THE EFFECT OF DIGITAL GAMES-BASED LEARNING ON MIDDLE SCHOOL STUDENTS' MATH ACHIEVEMENT AND ATTITUDE: A CASE STUDY

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ABSTRACT

The study examined the impact of digital game based learning on math achievement and attitude in a public school setting in Mount Lebanon. The case study was conducted using a quasi-experimental research design to collect data using inferential and descriptive statistics to determine the effect of digital games based learning (DGBL) in middle school classes. Several research questions were raised about the effect of DGBL on middle school students' attitude and achievement in mathematics. The study was conducted on 68 students. The *Mathematics and Technology Attitude Scale* (MTAS) was adapted and used to compare attitudes. The math tests were used to measure students' achievement during the experiment. The MTAS questionnaire and the math tests were administered before and after the implementation of DGBL to compare students' results during pre and post-tests. The analysis results indicated that there was a significant difference between the results of pre and post tests ($t = 8.399,\ p < 0.05$); there was a significant difference between midyear and final results ($t = 4.623,\ p < 0.05$); there was no difference in mean scores of high achievers in midyear and final results ($0.095 > 0.05$) ; there was a significant difference in the mean scores of low achievers in mathematics in the midyear and final exam ($0.00 < 0.05$), and there was no significant relationship between attitude and academic achievement in mathematics. Moreover, the research showed that digital games positively affected middle school students' attitude towards mathematics and technology, and helped the realization of educational goals.

Keywords: *Digital Game Based Learning, Mathematics Achievement, Traditional math teaching, Attitude, Constructivism.*

CHAPTER ONE: INTRODUCTION

The use of multimedia for teaching and learning could be in various forms, but how digital games could be integrated into existing education system remained as an important issue and trend in the world of education. The first computer games appeared in the 1950s. Since then, their development has increased at a very high pace (Minović, Starcevic and Milovanović, 2013). Educational technologies were often viewed not only as solutions to real or perceived inadequacies of traditional instruction, but also as tools to enhance educational outcomes (Ameil & Reeves, 2008). Computer games played a very important role in education since the latter gave the students the opportunity to actively participate in learning through the game leading them to better achievement and better attitude towards the subject.

Students are not passive receivers of information, but they are active responsible decision makers. Public education has been challenged to prepare the work force of tomorrow not only to utilize the technology of today, but to develop critical thinking and problem solving skills to enable them to adapt to the technology of the future (Swearingen, 2011). According to the Institute of International Society for technology in Education (ISTE), digital citizens were students who understood human, cultural, and societal issues related to technology and practiced legal and ethical behavior using the information collected from technology (Hamilton, 2015). Moreover, digital citizens demonstrated personal responsibility for lifelong learning (Hamilton, 2015)

One of the educational goals of digital games integration was to create competent individuals who can, at any time, access any type of information and use it in a required situation (Divjak and Tomić, 2011). Doing that across various discipline, allowed educational spare to create active teaching and learning environments. Mathematics was a subject taught in schools which required a lot of skills and helped students reach excellence in their future (Hamilton, 2015). However, the importance of mathematics faded away in students' life because of its abstract and hard concepts which was hard for students to understand easily. Teaching mathematics in the traditional way without any introduction to technology lead to the hatred of this subject disregarding its importance in the student's life (Hamilton, 2015). In addition Hamilton (2015) said that students often do not understand math concepts or see the value in it.

There has been an increasing interest in the use of digital games since the year 2000 in pursuit of educational goals. Digital games were highly engaging and motivating students that educators have suggested to take advantage of this wide tool to facilitate learning (Gee, 2007). According to Kim (1995), not all learning needs to be serious and having fun does not mean that learning is not taking place. Kim (1995) also suggested that one of the best ways to learn math is through games. Most individuals today have an electronic device to use on a daily basis, be it a phone, tablet, laptop (Eck, 2006). Currently students spend an average of approximately 7.5 hours (7:38) a day consuming media not including texting (Swearingen, 2011). Swearingen (2011) added that with the addition of multitasking, the number of hours of media actually being consumed rises to over 10.5 (10:45) hours. Why should education be so far from the reality students live every day? Why should education not use the technology to enhance teaching and learning and create real life working spares familiar to the students' life outside of class?

The purpose of the study was twofold: To investigate whether digital games could be adopted to enhance students' learning of math, and to measure students' confidence towards the subject being taught using technology.

Problem statement

Students needed 21st century skills to succeed in their life after school being in college, the military or the workforce (Crockett, 2016). The use of digital technology was simple yet powerful. Digital games used technology pedagogy to facilitate learning (Crockett, 2016). In the Middle East, despite the increased attention for digital games based learning received from educational researchers, most students were taught in a traditional manner without the use of any technology (Ahmad, Shafie, & Latif, 2010). Mathematics was considered one of the hardest and most challenging subjects in school. According to Li & Ma (2010), research has been conducted on the importance of digital game based learning, but very little has been conducted on its importance in mathematics middle school classes achievement influence and students' attitude.

Purpose of the Study

The focus of the research paper was twofold: To investigate whether digital games could be adopted to enhance students' learning of math, and to measure students' confidence towards the subject being taught using technology.

Hypothesis

With the integration of math games into the curriculum to teach middle school students, it was hypothesized that:

H_1: There would be a significant difference between the pretest and posttest achievement scores of middle school students using digital games based learning (DGBL) as a part of the mathematics teaching.

H_2: There would be a significant difference in the mean scores between the midyear and the final exams of the scholastic year 2016-2017.

H_3: There would be a significant difference in the mean scores of high achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.

H_4: There would be a significant difference in the mean scores of low achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.

H_5: There would be a significant linear relationship between attitude and academic achievement in math.

Research Questions

The two research questions explored were:

RQ1: Would digital game based learning have an effect on middle school students' attitude towards mathematics and technology?

RQ2: Would the integration of mathematical computer games influence the realization of educational goals as discussed with the two teachers that teach math to the sample perceived by the current teaching of math?

Definition of Terms

The following terms were used throughout the study. To ensure clarity, the definitions of each are:

Digital Game Based Learning (DGBL): Learning using computer games for educational purposes. Another type of game based learning (GBL). Applications of digital game-based learning draw upon the constructivist theory of education (Coffey, 2013).

Mathematics Achievement: The dependent variable in this study, math achievement is defined as the achievement level above 50 / 100. Low achievers are students whose final grade is below 50 and high achievers are students whose final grade is 50 or above over a total of 100 points.

Traditional math teaching: a sequence of memorization and forgetting basic facts. It is the type of teaching which followed the same path in every math lesson: note taking, guided and independent practice. (Okeke, 2016).

Constructivism: an educational theory that principally focused on the belief that learning is an active process. The learner is an information constructor. Students actively constructed or created their own representation of objective reality linked through prior knowledge (Simon, 1995).

Attitude: Everyday people love, hate, like, dislike, favor, oppose, agree, disagree, argue, persuade etc. All these are evaluative responses to an object. Hence attitudes can be defined as ‘a summary evaluation of an object of thought’ (Bohner & Wanke, 2014). Attitude in this research was measured by five factors: Mathematics Confidence [MC], Confidence with Technology [TC], Attitude to learning mathematics with technology [MT], Affective Engagement [AE] and Behavioral Engagement [BE].

Summary

Chapter 1 presented an overview on the importance of digital games in the world of education, and the benefits of introducing technology into the math classroom briefly. The research paper's focus was twofold: To investigate whether digital games could be adopted to enhance students' learning of math, and to measure students' confidence towards the subject being taught using technology. The problem statement, research questions, hypothesis, and definition of terms were discussed.

CHAPTER TWO: LITERATURE REVIEW

The research paper focused on the benefits of introducing technology into the math classroom, the research targeted both the issues of achievement and attitude towards mathematics and technology. This chapter provided an overview of the literature on the effect of DGBL on students' achievement in mathematics and attitude towards the subject. It involved the definition of DGBL, in addition to studies of its benefits and applications, specifically in mathematics. The literature then focused on the case of Lebanese public schools. The attitudes towards mathematics teaching using technology was also addressed. The chapter concluded with a brief summary.

Education in the past was more teacher centered in relation to today's teaching and learning environment. The focus was only on grades and test structure (Prensky, 2001). In that form of learning, the learner had no choice in the curriculum but to be a passive recipient, and the teacher was only working towards a specific goal which was getting students through the material outlined in the curriculum. Today, the era reframes the relationships; communication, to a certain extent, has become less print world oriented. According to Prensky (2001), "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (p.1). Moreover, Prensky (2001), described the need for educators from previous generations to change their teaching methods to meet the needs of the learners of today if they hope to reach them and teach them. Prensky (2001) stated that the current educational system is not appropriate for 21st century learners and the skills they need. The use of technology in schools increased gradually within the last decade but is still not enough to keep the students motivated and interested in school to help prepare them for the technological aspects outside of school. Technology may become the answer to increase motivation and involvement in the math classroom. According to Li & Ma (2010), research has been conducted on the importance of digital game based learning, but very little has been conducted on its importance in mathematics classes especially in achievement and students' attitude.

Math Education

There continues to be a great need for teachers to make math fun and meaningful for their students to motivate them to want to learn and study mathematics (Ahmad, Shafie, and Latif, 2010). Ahmad et al. (2010) also noted that the main reasons students' find problems in learning mathematics is the lack of motivation, lack of personal meaning of the subject, boredom, little encouragement for self-learning, and lack of continuity and focus. Many students lost their learning motivation in response to the repetitive and monotonous mathematical learning in the classroom given that many teachers continue to drill using exercises as basis to practice. The lost morale for learning mathematics is fast coming (Chen, ChenHui, WenShen, PenChen, & HanYun, 2014). Mathematics was a critical component of the careers responsible for many of the technological advances experienced in the growing global economy (Swearingen, 2011). STEM career opportunities were built on a solid foundation of mathematics. Thus, mathematics was considered as a very important subject in schools and should be taught in various ways to make learning more fun and reliable.

Learning mathematics presented various challenges for many children (Starkey, P. L. (2013). Mathematics was often associated as a difficult and tedious subject to learn. The idea that mathematics need not be learned by students for the sake of career choice or advancement but students should be able to learn mathematics with understanding and therefore be able to apply mathematical ideas later in life is what I as other math educators hope to do (Tanner, 2014; Stanic, 1995). The learning of mathematics was a continuous process and was not limited to the classroom experience only.

Prensky (2011) suggested that the educational system adopt a new pedagogy that included more learner centered approach like problem based and digital games learning models. He also added that the most effective use of technology in the classroom was to support a student's teaching themselves under the guidance of the teacher. The role of digital technologies in enhancing learning and teaching has been a subject of interest to mathematics educators for the past three decades (Geiger, Forgasz, Tan, Calder, Hill, 2012).

According to a research by Okeke (2016), mathematics was a universal language, a fundamental discipline, and the foundation of other scientific fields. However, young learners were frustrated with mathematics at elementary and secondary levels; the failure rate was alarming (Okeke, 2016). One solution to this failure rate was the use of computer technologies in which many abstract concepts were visualized through computer designs (Okeke, 2016). Moreover, Prensky (2011) argued that technology games helped improve success rates in schools.

My purpose was to use digital games to enhance my students' learning of math concept.

Constructivism in Mathematics Education

As defined by Simon (1995), constructivism was an educational theory that principally focused on the belief that learning was an active process. The learner was an information constructor. Students actively constructed or created their own representation of objective reality linked through prior knowledge. Constructivism has been a focus in mathematics education. Simon (1995), explained that since constructivism was not a teaching method but a perspective, educators were required to give students information and the important means to be able to explore mathematics in a constructivist approach by designing tasks that use the basic structures to stimulate thought for students. In this case, the role of the teacher became a facilitator who provided the tasks and widened the eyes of students to construct their own knowledge based on the given hints. Digital games based learning was a key to constructivism because it helped students collect hints from the games and therefore added to their educational experience reaching the goals of the required lesson.

