was 0.2, medium was 0.5, and the large was 0.8 (Cohen, 1988).

3. Result

The response rate was 100% as all thirty children (experimental group n = 15/control group n = 15) took part in all stages of the data collection process as shown in Table 2 below.

Table 2. Response Rate

Tests	Type of Group	Attendance		Absence		Total	
		n	Percent	n	Percent	n	Percent
Pre-test	Experimental	15	100.0%	0	0.0%	15	100.0%
	Control	15	100.0%	0	0.0%	15	100.0%
Post-test	Experimental	15	100.0%	0	0.0%	15	100.0%
	Control	15	100.0%	0	0.0%	15	100.0%

Regarding the demographic data (gender), chi-square shows that there was no significant difference between the experimental and the control groups as exemplified in Table 3 below.

Table 3. Descriptive Statistics of the Demographic Data between the Experimental and the Control Groups

Demographic Characteristics		Experimental Group		Control Group		χ^2	P Value
		n=15	%	n=15	%		
Gender	Male	11	73.3	8	53.3	1.292	0.256
	Female	4	26.7	7	46.7		

χ^2 = Chi-square analysis, P-value = significance level ($p < .05$).

Table 4 underneath shows that there were no outliers; the data were normally distributed as assessed by Shapiro-Wilk's test of normality ($p > .05$)

Table 4. Test of Normality

Type of Group		Shapiro-Wilk		
		Statistic	df	P-Value
Pre-test	Experimental	0.896	15	0.082
	Control	0.902	15	0.101
Post-test	Experimental	0.929	15	0.266
	Control	0.914	15	0.155

df = Degree of freedom, P-value = significance level ($p > .05$).

Likewise, the tests of assumptions were met; the homogeneity of variances was $p > .05$ and covariance was $p > .001$ as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. The significance in students' achievement of both groups in the pre-test was undertaken using the independent T-test. There were no significant differences between the groups at pre-intervention for any of the study outcomes, as shown in Table 5.

Table 5. Comparison between the Experimental and the Control Groups at Pre-intervention for the Study Outcome

Outcomes	Experimental Group (15)		Control Group (15)		P-value
	Mean	SD	Mean	SD	
Students Achievement	1.40	1.24	1.67	1.29	0.828

SD = Standard deviation, P-value = significance level ($p < .05$).

The effect of the educational game on students' achievements, time needed to carry out required tasks as well as group interaction were determined by Two-Way Mixed ANOVA. The Two-Way Mixed ANOVA is used to understand if there is a two-way interaction (interaction between and within groups), and to determine the differences between groups over time (Laerd-Statistics, 2015).

There was a statistical significance over time for students' achievement, ($F(1, 28) = 437.400$, $p < .001$, partial $\eta 2 = .939$). Also, there was a statistically significant interaction between the groups with moderate effect size ($F(1, 28) = 24.066$, $p < .001$, partial $\eta 2 = .458$). Furthermore, the effect of the intervention was also statistically significant between groups with small effect size ($F(1, 28) = 15.000$, $p = .014$, partial $\eta 2 = .195$), as shown in Table 6.

Table 6. Two-Way Mixed ANOVA for Student Achievements for both Groups

Source of variation	df	MS	P-value	η2
Time	1	437.400	<0.001	0.939
Time * Group	1	24.066	<0.001	0.458
Group	1	15.000	0.014	0.195

df = Degree of freedom, MS = Mean Square, P-value = significance level ($p < .05$), η^2 = Effect size

In comparison of the difference in the mean scores for students' achievements between the experimental and the control groups in the pre-intervention (T1), both groups were almost the same. At the post-intervention (T2), both groups had improved, albeit the improvement in the experimental group was more than that for the control group. See Table 7 and Figure 7 underneath.

Table 7. Mean Scores for Student Achievements for both Groups over Time

Group	T1		T2	
	Mean	SD	Mean	SD
Experiment	1.40	1.24	8.07	1.28
Control	1.67	1.29	5.80	1.27

SD = Standard deviation, T1 = pre-intervention, T2 = post-intervention.