21st century skills

The importance of reaching the needed 21st century skills came with the ability of introducing technology into the schools and allowing students to get their own tools (laptop, IPhone, etc.) to guide them through their learning (Ferguson, 2014). According to Ferguson (2014), schools aimed at the education of pupils, but they are not considered to be very successful today. To solve this issue, Ferguson (2014) insisted on encouraging schools to prepare all young people for lives of creativity, responsibility, citizenship and a life in the workplace filled with science and technology. Table 1 outlines 21st century skills as listed by 5 researchers.

Table 1

21st century skills

Research author(s)	Skills
Hamilton (2015)	Collaboration and teamwork
	Creativity and imagination
	Critical thinking
	Problem Solving
Crockett (2016)	Problem solving
	Creativity
	Analytic thinking
	Collaboration
	Communication
	Ethics, action, and accountability
Pacific policy research center (2010)	Learning and innovation skills: communication and collaboration; critical thinking and problem solving; creativity and innovation.
	Life and career: Leadership and responsibility; productivity and accountability; social and cross-cultural skills.
	Media and technology: media literacy; information literacy; technological literacy.
Griffin, McGaw, and Care (2015)	Ways of thinking: creativity and innovation; critical thinking, problem solving, decision making; learning to learn, metacognition.
	Ways of working: communication; collaboration
	Tools for working: information literacy; ICT literacy
	Living in the world: citizenship; life and career; personal and social responsibility.
Boyles (2012)	Analytical problem solving; Innovation and creativity; self-direction and initiative; flexibility and adaptability; critical thinking; communication and collaboration skills.

According to the pacific policy research center (2010), the skills needed by students for gaming reflected many of the 21st century skill set discussed in the table above. Moreover, the pacific policy research center (2010) inferred that in game play, players immersed themselves in complex information settings where they must sense and act quickly teaching them to try again when failing and indirectly targeting the 21st century skills needed to be taught to students.

The use of digital game based instruction has been shown to be effective in the teaching of 21st century skills, which include collaboration, communication, social skills, information technology skills, creativity, critical thinking, and problem solving (Little, 2015).

Digital games based learning helped students reach out for the 21st century skills which in turn guided them in their learning and workplace.

Digital game based learning in math education and its impact

Digital game based learning described an environment where game content and game play enhanced knowledge and skills acquisition. That also, included problem solving spaces that provided learners with a sense of achievement (Prensky, 2011). The use of math games that clarified math concepts and allowed math practice, knowledge and skills were acquired.

According to Trybus (2009), digital game based learning had many advantages which supported learning principles. It was cost effective, highly engaging, gave immediate feedback responses for students' mistakes in a nonthreatening manner to reward correct responses or clarify misconceptions, easily transferred learning to a real world environment, and included standardized assessments for student to student comparison. In addition, Trybus (2009) believed that DGBL taught students how to think and perform while facing real world situations, and provided interactive experiences, which motivated and engaged students in the learning process. Thus the advantages listed allowed confidence building and math acquisition. Moreover, Trybus (2009) argued that digital games did not have any negative influence on the achievement of students however games helped them achieve better results.

Little (2015), added that digital game based learning occurred in a virtual environment filled with fantasy elements, where students engaged in a learning activity using a technological tool like a computer. Moreover, researchers identified a number of common characteristics of digital game based learning necessary for student engagement which are goals , objectives, feedback, competition, challenge, interaction, and an interesting story line (Little, 2015).

Digital games may have been effective because the learning took place within a meaningful context (Eck, 2006). Learning that occurred in meaningful and relevant context was more effective than learning that occurred outside this context. Transforming learning spaces into real life experiences through simulations was proved effective in making students more engaged (Ahmad et al., 2010). In addition, Eck (2006) argued that play was a primary socialization and learning mechanism common to all human cultures and games, clearly, made use of the principle of play as an instructional strategy. Moreover, Eck (2006), discussed that games thrive as teaching tools when they created continuous cycles of cognitive disequilibrium and resolution while allowing the player to be successful. Thus games may be a solution to engaging students in the mathematics classroom leading to a change in attitude towards the concept of mathematics in school and improvement of grades along with finding the value of the subject in students' life.

The research by Cameron and Dwyer (2005) proved that playing computer games was an important learning strategy in realizing educational aims with children of different ages. Scholars suggested that students who played digital games showed increase in conceptual, declarative and procedural knowledge (Little, 2015).However, as important as realizing the impact of DGBL was, the research carried by Din and Calao (2000) indicated that there was no statistically significant differences between the group with traditional math learning and the other with digital games instruction. So, introducing digital games with no clear attention to details and a clear study of all lesson plans may not be an effective strategy to improve the teaching and learning of mathematics.

The use of games had certain characteristics inherent in their development. According to Divjak and Tomić (2011), if computer games were intended for increasing motivation and making learning mathematics easier, he concluded that mathematical computer games should contain:

- Subject matter that pupils are supposed to learn.
- Activities for learning.
- A basic learning model
- The way and concept of presenting the content
- Interface for manipulating with words and objects
- Navigation structure and order of activities
- Feedback information and reward systems
- Fun elements (graphics, sounds, story, characters, humor).

The target focus of the game then enabled students on practicing the concept being taught. Student attitude development of the endeavors may be key to positive perception of the game use in the teaching and learning process.

Attitude towards Mathematics and DGBL

Student's attitude towards mathematics has been a factor that was known to have a direct influence on student's achievement in mathematics (Mohamed & Waheed, 2011). Some research suggested that students with negative attitudes towards mathematics had performance problems simply because of anxiety (Tapia, 2014). Tapia (2014) also included that the research in the attitudes in the field of mathematics has dealt most exclusively with anxiety or the enjoyment of subject matter. Moreover, other researchers suggested that students may find mathematics to be simply unappealing.

According to Farooq and Syed (2008), the teaching method, the support of the structure of the school, the family and the student's attitude towards school were all factors that affected the attitude towards mathematics. The way that mathematics was represented in the classroom affected directly the student's attitude towards mathematics. Researchers concluded that positive attitude towards mathematics leads students towards success in mathematics (Farooq & Syed, 2008).

In the field of mathematics education, research on attitude has been motivated by the belief that 'something called "attitude" played a crucial role in learning mathematics' (Neale, 1969).

Yien, Hung, Hwang, and Lin (2011) conducted a quantitative study on the influence of DGBL on knowledge of nutrition, attitude, and habits of students via computer game usage. Their participants included 66 third grade students from elementary schools in Taiwan. They discovered a significant difference in achievement for the experimental group however, no significant difference in student attitudes.

Vale and Leder (2004) viewed students' attitudes to mathematics as being defined by the students' perception of their achievement and their aspiration to achieve in the disciplines. Galbraith and Haines (1998) viewed mathematics confidence as evidenced by the students who believe to obtain the effort they put into studying the subject and do not worry about the hard topics and generally feel good about mathematics as a subject.

Mathematics confidence was the students' ability to attain good results and their assurance to handle difficulties in the subject (Pierce, Stacey, & Barkatsas, 2007).

Vale and Leder (2004) viewed student's attitudes towards technology as being defined by the perceptions of their self-efficacy and their aspiration to achieve in these disciplines. However, Galbraith and Haines (1998) believed that technology confidence was referred to as the students who can see themselves assured while using the computer and the ones who can master any task required of them. They also added that confidence with technology (computers) happened because computers helped students find their mistakes easily and work confidently on resolving them. So confidence with technology may be summarized as students' being able to manage every aspect in a computer and enjoy the challenges they may face.

Vale and Leder (2004) and Galbraith and Haines (1998) both defined the attitude towards the use of technology for learning mathematics and the use of computers relevant to the learning of mathematics which contributed to the achievement of a student in mathematics. They claimed that 'Students indicating high computer and mathematics interaction believe that computers enhance mathematical learning by many means for example digital games.’ So digital games may helped in improving the attitudes of students’ towards math education and achievement.

Students engaging in digital games and feeling excited about math classes may mean that their comfort in the math learning has been established. Fredericks, Blumenfeld, and Paris (2004) saw that engagement was divided into three main components:

- Behavioral engagement: which was a positive conduct in school, and involvement in learning and academic tasks, and participation in school activities.
- Emotional engagement: the affective reaction to school and classroom activities including boredom and feeling of belonging.
- Cognitive engagement: psychological investment in learning.

According to Gee (2007), scholars have suggested that students who play digital games showed increase in confidence, and declarative knowledge. The use of digital game based learning has been found to be effective in increasing a variety of learning outcomes across learning environments and types of students (Gee, 2007). Moreover, Gee (2007), argued that digital games incorporate fundamentally sound learning principles that can be adapted to learning across a wide spectrum of environments.

Qin, Rau and Salvendy (2010) believed that affective engagement was higher when the difficulty of the game between levels was changed. Players’ engagement increased when the levels of a game were alternating and with a continuous change. The initial phase of affective engagement was driven by players’ aspiration for achievement from winning and solving challenges, and moderated by the alignment between play preferences and the game world and tasks (Ke, Fengfeng, Kui, & Ying, 2015).

Digital game based learning has been shown to be effective in increasing learning outcomes regardless of the gender (Joiner et al., 2011).

Lebanese program and philosophy of the public schools

The integration of technology into the math curriculum required access to computers, and educational software (Hariri, 2007). Lebanon included 2788 schools divided into three categories: 1025 private schools, 1399 public schools, and 364 free private schools (CERD 2006). Learning in the public schools was open to all students where the tuition fees do not exceed 70$ per student. Being so, financial difficulties deprived many public schools from getting computers (Hariri, 2007). However, the tuition of private schools ranged from 300$ to 10000$ per year which made it easier financially for private schools to integrate technology into their system.

The first reform of the Lebanese Mathematics curriculum took place after 25 years of the Lebanese war in 1997. The only technology used in the curriculum was graphic calculators (Hariri, 2007). Since 1997 till now, the mathematics curriculum was not updated. Mathematics in the Lebanese curriculum was a subject dominated by abstract concepts. According to Hariri (2007), the principle goals of the curriculum was the abstract and different representations of concepts and not the tools that facilitate learning. For example the calculations of measures of tendency were one of the objectives which can be calculated using a graphic calculator in few seconds. The same case was applicable in private schools since the latter were limited by the available curriculum and do not have control over the structure and the content (Hariri, 2007).

According to Hariri (2007), teachers required a mastery of the mathematics content, the pedagogical skills and the technology used for appropriate integration of technology. Some of the Lebanese math teachers were highly qualified for this step, but many as well were not. The most important factor that helped in technology integration was the teachers' beliefs about that. 70% of the mathematics teachers in the elementary and middle school were considered as inconvenient to teach mathematics, while this percentage decreased in secondary school (Hariri , 2007). This inconvenience prevented technology integration in the mathematics teaching in Lebanon one of the causes was the lack of appropriate training to teach teachers about new technologies and how to integrate them in their lesson plans. The integration of technology in math education created a crucial change in the learning objectives of the curriculum (Hariri, 2007).

According to Hariri (2007), one of the challenges the Lebanese Ministry of Education was facing is that technology integration had to be equal in all schools by ensuring that all schools have the necessary technological equipment to use. Moreover, introducing technology in the math curriculum led to a definite change in official exams and therefore school assessment methods (Hariri, 2007).

Challenges to the Lebanese Educational System

A study conducted by the Ministry of Education and Higher education in Lebanon (2012) revealed that the challenges to the Lebanese Educational System were:

- Lacked of high quality instruction in government schools, particularly at the pre-secondary level.
- Shortage of teachers in specific subject areas and in certain regions of the country.

- Comparatively low achievement levels of students in Lebanon regarding their international peers.
- National curriculum that does not integrate technology.
- Poor to uneven technology infrastructure and internet connectivity in Lebanese schools, particularly in certain regions.
- Lack of data at the national level.
- Uneven teacher professional development and the lack of a functioning teacher support system.
- A focus on high-stakes examinations (gr 9 and 12) that do not reflect the types of skills necessary for a digital age, such as critical thinking and information literacy skills.

However, according to a research done by the Ministry of Education and Higher Education (2012) in the Andree Nahas High School, technology improved learning by making students not only engaged in learning, but indispensable in their learning. The different ways student used technology was by Facebook (for learning from one another when solving homework), YouTube (to solve the issue of misunderstood concepts), language websites (to practice pronunciation), word processing (to automatically correct grammar and spelling), email and chat (to share ideas and solutions) etc. most importantly, the researcher added that shy students collaborated and shared their ideas online.

To be able to solve some of the challenges facing the Lebanese system the Ministry of Education and Higher Education (2012) implemented a strategic plan to help resolve the issues in the Lebanese schools and led to a better integration of technology and consequently led to technological educational system.

Context of the school

Public schools in Lebanon got the majority of their funds from the government while private schools relied mostly on private resources. Public schools in Lebanon had low economic situations and cannot afford money to buy the least for their students starting from appropriate seating. Moreover, some principals did not want any change to happen in the school for them not to get out of their comfort zone. In addition most of the students in a public school usually came from low income families. The school chosen for the case study was a public school in Mount Lebanon. The student's number in the school increased from 150 in 2001 to 500 in 2016. This increase proved the success of the vision of the principal in implementing technology for a change. The school consisted of 500 students divided into two sections: English and French. The French sections were from grade 10 to 12 (General sciences, life sciences, economics and sociology, and humanities), and the English sections were from grade 7 to 12 (Economics and sociology, life sciences).The school was well known in the region for its quality of teaching and was recognized as a showcase school by Microsoft, the leading international company in technology (see Appendix A). All of the students and teachers had their own tablets provided by the school and connected to its server. Internet connection was available all throughout the scholastic year. Midyear and final exams were done on the tablets , and all scholar books used for the scholastic year 2016-2017 were downloaded as well as software used by every teacher depending on his/her lesson plans. Student and teachers' laptops had the latest Microsoft office, and the program "Lan-School" which permitted the teacher to control the classroom (viewing every student, and permitting the access to the required websites or software used in the current classroom) was installed. All students and teachers had private usernames and passwords for the ability to check homework, classwork, and grades on the google classroom application. The classrooms of the school all included LCD projectors, active-boards, and a white board. The school was the only public school in Lebanon with technological facilities. Being so, the researcher chose this school for the research on the integration of digital games into the mathematics classroom.

Summary

The section provided a brief overview on the importance of integrating digital games into the mathematics curriculum. It showed the relation between the achievement of students in mathematics and the attitude they possess. The purpose of the study was to investigate whether DGBL could be adopted to enhance mathematics learning and to measure students' confidence towards the subject being taught. It was hypothesized that with the integration of digital games into the mathematics classroom, there would be a significant difference in the achievement of students and there would be a linear relationship between attitude and academic achievement in mathematics. Moreover, the research questions explored were whether digital games based learning would have an effect on the attitude of students towards mathematics learning and whether digital games would help the realization of educational goals. This study gave additional insight into the significance of digital game based learning on mathematics achievement and students' attitude.

CHAPTER THREE: METHODOLOGY

The purpose of the chapter was to explain the methodology used to complete this case study. The case study examined the use of digital game based learning (DGBL) and the possible effects of DGBL on math achievement and attitude in middle school. The chapter included a description of the research design, the research context, the instrument used, research participants, and how the data were analyzed to answer the research questions.

Design

The case study included both the quantitative and qualitative research design. In the quantitative approach, the methodology used was a quasi-experimental design using pre and posttests. The population chosen was the convenience sample. The pretest was done before receiving DGBL to check for the knowledge of material. The posttest was done after receiving the DGBL in math instruction for the same sample of students. Students participating in this study were the middle school students of the scholastic year 2016-2017.

Qualitative data was obtained from a case interview with the teacher during the treatment of DGBL. The teacher was asked about the efficiency of DGBL and the possibility to reach educational goals enhancing this method.

Descriptive statistics such as the mean and standard deviation were used to describe the comparison groups and subgroups. Inferential statistics such as the *t*-test were used to determine whether differences in mean scores of each group were statistically significant (Gay et al., 2009). The conventional alpha level .05 was used to determine statistical significance from the dependent paired sample *t*-test (Borg, & Gall, 2007). In addition, the non-parametric test, Wilcoxon test, was used in the cases where the sample was not normally distributed. Moreover, ANOVA was used to test for linear relationships between dependent and independent samples.

Participants

The population for the study was a convenience sample of 68 students at a public school in Mount Lebanon. The whole population was the sample used. The 68 students were middle school students where 17 were from Grade 7, 18 Grade 8 students, and 33 Grade 9 students. The participants were consisted of 29 girls and 39 boys, ages between 12 and 15 years old.

Moreover, two mathematics educators participated in this study. One of them was the researcher and the second was a mathematics educator who had 17 years of experience in the field.

Instruments

In order to collect data, five instruments were used in the study: A pretest and posttest, the curriculum and the book, digital games, mathematics and technology attitude scale, and interview questions.

1. **Pretest and Posttest**

The purpose of the pretest and the posttest was to measure students' knowledge on the mathematical chapters which were taught during the study.

The pretest and posttest was formed of the same questions. (See Appendix C for grade 7 pre and posttest, Appendix D for grade 8 pre and posttest, and Appendix E for pre and posttest). The pretest for every grade level was formed of six questions. The questions included concepts related to the chapters that were covered related to algebra, geometry and analytic geometry. Students sat for the pretest and the posttest before and after the study. Both the pretest and the posttest were scored over 25 depending on students' answers. The same pretest was used as a posttest to study the effect of digital game based learning on the achievement of mathematics.

Data was collected from this instrument by taking the scores of each participant in both the pretest and posttest. The scores were compared using descriptive statistics and inferential statistics.

2. The Curriculum and the Book

The purpose of the curriculum and the book was for guided practice required for the students that were relevant to the chapters taught in the mathematics lesson.

The curriculum used was the Lebanese curriculum and the books were the "Building up Mathematics" books appropriate for each grade level. Chapters were distributed according to the grade levels and requirements in the Lebanese curriculum. Table 2 showed the chapters that were covered throughout the study as well as the time taken for each chapter. Each class had a variety of algebra and geometry chapters covered to ensure that the same strength of mathematics was given to the three classes.

The curriculum and the book helped the researcher in forming the pretest and the posttest to collect appropriate data using the mathematics chapters covered throughout the study.

Table 2

Chapters Covered in the Study

Chapters covered		
Grade 7	Grade 8	Grade 9
Reduction of fractions (5 sessions)	Square roots (5 sessions)	Lines In a coordinate system/ Vectors (5 sessions)
Decimal fractions (5 sessions)	Factorization (4 sessions)	Thales' property/ Similar triangles (4 sessions)
The perpendicular bisector (6 sessions)	Mid-segment theorem (5 sessions)	System of equations/ inequalities (4 sessions)
Triangles case of equality (6 sessions)	Equations – Inequalities (5 sessions)	Trigonometric relations (3 sessions)
Algebraic expressions (5 sessions)	Pythagorean theorem (4 sessions)	Statistics (3 sessions)
	Circle (4 sessions)	

3. Digital Games

The third instrument used in this study was the digital games which was formed of two game applications: ITooch and K-Lite, and one website game from www.mathgames.com.

a. **ITooch**

The purpose of this application was to keep students on task with lots of encouragement and fun during the math lesson.

The application was downloaded on all the students' tablets, which included games directly related to the curriculum. This application included tests for the students to practice and directly gave them their grades with motivational stars. In addition, it included belts for taekwondo which changed colors every time the student played. The application covered ground concept and combined no-frills approach to content while providing students with an exciting learning experience. In addition logic questions were included which led the students to think a bit further than the explained chapter in class.

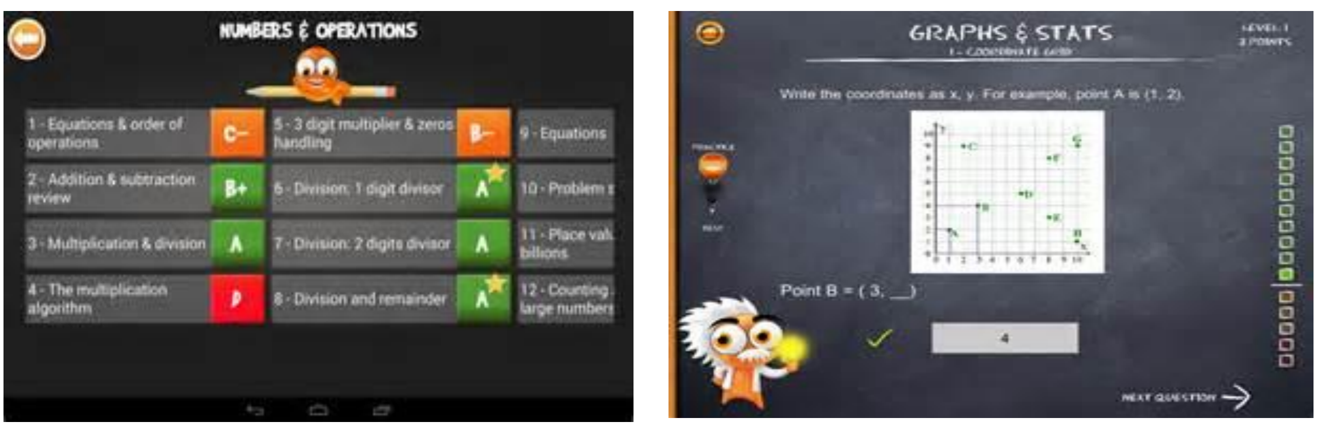

Figure 1. Screenshots of the ITooch Application

b. **K-Lite**

The purpose of this application was for students to exercise the material explained in class, or to watch videos related to the lesson, where the teacher was able to monitor the students' progress without any need of internet connection. In this application, students were able to play and watch course videos.

This application was accessed through the school's server. The application gave the participants motivational badges and extra points, and included exercises directly related to the curriculum. This application was connected to the teacher's laptop through which he/she could see the students' struggling points and improvement throughout the session. Every question included a number of hints specific to help the student solve the given problem.

Figure 2. Screenshots of the KA-Lite application

c. **Online Games (www.mathgames.com)**

The purpose of this website was to give exciting homework where the teacher could see the time spent of each student whether in school or not, and in addition the teacher could see the answers the students chose as well as his/her struggling points.

This website included a variety of games related to the subject to be taught in the classroom on different levels. The games were interactive and got harder every time an aspect was solved. One of the games' pictures is given below. The math muncher game is where a student chooses a fish and has to eat the right answer before a bigger fish eats the player's fish. This website was also connected to the teacher's laptop where the latter was able to monitor the students' progress.