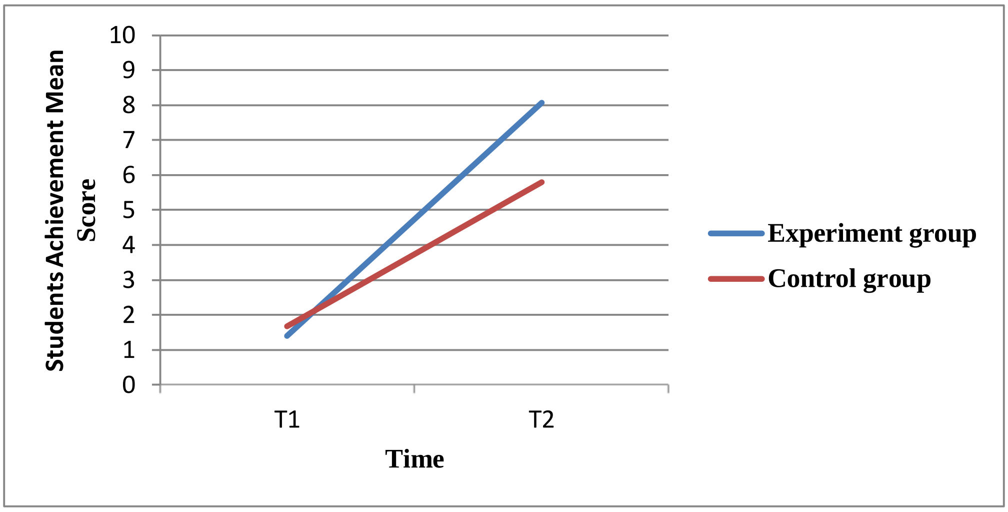

Figure 7. Mean scores for Student Achievements for both groups over time

As seen in Table 8 and Figure 8 below, the lowest performance in the pre-intervention test (experimental group pre-test) was for Q4, Q8, Q9, and Q10, which were considered the most difficult questions because they needed summation with carrying, or were indirect questions. However, these results improved after the intervention (using the game) in the post-intervention test (experimental group post-test), which means that the game was effective in facilitating summation to the students.

Table 8. Student Performance in the Experimental Group

Pre-intervention Test			Post-intervention Test		
Questions	Correct Answer		Questions	Correct Answer	
	n	%		n	%
Q1	4	26.7	Q6	13	86.7
Q2	1	6.7	Q1	15	100
Q3	7	46.7	Q7	14	93.3
Q4	0	00	Q2	14	93.3
Q5	3	20	Q5	13	86.7
Q6	3	20	Q9	13	86.7
Q7	1	6.7	Q3	12	80
Q8	0	00	Q8	10	66.7
Q9	1	6.7	Q10	6	40
Q10	0	00	Q4	12	80

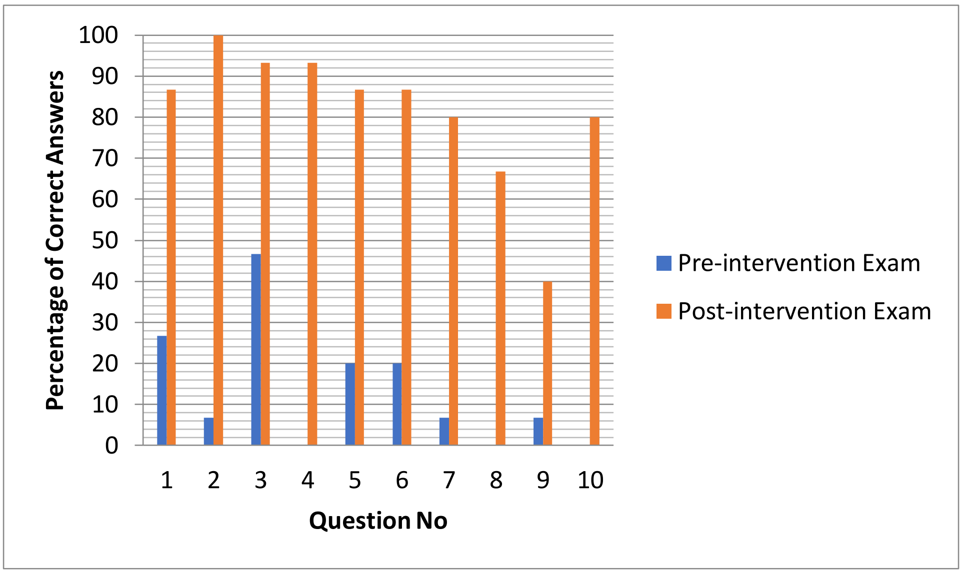

Figure 8. Student Performance in the Experimental Group

Similar to the experiment group, the lowest performance in the pre-intervention test was for Q4, Q8, Q9 and Q10, which were considered the most difficult questions because they needed summation with carrying, or were indirect questions. Using the traditional teaching methods show that the students' performance improved, but not for all the questions (e.g., Q8 & Q10); see Table 9 and Figure 9 below.