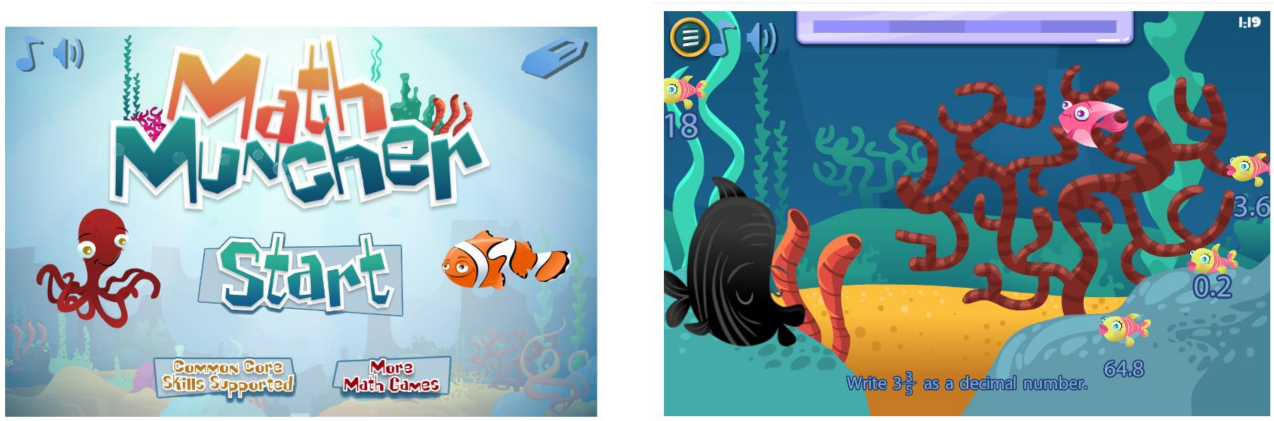

Figure 3. Screenshots of the Math Muncher game from the website www.mathgames.com

The three games were used as homework, classwork, and extra practice for the participants throughout the study. The games used targeted directly the chapters explained by the instructors and gave extra resources for students.

4. Mathematics and Technology Attitude Scale

The purpose of this questionnaire was to study the attitude of the students prior to the study and after the study.

The mathematics and technology attitude scale (MTAS), formed of 20 questions, was distributed to students to be answered in a Likert scale. This questionnaire was developed in 2007 by Anastasios N Barkatsas (see Appendix B). It targeted 5 subscales related to Mathematics Confidence [MC], Confidence with Technology [TC], Attitude to learning mathematics with technology [MT], Affective Engagement [AE] and Behavioral Engagement [BE]. To tailor MT items to a particular class, the words "graphics calculators" were changed to the technology used by that class which was digital gaming, however, the items in confidence with technology were not changed.

This instrument was used in the beginning of the study before the introduction of digital games, and in the end of the study after the introduction of digital games. Data collected from this instrument was analyzed by descriptive and inferential statistics which helped in studying the attitudes of students before and after the introduction of digital games into the mathematics classroom.

5. The Interview Questions

The purpose of the interview was to show the influence of digital games on the realization of mathematical educational goals.

The two educators participating in the case study were interviewed on their opinion on the integration of digital games in their classes. The interview consisted of five questions (see Appendix F) related to the integration of applications into the math classroom. The interview gave a brief explanation on how the educators felt when a new tool was added in their lesson plans. Moreover the interview showed whether or not the educators are positive or negative to include digital games into the classroom.

Procedure

The procedure of the study was as follows:

1. Participants of the three grade levels sat for the midyear exam.
2. Participants of the three classes sat for a pretest to gather information on their knowledge in the chapters.
3. Participants were given the mathematics and technology attitudes scale to fill out.

4. School emails and passwords were created to every participant, and applications were downloaded on each of the students' tablets.
5. Every math session included 15 minutes of chapter explanation, 20 minutes of guided practice (exercises from the book downloaded on their tablets), and 20 minutes on the game or the application relevant to the session.
6. At the end of the class sessions, participants sat for the posttest.
7. Participants were given the mathematics and technology attitudes scale to fill out.
8. Participants sat for the final exam to check for means deviation and percentage of high and low achievers.
9. The two educators were interviewed to check for the realization of educational goals and whether the technique was effective in teaching mathematics. The participating educators used a combination of traditional math instruction and DGBL instruction, defined as learning by using computer games for educational purposes. The teachers replaced classwork with digital games activities in every math session for a period of approximately 10- 15 minutes daily. The same textbook and workbook assignments were used on a regular basis with each teacher however, some of the assignments were replaced with digital games and given as homework instead of classwork.

Summary

The focus of Chapter 3 was the overall research method of the study. The chapter focused on eight components of the research design: the design, research questions, hypothesis, participants, instruments, and procedure. Design and methodology were essential factors when analyzing data for this study. The following chapter, Chapter 4, presented data analysis and the research findings.

CHAPTER FOUR: RESULTS AND DISCUSSION

The purpose of the chapter provided the results of the data collection and analysis of the study arranged in order of the hypothesis and research questions that guided the case study and concludes with a summary of the chapter. The purpose of this case study was twofold: To investigate whether digital games could be adopted to enhance students' learning of math, and to measure students' confidence towards the subject being taught using technology in the middle school of a public school in Mount Lebanon. In the following section, a summary of test results was used to present the quantitative data collected. A more detailed analysis of the data collected will be discussed under the analysis of findings section.

Hypothesis 1:

It was hypothesized that there would be a significant difference between the pretest and posttest achievement scores of middle school students using DGBL as a part of the mathematics teaching.

The hypothesis was supported. There was a significant difference between the results of the pretest and the posttest.

The difference in the mean which was 5.79 between both tests showed that the results in the pretest and the posttest were significantly different. The mean and the standard deviation of the pretest $(M = 4.63, S.D. = 3.16)$ as well as the mean and the standard deviation of the posttest $(M = 10.42, S.D. = 5.10)$ were showed in table 3.

Table 3

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	4.6250	68	3.15770	.38293
	Posttest	10.419	68	5.09727	.61813

Table 4 showed the result of the t-test used to analyze the pretest and the posttest. It was witnessed that ($t = 8.399,\ p < 0.05$).

Table 4

Paired Sample Statistics T-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% C. I.				
					Lower	Upper			
Pair 1	Pretest – Posttest	5.794 12	5.68875	.68986	7.17109	4.41715	8.399	67	.000

The results showed that learning happened when digital games were used in the classroom. The average of the participants in the pretest was 4.63 which increased by 5.79 points and reached an average of 10.42. Moreover results indicated that students gained knowledge with the introduction of a new method to their teaching. The above results supported Prensky (2011) who suggested that technology games helped improve success rates in schools. In addition, Okeke (2016) insisted that the solution to solving the issue of mathematical failure is the introduction of digital games into schools. The integration of digital games based learning into the math classroom made the subject more fun and acceptable for the students which helped in the gaining of knowledge and improved the success rates in the subject in the school (Okeke, 2016).

Hypothesis 2:

It was hypothesized that there would be a significant difference in the mean scores between the midyear and the final exams of the scholastic year 2016-2017.

The hypothesis was supported. There was a significant difference between the results of the midyear exam and the final exam.

Table 5 showed the mean and the standard deviation of both the midyear exam($M = 24.10, S.D. = 11.95$) and the final exam ($M = 28.36\ , S.D. = 11.46$).

Table 5

Paired Samples Statistics

Pair 1	Mean	N	Std Deviation	Std. Error Mean
Midyear	24.0956	68	11.95186	1.44938
Final	28.3566	68	11.45614	1.38926

Table 6 showed the result of the t-test done between the pair the midyear exam and the final exam which revealed that the hypothesis was accepted ($t = 4.623\ , p < 0.05$).

Table 6

Paired Samples Test

Pair	Mean	Std. Dev.	Std. Error Mean	Lower (95% CI)	Upper	T	Df	Sig (2-tailed)
Midyear-Final	4.26103	7.60099	.92176	6.10086	2.42120	4.623	67	.000

The results showed that the average score between the midyear exam (M = 24.1) and the final exam (M= 28.4) increased thus implying that there was an achievement on the scores of the participants on all chapters used in the study. The findings of this hypothesis support the research by Little (2015) showing that students who played digital games showed increase in conceptual, declarative and procedural knowledge. The knowledge students grasped while using digital games was a knowledge rich in relationships and understanding. It was a connected web network in which the linking relationships were as prominent as the discrete bits of information.

Thus, learning through digital games made a difference between midyear and final exams which proved that students' knowledge formed from more than one aspect in mathematics was learnt.

Hypothesis 3:

It was hypothesized that there would be a significant difference in the mean scores of high achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.

The hypothesis was not supported. There was no significant difference in the mean scores of high achievers in the mathematics midyear and final exam of the scholastic year 2016-2017.

The 21 participants who got a grade above average (50/100) were considered to be the high achievers. The number of participants in the high achievers case of the midyear and the final exam as well as the missing number of participants were shown in table 7 which revealed a total of 68 participants.

Table 7

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	%	N	%	N	%
Highachmid	21	30.9%	47	69.1%	68	100.0%
Highachfinal	21	30.9%	47	69.1%	68	100.0%

The Kolmogorov-Smirnov test was used to test for normality of the data. The data was not normally distributed since 0.049<0.05 as shown in Table 8.

Table 8

Tests Of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Diff4	.189	21	.049	.846	21	.004

Since the data was not normally distributed, a non-parametric test, the Wilcoxon test was used to analyze the data. The percentiles were chosen among the 21 participants considered to be the high achievers decomposed into the 25th percentile, the 50th percentile (median) and the 75th percentile as shown in table 9.

Table 9

Descriptive Statistics

	N	Percentiles		
		25th	50th (Median)	75th
highachmid	21	32.0000	38.0000	44.5000
highachfinal	21	36.0000	40.5000	48.0000

According to the data collected, the Wilcoxon signed rank test decomposed the data into negative, positive, and tied data. Negative ranks were the number of students who got lower grades in the final exam than in the midyear exam. Positive ranks were the students who got higher grades in the final exam than in the midyear exam, and the ties were the number of students who got the same average in both exams as shown in table 10.

Table 10

Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
highachfinal – highachmid	Negative Ranks	4[a]	16.88	67.50
	Positive Ranks	17[b]	9.62	163.50
	Ties	0[c]		
	Total	21		

a. Hiachfinal<highachmid
b. Highachfinal>highachmid
c. Highachfinal=highachmid

Table 11

Wilcoxon Signed Ranks Test

Test Statistics[a]	
	highachfinal – highachmid
Z	-1.669-[b]
Asymp. Sig. (2-tailed)	.095

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

The results of the Wilcoxon test revealed that there was no significant difference in the mean scores of high achievers in the mathematics midyear and final exams of the scholastic year 2016-2017 sig= 0.095 > 0.05 as shown in table 11. The mean score of the midyear exam was 38 for the 21 students, and the mean score for the final exam was 40.5. The mean score increased from midyear to final but was not enough to create a significant difference. High achievers were the participants who had no problems in mathematics and had high grades with respect to other participants. There was no significant difference which showed that their grades were not affected negatively by the introduction of a new method of teaching. The results supported Trybus (2009) who said that introducing digital games is not a bad influence on students' achievement. Moreover, Cutumusi (2019), suggested that digital math games helped the students reach higher levels in mathematics without any negative effect on their achievement. Hence, digital games did not affect the high achievers in mathematics neither negatively nor positively. Their grades as well as their potential remained high.

Hypothesis 4:

It was hypothesized that there would be a significant difference in the mean scores of low achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.

The hypothesis was supported. There was a significant difference in the mean scores of low achievers in the mathematics midyear exam and the final exam of the scholastic year 2016-2017.

Table 12

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
lowachmid	47	69.1%	21	30.9%	68	100.0%
lowachfinal	47	69.1%	21	30.9%	68	100.0%

The 47 students who got a grade lower than 50/100 on the midyear exam were considered to be the low achievers in the case study. Table 12 showed the number of low achievers and their percentage as well as the missing students which were included in the high achievers part which revealed a total of 68 students decomposed into 47 low achievers and 21 high achievers.

The Kolmogorov-Smirnov test was used to test for the normality of the data. The data was not normally distributed since 0.027< 0.05 as show in table 13.

Table 13

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Diff3	.137	47	.027	.965	47	.170

a. Lilliefors Significance Correction

Since the data was not normally distributed, a non-parametric test, the Wilcoxon test was used to analyze the data. The percentiles were chosen among the 47 participants who were considered as the low achievers and were decomposed into the 25th percentile, 50th percentile (median), and the 75th percentile as shown in table 14.

Table 14

Descriptive Statistics

	N	Percentiles		
		25th	50th (Median)	75th
lowachmid	47	11.2500	17.2500	24.2500
lowachfinal	47	16.5000	22.5000	29.7500

According to the data collected, the Wilcoxon signed rank test decomposed the data into negative, positive and tied data. Negative ranks were the number of students who got lower grades in the final exam than in the midyear exam. Positive ranks were the students who got higher grades in the final exam than in the midyear exam, and the ties were the students who got the same grade on the final and the midyear exams as shown in table 15

Table 15

Wilcoxon Signed Ranks Test

Ranks		N	Mean Rank	Sum of Ranks
lowachfinal – lowachmid	Negative Ranks	11[a]	17.18	189.00
	Positive Ranks	35[b]	25.49	892.00
	Ties	1[c]		
	Total	47		

a. Lowachfinal < lowachmid
b. Lowachfinal > lowachmid
c. Lowachfinal = lowachmid

Table 16

Wilcoxon Signed Ranks Test

	Lowachfinal-lowachmid
Z	3.841[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon signed ranks test
b. Based on negative ranks

The results of the Wilcoxon test revealed that there was a significant difference in the mean scores of low achievers in the mathematics midyear and final exams of the scholastic year 2016-2017 sig= .000<0.05 as shown in table 16. The mean of the midyear exam was 17.25 however the mean of the final exam was 22.5 which showed that there was a significant difference in the mean scores. Achievement in mathematics was achieved among the grades of low achievers. The results indicated that digital games helped low achievers reach higher goals in mathematics by targeting multiple intelligences and giving the participants wider areas to understand and self-explain the required chapters. According to Eck (2006), games occur in a meaningful context and relates to real life situations. The findings of this hypothesis showed that digital games helped participants achieve better in mathematics especially when more than one context was available to them to study. In addition, and according to Little (2015) digital games occur in a virtual environment filled with fantasy that may target more students which differ with their learning styles and motivates them to study the subject in using different methods. Thus, digital games' importance was in reaching out to more than one learning style and more than one case of multiple intelligence.

Hypothesis 5:

It was hypothesized that there would be a significant linear relationship between attitude and academic achievement in mathematics.

The hypothesis was not supported. There was no significant linear relationship between attitude and academic achievement in mathematics.

Linear regression was used to analyse this hypothesis. Regression estimate was used to describe data analysis and explained the relationship between one dependent variable and one or more independent variables showing that there was no relationship between attitude and academic achievement. Moreover, regression was used to identify the strength of the effect that the independent variable(s) have on a dependent variable also showing that there was no relationship between attitude and academic achievement.

Related to this study, the question asked was: "What is the strength between academic achievement in math and attitude"; the dependent variable was the final exam and the independent variable was the attitude test which was decomposed into five subscales: Mathematics Confidence [MC], Confidence with Technology [TC], Attitude to learning mathematics with technology [MT], Affective Engagement [AE] and Behavioral

Engagement [BE]. Each subscale of the attitude questionnaire was tested to study the effect of attitude on the achievement score. The results of this hypothesis showed no relationship between attitude and academic achievement which showed that attitude and academic achievement related to this case study were not related and not affected by one another. In summary, regression analysis helped understand how much the dependent variable would change when the independent variable changed.

Table 17

Descriptive Statistics

	Mean	Std. Deviation	N
Final	28.3566	11.45614	68
attitude_post_MC	14.9118	3.34903	68
attitude_post_AE	15.0147	3.67116	68
attitude_post_MTg	16.5000	2.99502	68
attitude_post_BE	15.4118	3.20557	68
attitude_post_TC	15.5882	3.38670	68

The mean scores for each of the subscales of the attitude test were shown in table 17 as well as the mean score of the final exam for the whole sample of 68 students.

Table 18

Model Summary[b]

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.300[a]	.090	.017	11.35928	2.161

a. Predictors: (Constant), attitude_post_TC, attitude_post_AE, attitude_post_MTg, attitude_post_MC, attitude_post_BE

b. Dependent variable: Final

Table 18 showed that the adjusted R square of the model is 0.017 and the R square =0.090. The adjusted R square gave the percentage of variation explained by independent variables which were the parts of the attitude test that actually affected the dependent variable which was the final exam, and the R square assumed that every single variable explained the variation in the dependent variable which was the final exam. Table 18 also showed, the Durbin-Watson =2.161 which is between 1.5 &2.5, therefore was assumed that there was no first order linear autocorrelation in the data with the attitude and the dependent variable: the final exam.

The ANOVA test was used in the study to recheck for autocorrelation. The test was used to further prove that there was no effect between attitude and academic achievement. (See table 19 for the result of the ANOVA test).

Table 19

$ANOVA^a$

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	793.226	5	158.645	1.229	$.306^b$
Residual	8000.064	62	129.033		
Total	8793.290	67			

a. Dependent Variable : Final
b. Predictors: (Constant), attitude_post_TC, attitude_post_AE, attitude_post_MTg, attitude_post_MC, attitude_post_BE

Hypothesis five was rejected; there was no relationship between attitude and academic achievement in mathematics although every part of the questionnaire was targeted in the research. The research revealed no relation to mathematics and attitude; this did not agree with the research done by Farooq and Syed (2008). The latter argued that attitude and mathematics achievement were directly related. However, the research by Yien, Hung, Hwang, and Lin (2011) argued that there was a significant difference in achievement but no difference in attitude.

Quantitative data were decomposed into five hypothesis. Table 20 showed a summary of the hypothesis and the results found in each one of them.

Table 20

Summary of Hypothesis

Nb.	Hypothesis	Status
1	There would be a significant difference between the pretest and posttest achievement scores of middle school students using DGBL as a part of the mathematics teaching.	Accepted
2	There would be a significant difference in the mean scores between the midyear and the final exams of the scholastic year 2016-2017	Accepted
3	There would be a significant difference in the mean scores of high achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.	Rejected
4	There would be a significant difference in the mean scores of low achievers in the mathematics midyear and final exams of the scholastic year 2016-2017.	Accepted
5	There would be a significant linear relationship between attitude and academic achievement in math	Rejected

In this section, qualitative data was discussed and results were shown according to the data collected using the Math and technology attitude scale and teachers' interview were described and discussed. Results showed that digital games had a positive effect on student's attitude towards mathematics and moreover helped in the realization of educational goals.

Research Question One

Would digital game based learning have an effect on middle school student's attitude towards mathematics and technology?

The results of the research showed that digital games had a positive effect on middle school student's attitude towards mathematics and technology.

Research Question One investigated the effect of utilizing digital game based learning to change the attitude of students towards mathematics and technology. The mathematics and technology attitude scale (MTAS) was distributed to the participants prior to DGBL (see Appendix B), and the same MTAS questionnaire was distributed after the experiment on DGBL to check for improvement of participants in attitude towards mathematics and technology. The questionnaire targeted five categories: behavioral engagement, technology confidence, math confidence, active engagement, and math with technology.

Table 21

Behavioral engagement pre and post attitude classification

Behavioral engagement	Negative attitude	Moderately high attitude	High Attitude
Pre attitude	38%	43%	19%
Post attitude	16%	41%	43%

The percentages of the behavioral engagement in pre and post attitude classification was shown in table 21. Before the introduction of digital games to the middle school, the negative attitude towards behavioral engagement was 38% and decreased to 16% after introducing digital games. In addition, the high attitude towards behavioral engagement was 19% and increased to 43%. The results of this category showed that digital games students' behavioral engagement in the math classroom improved after introducing DGBL. Students felt more comfortable in math classes and more excited about the lessons taught. Behavioral engagement included attention, participation and effort in academic activities. According to Fredrickes, Blumenfeld, and Paris (2004) students who engaged in digital games and felt excited about math classes meant that their comfort in the math learning was established. In addition, Fredrickes, Blumenfeld, and Paris (2004) saw that behavioral engagement was positive conduct in school, involvement in learning and academic tasks, and participation in school activities. This showed that digital games affected students positively regarding their attention, participation, and involvement in math classes.

Table 22

Technology confidence pre and post attitude classification

Technology Confidence	Negative attitude	Moderately high attitude	High Attitude
Pre attitude	26%	41%	33%
Post attitude	13%	43%	45%

The results of the technology confidence in pre and post attitude classification were shown in table 22. The negative attitude towards technology confidence was 26% before digital games which decreased to 13% after digital games. However, the high attitude towards technology confidence was 33% before digital games which increased to 45% after digital games. Thus, digital games helped in improving technology confidence. Students knew their way around technological devices found in the classroom and did not panic in case of malfunction. Students were more According to Galbraith and Haines (1998), technology confidence was referred to as the students who can see themselves assured while using the computer and the ones who can master any task required of them. They also added that confidence with technology (computers) happened because computers helped students find their mistakes easily and work confidently on resolving them. Students' capability to manage any technological device available for them increased their confidence in technology and moreover let them accept the new educational challenges they face with the integration of technology. Digital games helped improve the attitude towards technology in this research which led to participants being more willing to manage devices in order to play the games required from them.

Table 23

Mathematics confidence pre and post attitude classification

Math Confidence	Negative attitude	Moderately high attitude	High Attitude
Pre attitude	45%	37%	18%
Post attitude	25%	40%	35%

The results of the mathematics confidence in pre and post attitude classification were shown in table 23. Before the integration of digital games into the mathematics classroom, the negative attitude towards mathematics was very high and reached 45% which dropped to 18% after digital games. High attitude towards confidence in mathematics attained 35% and mostly the participants were in the moderately high attitude towards mathematics with a 40%. This showed that mathematics confidence improved with the integration of digital games. Vale and Leder (2004) viewed students' attitudes to mathematics as being defined by the students' perception of their achievement and their aspiration to achieve in the disciplines. This agreed with the fact that the attitude of the participants towards confidence in mathematics increased after the introduction of digital games into the classroom. Moreover, Galbraith and Haines (1998) viewed mathematics confidence as evidenced by the students who believed to obtain the effort they put into studying the subject and generally felt good about mathematics.