Table 9. Student Performance in the Control Group

Pre-intervention Test			Post-intervention Test		
Questions	Correct Answer		Questions	Correct Answer	
	n	%		n	%
Q1	6	40	Q6	15	100
Q2	2	13.3	Q1	14	93.3
Q3	5	33.3	Q7	9	60
Q4	1	6.7	Q2	11	73.3
Q5	5	33.3	Q5	15	100
Q6	3	20	Q9	5	33.3
Q7	1	6.7	Q3	11	73.3
Q8	1	6.7	Q8	0	00
Q9	1	6.7	Q10	0	00
Q10	0	00	Q4	7	46.7

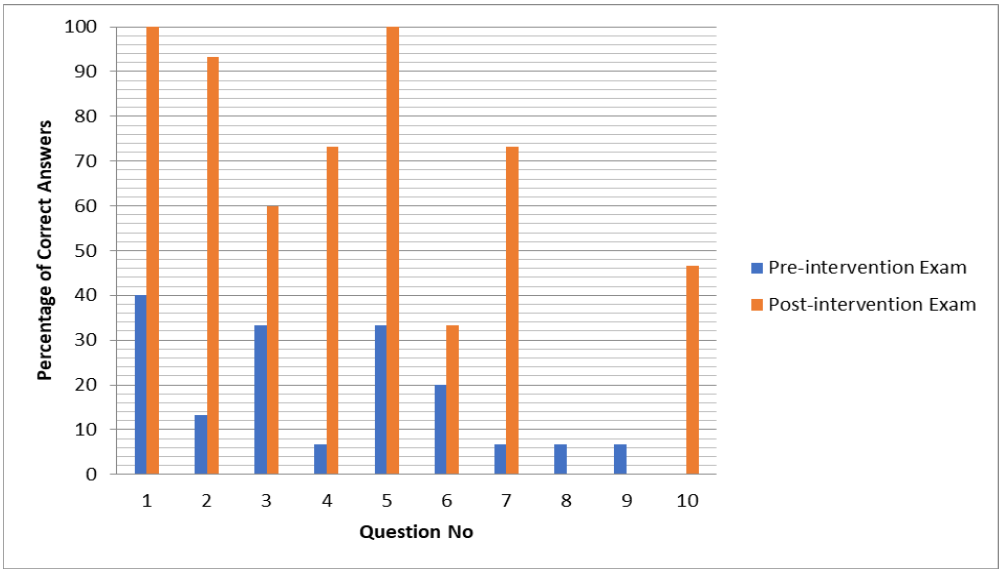

Figure 9. Student Performance in the Control Group

4. Discussion

This study aimed to shed light on the effect of using educational games on the achievement of primary second grade students at the Al-Aqsa Integrated School in mathematics. The study targeted 30 male and female students divided into two groups: an experimental group, and a control group with each having participants from both genders. The former was taught via a selected educational game whereas the latter was taught the same materials via suing the traditional way. The independent T-test shows that there was no significant difference between the groups at pre-intervention for any of the study outcomes. After applying intervention, however, the experimental group and the control group improved, but the improvement in the experimental group was far more than that for the control group. The difference in achievement was in favour of the experimental group, signifying that teaching using the educational game produced better and higher knowledge of the subject matter.

Noteworthy is that the result of the current study goes in line with and supports the results of several previous studies on the use of educational games in teaching. Balakrishnan et al. (2017) examined the use of a specific educational game in teaching English to 20 Malaysian dyslexic children. The result showed that the use of educational games as a teaching method was better than that of traditional teaching. Likewise, Kebritchi et al. (2010) studied the effect of using educational games in teaching mathematics in Florida. It came out that teaching mathematics via educational games had a positive impact on students' achievement. Measuring the effect of educational games on eighth-grade students' achievement in mathematics and their role in increasing their motivation in Taiwan schools, found that educational games improved the achievement of the eighth-grade students in mathematics compared to their previous achievement. Chuang and Chen (2015) found that educational games made clear improvements in teaching students about fighting fires, first aid, and the dangers of fire.

Based on the results of the study, few recommendations are to be made here. Future studies should include more thorough studies of various lessons and the use of various strategies. Further studies can be carried out involving larger samples than the one used in this study. Studies should be geared to target teaching mathematics in other levels and across different age groups. The use of educational games in teaching can also be explored in teaching other subjects other than mathematics. Training courses should be offered to familiarize teachers in the primary stage, particularly the second-grade primary teachers, with the use and the importance of incorporating educational electronic games in teaching mathematics and other subjects. Efforts should be made to improve teaching methods and curricula used for second-grade students in particular, and primary students in general. Distinguished programmers in the field of electronic games can be recruited to collaborate with teachers to design high-quality educational electronic games. Teachers of mathematics and other subjects alike should make electronic games an integral part of the educational process and teaching method in Palestinian schools. Teachers should develop their teaching methods, integrate educational electronic games into their teaching, and use them as a method or as an assistant to communicate information and concepts to students in an innovative way. Several types of electronic games should be developed for the Palestinian curriculum through employing specialized programmers to develop and design electronic games that suit Palestinian educational curricula developed by the Palestinian Ministry of Education.

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