Table 24

Affective Engagement pre and post attitude classification

Affective Engagement	Negative attitude	Moderately high attitude	High Attitude
Pre attitude	38%	38%	24%
Post attitude	23%	40%	37%

The results of the affective engagement in pre and post attitude classification were shown in table 24. Students' negative attitude towards affective engagement was 38% before the integration of digital games and became 23% after digital games based learning. Moreover, students' high attitude towards affective engagement was 24% before the integration of digital games and became 37% after digital games. This showed that the integration of digital games increased students' affective engagement in classes where students felt more involved and felt more belonging to school and towards their education. This positive increase in affective engagement showed that participants got more excited when levels were changed and got harder and simpler alternatively which led them to participate better in the classroom and exclude the risk of failing factor from their lives. The results of this factor agreed with Rau and Salvendy (2010) who believed that affective engagement was higher when the difficulty of the game between levels was changed. They also added that players' engagement increased when the levels of a game were alternating and with a continuous change. Moreover the research by Ke, Fengfeng, Kui, & Ying (2015) stated that players' initial phase of affective engagement was driven by players' aspiration for achievement from winning and solving challenges. Increased attitude towards affective engagement is a very important factor since mathematics lessons usually include a variety of tasks that cater the diverse needs of learners. Having a high positive attitude towards affective engagement is directly related to the relevance of the mathematics curriculum which was explicitly linked to students' lives outside the classroom and empowered students with the capacity to transform and reform their lives. In addition, tasks for participants became positive and provided an opportunity for all students to achieve a level of success and are challenging for all. Moreover, technology is embedded and use when appropriate to enhance mathematical understanding through a student centered approach to learning.

Table 25

Mathematics with technology pre and post attitude classification

Mathematics with Technology	Negative attitude	Moderately high attitude	High Attitude
Pre attitude	31%	43%	26%
Post attitude	12%	32%	56%

The results of the mathematics with technology in pre and post attitude classification were shown in table 25. Before the integration of digital games into the mathematics classroom, the negative attitude towards mathematics with technology was 31% which dropped to 12% after digital games. High attitude towards mathematics with technology was 26% before digital games and improved to 56% after digital games. Thus, digital games helped improve mathematics with technology by virtual manipulatives which added to the learning experience, and gave students prompts, feedback and answers to problems while working on the problem which allowed them to have more self-exploration. The results showed in this factor supported the results of the researchers Vale and Leder (2004) and Galbraith and Haines (1998) who both defined the attitude towards the use of technology for learning mathematics and the use of computers relevant to the learning of mathematics which contributes to the achievement of a student in mathematics. Both researches claimed that 'Students indicating high computer and mathematics interaction believe that computers enhance mathematical learning by many means for example digital games.' So digital games helped in improving the attitudes of students' towards math education and achievement. Participants' high attitude towards mathematics and technology indicated that they had comfort in learning mathematics and felt excited for the math class therefore math learning has been established.

Discussion of research question one

After the analysis of the five factors of the Mathematics and Technology Attitude Scale, it was concluded that there was a significant difference in the attitude towards mathematics before the study and the attitude after the study. It can be said that the change in attitude in the mathematics with technology factor may be affected by the concept that it is new for the students to learn mathematics using this precise technique and specific technology related to their everyday life practice. The results of this research question agreed with the researchers Farooq and Syed (2008) who suggested that the way that mathematics is represented in the classroom affects directly the students' attitude towards mathematics and concluded that positive attitude towards mathematics leads students towards success in mathematics. In addition, the results of this research question agreed with the researchers Vale and Leder (2004) who claimed that 'Students indicating high computer and mathematics interaction believe that computers enhance mathematical learning by many means for example digital games.' In addition, Gee (2007), suggested that students who play digital games show increase in confidence, and declarative knowledge. The difference in percentages was remarkable. The decrease in percentages in negative attitudes and the increase in percentages in positive attitudes show that digital games had an influence on the attitudes of students on all the scales behavioral engagement, technology confidence, math confidence, affective engagement and mathematics with technology. The least influence was on the affective engagement factor, and the most influence was in the mathematics with technology factor. We can then state that digital games mostly affects the attitudes targeting confidence (math and technology) and the mathematics with technology factor. It can be then concluded that digital games based learning helped had a positive effect on students' attitude towards learning mathematics. The results of this research question come in favor with the results of the hypothesis 1, 2 and 4 which showed a significant difference in the achievement of students' before and after the integration of digital games into the mathematics classroom changing their way of learning math and their view to one of the hardest subjects they encounter throughout their scholastic years.

Research question two

Research question two: Would the integration of mathematical computer games influence the realization of educational goals as discussed with the two teachers that teach math to the sample perceived by the current teaching of math?

The results research question two proved that the integration of mathematical computers games helped in the realization of educational goals.

The second research question investigated whether the integration of mathematical computer games influenced the realization of educational goals. To answer this question, an interview was conducted with the two teachers who taught math to the sample (see Appendix F).

The answers to the interview questions by the two teachers were given below.

Question 1: Is technology a way to inspire both teachers and students?

Teachers' answers to this questions revealed that technology was a way to inspire them as well as the students.

Both teachers agreed to the fact that technology helps mathematics in different ways. It helped with faster calculation, with visuals that are hard for the eye to see or for the student to draw. Technology helped in improving lesson plans and helped in taking the students to a reality which is available only while using software. Moreover, both teachers found a benefit in technology in saving the material that was presented in class be it the digital notebook, the videos, the exercises ... more importantly all the material, with the use of technology, was easy to find and proofread. Moreover, technology helped one of the teachers me in widening the areas of explanation by providing them with more than one way to explain a certain mathematical concept."

Question 2: How do you feel about the integration of digital games into the mathematics classroom?

The results of the interview showed that the two teachers did not have a common point of view on the answer to this question however it was stated that in general digital games could be integrated into the math classroom with appropriate planning and the game should be directly related in a manner to the curriculum required by the student to end by the end of the year.

According to the first teacher, integrating digital games into the math classroom helped with explaining the basic fundamentals of math and helped students practice in a fun way the chapters covered. In addition, digital games gave the students the opportunity of trial and error and gave them the chance to keep on practicing untill they reached the next level and directly learn from their mistakes. More importantly, digital games gave the student immediate feedback and made him/her recalculate and rethink about their soultions to the given problems.

However, the second teacher argued that integrating digital games into all the math lessons might be a waste of time in some mathematical concepts. She believed that some chapters may be explained without digital games and still be easy and fun for the student. She agreed on having sessions only for digital games if the game found was directly related to the chapter and had clear objectives that are included in the Lebanese curriculum.

Question 3: Do you support the idea of integrating an “app” to each class?

The answers of this question were opposite and showed that the introduction of applications to the math classroom may cause problems in repreparing the lessons and changing them to become suitable for the 21st century.

The first teacher’s opinion on introducing an “ app” to each math class was negative. She beleived that it will take a lot of time and will require a lot of preparation. She was worried about the amount of time she will put into fixing new lesson plans suitable to the integration of specific application which may be changed according to continuous innovation. In addition and in her oppinion, students will start waiting for the math class to play games and not study traditionally, and whenever this is not the case she will not be able to grab their attention appropriately.

However, the second teacher’s opinion was totally different. She believed that a classroom is worth being fun and noisy if learning is happening. The introduction of an “ app” to the classroom makes the subject more fun and students will be waiting for the math lesson to break the routine they have always been in. She adds : “ A playful mind is a mind full of curiosity , creation and experiment. A playful mind helps a student craft solutions to real life challenges. This is why I would love the idea of introducing an “app” into every classroom.”

Question 4: In your opinion, would this method help us (math teachers) reach our educational goals easier? How?

The answers by the two teachers revealed that integrating digital games into the mathematics classroom helped reach educational goals easier.

Both teachers discussed that introducing digital games to the math classroom helped in reaching the educational goals in the areas where math became hard and boring. Digital games, if well prepared, and integrated properly in the curriculum, will help teachers reach their educational goals and help students as well reach the required goals. The implementation of digital games had to be studied from the beginning of the year and combined in the lesson plans of mathematics chapters.

Question 5: What do you think are the disadvantages of digital games based learning?

Some disadvantages of digital games were time, internet connection, and official exams.

According to both teachers, digital games may require more time than usual teaching. Schools in Lebanon are directly related to the Lebanese program and have an obligation to finish the required curriculum for the class for the students to be able to sit for the official baccalaureate exams. Both teachers agreed to the fact that the math curriculum is loaded and already, without the integration of digital games, the required curriculum does not end by the end of the year using tradional teaching. Therefore, if digital games were to be integrated, planning is required ahead of time. Moreover, games played using internet connection were hard in the classroom given that Lebanon's internet was not stable and gave students some hard time accessing the games.

Summary of the interview

Table 26

Summary of interview responses by the two teachers

Question nb	Question	Teacher 1	Teacher 2
1	Is technology a way to inspire both teachers and students?	Yes	Yes
2	How do you feel about the integration of digital games into the mathematics classroom?	Helpful	Helpful
3	Do you support the idea of integrating an "app" to each class?	No	Yes
4	In your opinion, will this method help us (math teachers) reach our educational goals easier? How?	Yes	Yes
5	What do you think are the disadvantages of digital games based learning?	Time Internet connection Official Exams	Time Internet connection Official Exams

Discussion of research Question Two

As a summary, and according to the answers of the teachers to the interview questions, it was concluded that the integration of mathematics computer games helped influence in the realization of educational goals. The main purpose of the interview was to check the agreement of educators on the integration of educational mathematics digital games into the math curriculum, and whether this integration would lead to the realization of educational goals. Both teachers had mostly common opinions on digital games except for the introduction of "apps" into the classroom. The main difference was time and the need to finish the curriculum of the class before the end of the year to be able to prepare the students for the Lebanese official exams. Hence, the introduction of digital games into the math classroom has to be studied and integrated into the curriculum within an interval of time to be able to help teachers in finishing the required curriculum and deviate away from the concept of traditional teaching. According to the literature review, digital game based learning has been shown to be effective in increasing learning outcomes regardless of the gender (Joiner et al., 2011). In my opinion, students need a fun way to learn mathematics which is more related to the current life they are living – being socially connected 24/7- however, schools are very far from this reality. The closer the material gets to students' everyday life, the better the realization of educational goals. The results of this research question agreed with the hypothesis which showed better achievement in mathematics especially for low achievers since educational goals were targeted in an appropriate manner. Knowledge gained while using digital games was not only relevant but applied and practiced within the educational context. Digital games added to students the sense of competition and engagement. Moreover, digital games gave immediate rewards, reinforcement and feedback which directly led to encouragement in students and motivated them to practice more the subject.

Summary

This section was organized into six subsections based upon research questions and hypothesis: the effect of DGBL on pretest and posttest achievement scores, the effect of DGBL on midyear and final scores, the effect of DGBL on high achievers, the effect of DGBL on low achievers, the relationship between attitude and academic achievement in mathematics, the effect of DGBL on middle school students' attitude towards mathematics and technology, and the influence of DGBL on the realization of educational goals,

The effect of Digital Games Based Learning on pretest and posttest achievement scores.

The analysis of the data showed that the hypothesis was accepted in this case. It was concluded that there was a significant increase in the mean scores from the pretest to the posttest therefore learning has happened using digital games.

The effect of Digital Games Based Learning on midyear and final scores.

The analysis of the data showed that the hypothesis was accepted in this case. There was a significant difference in the mean scores between the midyear and the final exam. The mean scores of the final exams were higher than the mean scores of the midyear exams.

The effect of Digital Games Based Learning on high achievers.

The analysis of the data showed that the hypothesis was rejected in this case. Digital games based learning did not make any difference in the mean scores of high achievers.

The effect of Digital Games Based Learning on low achievers.

The analysis of the data showed that the hypothesis was accepted in this case. Digital games based learning made a significant difference in the mean scores of low achievers changing the scores from low to higher grades closer to the average.

The relationship between attitude and academic achievement in mathematics.

The analysis of the data showed that the hypothesis was rejected in this case. This research did not prove any linear relationship between mathematics attitude and achievement in mathematics.

The effect of Digital Games Based Learning on middle school students' attitude towards mathematics and technology.

The analysis of the data on student's attitude towards mathematics and technology indicated that providing digital games to the students had a positive effect on students' attitude towards learning mathematics.

The influence of digital games based learning on the realization of educational goals.

The researcher found that according to the interview with the teachers, the integration of mathematics computer games helped influence in the realization of educational goals. The only issue was related to the official exams in Lebanon and whether or not implementing the digital games method to classes with official exams would help finish the curriculum and therefore the risk couldn't be taken.

Chapter 4 presented the statistical analysis of the data collected and an explanation of the findings as well as an analysis of the results. Chapter 5 presented a conclusion of the study, discussions, and stated the limitations and implications. The chapter concluded with recommendations for further research based upon these findings.

CHAPTER FIVE: CONCLUSION

The purpose of the chapter was to include a brief overview of the study, implications of the study, limitations, recommendations for further studies, and a general conclusion.

Brief overview of the study

The focus of the study was to determine if the use of digital games in the mathematics classroom of the middle school would significantly affect the attitude of students and their achievement in mathematics. In addition, the case study sought to measure students' confidence towards mathematics with the use of DGBL.

The case study followed a quasi-experimental design and included both quantitative and qualitative approaches. The sample chosen was a convenience sample formed of 68 middle school students. Quantitative data were collected using pre and post tests and were analyzed using descriptive and inferential statistics. Qualitative data were obtained from a case interview with the teachers as well as an attitude scale.

The research showed that digital games could be used to improve students' learning of mathematics in addition helped in the realization of educational goals, and moreover, increased student's confidence towards mathematics learning as a whole.

Implications

The implications that emerged from this study demonstrated that digital games can be used to boost mathematics achievement and attitude in the middle school. Technology, with all the help it can offer in the world of teaching mathematics, is in total alignment with what the young generation of today in the 21st century are searching for. The results of this case study indicated that digital games did impact the learning of mathematics. Digital games changed the mathematics classroom into a fun classroom improving the motivation of students and their sense of belonging. Digital games trained students' brain to make faster decisions and analysis without losing accuracy. Moreover, digital games helped students to deal with immediate problems while keeping long term goals by building maps in his/her head to navigate around the virtual world. In addition, digital games taught the students the perseverance by reaching higher levels and failing multiple times, but nevertheless kept trying to succeed and move on to the next level.

Limitations of the study

There were four limitations to the case study.

The first limitation was that all participants in the research were from one public school in Mount Lebanon which was the only school well equipped and relevant to the study. This factor may limit the generalizability of the findings. The size of the school also limited the number of participants in the study, reducing the statistical power of the study. There was only one class in each level. Grade 7 class was formed of 17 students, grade 8 class was formed of 18 students, and grade 9 class was formed of 34 students.

The second limitation was in the amount of prior knowledge of digital games students possessed. Some of the students were incapable of using the tablets and were not even familiar to surfing the web. Those students were given help from their friends and from the participating teachers for two or three sessions and were then able to excel similar to their colleagues.

The third limitation in the research was the time. The time of this study was short, however the same time for concept teaching in each class was taken.

The fourth limitation in the research was the availability of internet connection. Internet was available in classes using digital games however its speed was not as fast as some games required.

Recommendations for the Future

A Lebanese E-curriculum could be done in order to integrate digital games properly into the curriculum to reach the goals of the official exams and to be able to use digital games freely in the math classroom. Teacher training could be done to change mindsets of teachers and help them with the integration of different concepts of teaching in their classrooms.

In the light of the limitations of this study, the researcher recommended the following for future research. Clearly, the need for further research in the use of DGBL in mathematics at the middle school level is needed. Future studies could be done widely targeting all the areas of mathematics in middle school and high school in schools all around Lebanon. The number of participants could be increased and the time of the study could be widened to cover a whole year of the mathematics curriculum including control and experimental groups in order to allow students more time on task which could provide a number of benefits for example reduce the effect of novelty and allow students to play more complex games. Moreover, future studies may focus on the relationship between academic achievement and attitude towards mathematics to find the specific part of the students' attitude which related to mathematics achievement using digital games. In addition to that, a Lebanese E- curriculum could be done in order to integrate digital games properly into the curriculum to reach the goals of the official exams and to be able to able to use digital games freely in the math classroom. Moreover, future studies could build upon the findings of this research by utilizing different types of digital games or focusing on different subject matter.

Conclusion

The case study sought to provide information regarding the use of digital games based learning as an educational tool in mathematics and explore its effect on the attitude of students and their academic achievement scores. In addition, the study examined the relationship between attitude towards mathematics lessons and their academic achievement. The outcomes of the research were positive concerning the effect of DGBL on mathematics achievement and on students' attitudes towards the subject. The utilization of digital games to provide supplemental instruction in mathematics classes proved to be very beneficial on students' achievement as well as attitude towards the subject. The conclusions that emerged from this study showed a positive effect of digital games on math instruction. Students seek new ways to learn, and the use of digital games as a new learning tool was welcomed by students and increased their motivation and enjoyment in learning mathematics. Moreover, the study indicated that the use of DGBL helped in the realization of educational goals. Even though the results demonstrated no linear relationship between attitude and academic achievement in mathematics for the given group.

Digital games must be studied and integrated properly into the curriculum to keep track of every level and the appropriate learning environment must be considered because it can influence the use of a new learning tool and how students' learning is affected.

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Appendix A

Microsoft Showcase School

The purpose of Appendix A was to show that the school used in the research was considered as a Microsoft showcase school for the technology available in it. The Appendix included an email sent to the school in the scholastic year 2014-2015 recognizing it as a successful school in the integration of technology with teaching and learning.

Dhour Shweir Public Secondary School selected as a 2014-2015 Microsoft Showcase School

Dhour Shweir Public Secondary School recognized as a global leader in successful integrations of technology with teaching and learning

Lebanon – Dhour Shweir Public Secondary School selected by Microsoft as a 2014-2015 Microsoft Showcase School for its excellence in transforming its learning environment to deliver more personalized education to students, using mobile and cloud technology to better prepare students for success in the workplace.

Dhour Shweir Public Secondary School joins an exclusive community of over 150 premier schools from around the world, recognized to celebrate their truly pioneering efforts and innovation in rethinking teaching, learning and assessment in order to drive deep 21st century competencies.

“Being selected as a Microsoft Showcase School is an amazing honor and recognition of the passion our teachers and staff have for creating the best learning environments possible," said Ms. Sabah Mjaess /school leader at Dhour Shweir Public Secondary School. "We look forward to sharing our experiences with other schools in our community and the world to continue finding innovative ways to equip our students with the proper tools needed for success inside and outside of the classroom."

As a Showcase School, Dhour Shweir Public Secondary School will work closely with Microsoft to lead innovation in education and communicate a vision for education enabled by technology through the hosting and mentoring of other schools in the community on transformational educational practices.

"Microsoft Showcase Schools are inspiring examples of how schools are using mobile-first, cloud-first technology to increase students' productivity and develop the skills needed in the workplace," said Anthony Salcito, vice president, Worldwide Education, Microsoft Corp. "With an innovative use of technology, these schools are transforming learning environments and delivering more personalized education to students, allowing them to do more and achieve more."

As well as being recognized on a global scale for their innovative approach to educating tomorrow's workforce, Showcase Schools also receive the following benefits from Microsoft as part of the program:

- Collaboration with an international group of thought leaders
- Complimentary Microsoft IT Academy membership
- Special pricing on SteelCase Education learning classroom furniture
- Eligibility to have at least two High School Student Ambassadors (secondary/high schools only)

- Expert Educator/s on staff to help drive innovation and to support staff, peers and students
- Access to professional development for Educators within their school
- Invitations to Regional Global Forums and BETT (London or Singapore)
- Monthly community webinars and Yammer group discussion, exclusive to Showcase Schools
- Email signature and welcome kit

Microsoft Showcase School Acceptance

Congratulations to the school community of Dhour-Shweir Public Secondary School on your recognition as a Microsoft Showcase School for 2014-2015 (November, 2014 to 2015).

You are joining an exclusive group of schools across the world who are recognized innovators of leading and learning. With limited spaces and high interest, the 2014-2015 Showcase Schools represent the very best practice in learning transformation.

As a Microsoft Showcase School, engagement means:

- Recognition as a leader in educational transformation
- Collaboration opportunities with other leaders from around the world
- Invitations to local and regional events
- Professional learning opportunities for leadership teams
- IT Academy membership
- Steelcase furniture special pricing

Attached in the email you will find:

- A email template you can use to share this exciting new with your local community
- Showcase Schools profile to complete and return
- Dates for the Virtual University sessions we will be running over the next nine months.

Again, CONGRATULATIONS on your selection as a Microsoft Showcase School. On behalf of the worldwide Microsoft in Education team, we are excited to be a part of your journey in creating an environment that fosters 21st century learning and innovative teaching practices.

We look forward to meeting you at our kick off, Lync online event scheduled for **November 17, 2014**. Please attend either 700am PST or 400pm PST. Click here to check your time.

Meeting information:
Join Lync Meeting
Join by phone
Find a local number
Conference ID: 887613129

Share your fantastic news –you are a Microsoft Showcase School!

Regards,
Mark Sparvell, Microsoft Corporation Worldwide School Audience Lead
Mary Meucci, Microsoft Corporation Worldwide School Audience Program Manager

NEXT STEPS FOR SCHOOL LEADERS:

- ✓ Share this great news with the appropriate people within your local, state or country ministry of education.
- ✓ Complete the Showcase Schools Profile and forward to [illegible] by December 12, 2014.
- ✓ We are going to share this great news through our social media channels - @microsoftedu, #msftedu and #showcaseschools. Please include these channels in your communication to your school community and media.
- ✓ The Microsoft Showcase Schools announcement can be found [illegible].

Once again, congratulations to you and your schools. We are looking forward to our shared work.

Microsoft

Figure A 1. Email sent to the school by Microsoft.

Appendix B

Mathematics and Technology Attitudes Scale

The purpose of Appendix B was to show the mathematics and technology attitude scale by its subdivisions used by the researcher in the case study to study the effect of digital games based learning on students attitudes. The mathematics and technology attitude scale was divided into five subscales: Mathematics Confidence [MC], Confidence with Technology [TC)], Attitude to learning mathematics with technology [MT], Affective Engagement [AE] and Behavioral Engagement [BE]. (MTg = MT – digital games). To tailor MT items to a particular class, the words "digital games" were changed to the technology used by that class (e.g. computers, graphics calculators, computer algebra systems…).TC items were not changed. This scale was distributed in the beginning of the study and at the end of it.

The detailed scale used in the study which was sent to the participants before and after the study and analyzed using descriptive and inferential statistics was shown below.

		Hardly ever	Occasionally	About Half the time	Usually	Nearly Always
1	I concentrate hard in mathematics [BE]	HE	Oc	Ha	U	NA
2	I try to answer questions the teacher asks [BE]	HE	Oc	Ha	U	NA
3	If I make mistakes, I work until I have corrected them. [BE]	HE	Oc	Ha	U	NA
4	If I can't do a problem, I keep trying different ideas. [BE]	HE	Oc	Ha	U	NA
5	I am good at using computers [TC]	HE	Oc	Ha	U	NA
6	I am good at using things like VCRs, DVDs, MP3s and mobile phones [TC]	HE	Oc	Ha	U	NA
7	I can fix a lot of computer problems [TC]	HE	Oc	Ha	U	NA
8	I am quick to learn new computer software needed for school [TC]	HE	Oc	Ha	U	NA
9	I have a mathematical mind [MC]	HE	Oc	Ha	U	NA
10	I can get good results in mathematics [MC]	HE	Oc	Ha	U	NA
11	I know I can handle difficulties in mathematics [MC]	HE	Oc	Ha	U	NA
12	I am confident with mathematics [MC]	HE	Oc	Ha	U	NA
13	I am interested to learn new things in mathematics [AE]	HE	Oc	Ha	U	NA
14	In mathematics you get rewards for your effort [AE]	HE	Oc	Ha	U	NA
15	Learning mathematics is enjoyable [AE]	HE	Oc	Ha	U	NA
16	I get a sense of satisfaction when I solve mathematics problems [AE]	HE	Oc	Ha	U	NA
17	I like using digital games in mathematics [MTg]	HE	Oc	Ha	U	NA
18	Using digital games in mathematics is worth the extra effort [MTg]	HE	Oc	Ha	U	NA
19	Mathematics is more interesting when using digital games. [MTg]	HE	Oc	Ha	U	NA
20	Digital games help me learn mathematics better [MTg]	HE	Oc	Ha	U	NA

Appendix C

Pre and Post Test Grade 9

The purpose of Appendix C was to show the pre and posttest used for grade 9. The test included six questions and was graded over 25 points. The test targeted all the chapters used throughout the study. The chapters used in the study were decomposed into three main math concepts; Geometry: Thales' property, trigonometric relations and similar triangles, Algebra: system of equations and inequalities and statistics as well as analytic geometry.

Exercise I (4.5 points)

1. Complete the following statistical data table.

Age	12	13	14	15	Total
Frequency	5	12	10	8	
Relative Frequency					
Percentage					

2. Draw the frequency bar graph.
3. Calculate the average age of the above distribution.

Exercise II (2.5 points)

Prove the following relation.

$$(sinx - cosx - 1)(sinx - cosx + 1) + 2sinxcosx = 0$$

Exercise III (5 points)

BEL is a right triangle at B such that [EL] =9cm and [BL] =8cm.

1) Draw an accurate figure.
2) Calculate BE.
3) Calculate $cos\hat{L}$ and sin$\hat{L}$.

Exercise IV (5 points)

Consider the plane of an orthonormal system $(x'Ox, Y'Oy)$

1) Plot the points A(3,0) and $B(-1,8)$
2) Find the equation of the line (AB).
3) Let $(d): y = \frac{1}{2}x + \frac{7}{2}$

Show that $C(-5,1)$ belongs to (d).

4) Find the intersection point of (d) and (AB).

Exercise V (3 points)
MARI is a parallelogram.
Construct the point:
1) E such that $\overrightarrow{ME} = \overrightarrow{MA} + \overrightarrow{MI}$
2) F, the translate of I by the translation vector $\overrightarrow{MR}$
3) K such that $\overrightarrow{MK} = -\overrightarrow{AK}$

Exercise VI (5 points)
TEQ is an isosceles triangle such that TE=TQ=5cm and QE=6cm.
I is the foot of the height drawn from T and U is the foot of the height drawn from E.
1) Draw an accurate figure.
2) Show that the triangles QUE and TIQ are similar.
3) What is the ratio of reduction k from QUE to TIQ?

Good Luck!

The test was graded over 25 according to the following answer key.

Answer Key

Exercise I (4.5 points)

Answers	Grade
1. Completing of table	2
2. Frequency bar graph	1
3. $\bar{x} = 13.6$	1.5

Exercise II (2.5 points)

Answers	Grade
$\sin^2 a + \cos^2 a = 1$	1
Expanding correctly	1
Final answer	0.5

Exercise III (5 points)

Answers	Grade
1. Figure	1
2. Using Pythagorean theorem prove: $BE = \sqrt{17}$	2
3. $cosL = \frac{BL}{BE} = \frac{8}{9}$ $sinL = \frac{BE}{LE} = \frac{\sqrt{17}}{9}$	2

Exercise IV (5 points)

Answers	Grade
1. Figure	0.5
2. $a = \frac{8}{-4} = -2$ Then equation of line (AB): $y = -2x + 6$	1.5
3. Coordinates of C satisfy the equation of the line 1=1	1.5
4. Intersection point (1,4)	1.5

Exercise V (3 points)

1 point on construction of each point.

Exercise VI (5 points)

Answers	Grade
1. Figure	1
2. Common angle Q Angles U and E are right	2
3. $\frac{QU}{QI} = \frac{QE}{QT} = \frac{UE}{IT} = 1$	2

Appendix D

Pre and Post Test Grade 8

The purpose of Appendix D was to show the pre and posttest used for grade 8. The test included six questions and was graded over 25 points. The test targeted all the chapters used throughout the study. The chapters tested were decomposed into the main mathematics concepts; Geometry: mid-segment theorem, Pythagorean theorem, and circles, and Algebra: square roots, factorization, and equalities and inequalities.

Exercise I: (4.5 points)
Write the following expressions in the form of $a\sqrt{b}$ where $b \geq 0$.
$A = 5\sqrt{2} - 3\sqrt{2}$
$B = \sqrt{5} \times \sqrt{5} \times \sqrt{5}$
$C = 3\sqrt{7} - 4\sqrt{7} - 8\sqrt{7} + 5\sqrt{7}$

Exercise II: (7 points)
Given the expressions:
$A(x) = (5x - 3)(x - 6) - (x + 4)(6 - 10x)$
And $B(x) = (25x^2 - 9) - (5x - 3)(x + 2) + (25x^2 - 30x + 9)$
1) Expand and reduce $A(x)$ and $B(x)$.
2) Factorize $A(x)$ and $B(x)$.
3) Solve $A(x) = B(x)$
4) Consider $F(x) = \frac{A(x)}{B(x)}$

a) For what values of x is $F(x)$ defined?

b) Solve $F(x) = \frac{1}{3}$

Exercise III (3 points)
Solve the following inequality and represent the solution on a number line.

$$\frac{3}{4}x + \frac{11}{2} > \frac{7x}{2} - \frac{5}{4}$$

Exercise IV (5.5 points)
ABCD is a parallelogram. I is the midpoint of [AB] and J is the midpoint of [DC]. Line (BD) cuts (AJ) at M and (CI) at N.
1) Draw an accurate figure.
2) Prove that AICJ is a parallelogram.
3) Prove that M is the midpoint of [DN].

Exercise V: (3 points)

Two circles (C) and (C') with respective centers O and O'and having the same radius R, intersect at A and B.

Show that quadrilateral OAO'B is a rhombus.

Exercise VI: (2 points)

PAS is a right triangle at P such that $PS = 12cm\ and\ SA = 13\ cm.$

Calculate PA.

Good Luck!

The test was graded over 25 according to the following answer key.

Answer Key

Exercise I (4.5 points)

Answers	Grade
1. $A = 2\sqrt{2}$	1.5
2. $B = 5\sqrt{5}$	1.5
3. $C = -4\sqrt{7}$	1.5

Exercise II (7 points)

Answers	Grade
1. $A(x) = 15x^2 + x - 6$ $B(x) = 45x^2 - 37x + 6$	2
2. $A(x) = (5x - 3)(3x + 2)$ $B(x) = (5x - 3)(9x - 2)$	2
3. $x = \frac{3}{5}\ or\ x = \frac{2}{3}$	1
4. A. $x \neq \frac{3}{5}\ \ and\ x \neq \frac{2}{9}$	1
B. $0 = -8$ impossible	1

Exercise III (3 points)

Answers	Grade
$x < \frac{27}{11}$	2
Number line	1

Exercise IV (5.5 points)

Answers	Grade
1. Figure	0.5
2. $(AI) // (JC)$ $\mathrm{AI} = \frac{1}{2}\mathrm{AB}$ and $\mathrm{JC} = \frac{1}{2}\mathrm{DC}$ but $\mathrm{AB} = \mathrm{DC}$ since ABCD is a parm Then AI = JC therefore AICJ is a parallelogram	2.5
3. J midpoint of DC (MJ) // (NC) Then M midpoint of DN by the converse of midsegment theorem.	2.5

Exercise V (3 points)

Answers	Grade
The radii OA'=AO=O'B=BO then OAO'B is a rhombus	3

Exercise VI (2 points)

Answers	Grade
By Pythagorean theorem PA = 5cm	2

Appendix E

Pre and Post Test Grade 7

The purpose of Appendix E was to show the pre and posttest used for grade 7. The test included six questions and was graded over 25 points. The test targeted all the chapters used throughout the study. The test was decomposed into two main mathematic concepts; Geometry: the perpendicular bisector and congruent triangles, Algebra: reduction of fractions, decimal fractions, and algebraic expressions.

Exercise I (3 points)

Calculate:

1) $\frac{4}{5}\times\frac{5}{2}+\frac{3}{2}\times 4$
2) $\left(\frac{3}{4}-\frac{49}{6}\right)\div\frac{2}{3}$

Exercise II (3points)

Write the fraction that corresponds to:

1) Half of the third.
2) Three quarters of the half.
3) The fifth of the three halves.

Exercise III (4 points)

Calculate for $a=\frac{1}{2}$ and $b=\frac{3}{7}$

1) $3a-2b$
2) $-2a+b+1$

Exercise IV (7 points)

Let ABC be a triangle right at C.

H is the midpoint of [AB]. The perpendicular bisector of [AB] cuts (AC) and (BC) at F and E respectively.

1) Draw an accurate triangle.
2) Show that triangle EAB is isosceles of vertex E.
3)
a) What does F represent for triangle ABE?
b) Deduce that (BF) is perpendicular to (AE).

Exercise V (2 points)

ABC and DEF are two triangles such that $B\hat{A}C=E\hat{D}F, A\hat{B}C=D\hat{E}F, and\ A\hat{C}B=D\hat{F}E.$

Are these two triangles congruent? Why?

Exercise VI (6 points)

Given:

$A = 2x^3 - 4x^2 - 3x + 8$ And $B = x^4 - 2x^3 + 6x - 4$.

Calculate:

1) A+B
2) $A - B$
3) $2A + B$
4) $3A - 2B$

Good Luck!

The test was graded over 25 according to the following answer key.

Answer Key

Exercise I (3 points)

Answers	Grade
1. 8	1.5
2. $-\frac{89}{8}$	1.5

Exercise II (3 points)

Answers	Grade
1. $\frac{1}{6}$	1
2. $\frac{3}{8}$	1
3. $\frac{3}{10}$	1

Exercise III (4 points)

Answers	Grade
1. $\frac{9}{14}$	2
2. $\frac{3}{7}$	2

Exercise IV (7 points)

Answers	Grade
1. figure	1
2. EA= EB any point on the perpendicular bisector is equidistant to its extremities.	2
3. A. orthocenter= intersection of heights	2
B. passes through the orthocenter F	2

Exercise V (2 points)

Answers	Grade
No the triangles are not congruent since the three postulates are ASA , SSS and SAS	2

Exercise VI (6 points)

Answers	Grade
1. $x^4 - 4x^2 + 3x + 4$	1
2. $-x^4 + 4x^3 - 4x^2 - 9x + 12$	1
3. $x^4 + 2x^3 - 8x^2 + 12$	2
4. $-2x^4 + 10x^3 - 12x^2 - 21x + 32$	2

Appendix F

Interview

The purpose of Appendix F was to show the interview questions asked to the math instructors who participated in the study.

The interview questions were the following:

1) Is technology a way to inspire both teachers and students?
2) How do you feel about the integration of digital games into the mathematics classroom?
3) Do you support the idea of integrating and “app” to each class?
4) In your opinion, will this method help us (math teachers) reach our educational goals easier? How?
5) What do you think are the disadvantages of digital games based learning?

The results of this interview showed positive feedback on the integration of new technological tools such as digital games into the mathematics curriculum however the only concern was the Lebanese official exams and the time to manage the lessons with the digital games.