Learning Games and their impacts on Student's Educational Performance

الألعاب التعليمية و تأثيرها على الأداء العلمي للطالب

by

Sara Ihsan Alhaddad

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Dr. Sherief Abdallah

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Abstract – English

Developing an application through which the user can learn and have fun at the same time is being challenging for developers. For young learners these applications, or learning games sound interesting and very attractive to use. Yet, the concept of interactivity is essential in those applications to increase the learning potential. Interactivity ensures a bi-directional communication channel between learner and the game system. To find how such learning games affect the learner's performance, an interactive game has been developed. The game focuses only on Math subject specifically on Math Addition Skills. In this research, both quantitative and qualitative studies are applied to assess students' educational performance before and after involving learning games within their traditional learning process.

Abstract – Arabic

يعتبر تطوير التطبيقات التي توفر للمستخدم الترفيه بجانب التعليم تحدياً للمطورين. تجذب هذه التطبيقات أو الألعاب التعليمية اهتمام المتعلمين الصغار. و مع ذلك، يعتبر مفهوم التفاعل ضروري لهذه التطبيقات لزيادة نسبة التعلم المحتملة. يضمن التفاعل بناء قناة اتصال ثنائية الاتجاه بين المتعلم و نظام اللعبة. تم تطوير لعبة تعليمية تفاعلية لمعرفة كيفية تأثير هذه الألعاب التعليمية على مستوى أداء المتعلم. اللعبة تركز فقط على مادة الرياضيات وعلى وجه التحديد المهارات الحسابية في الجمع. في هذا البحث، يتم إجراء دراسات كمية ونوعية لتقييم الأداء التعليمي للطلاب قبل وبعد ان يتم ادراج الألعاب التعليمية داخل العملية التعليمية التقليدية.

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Chapter 1

1. Introduction

Nowadays, most of the developers are working on engaging computer technology within the traditional learning methods. This resulted in having distinctive versions of intelligent tutoring systems, animated educational software and computer-based learning games (Nunes, et al. 2002). These learning systems are likely to be afforded as web-based learning systems, as a result of the wide presence of the Internet and its ease of availability in any place.

Brusilovsky (1998) defined web-based learning systems as applications installed and supported in a single location and are accessible by thousands of learners from different geographic locations that are equipped with any kind of Internet-connected device. These web-based systems aim to improve the traditional classroom learning, develop the paper-based learning and support individual long-term learning (Melis & Siekmann 2004). They can be adapted in different learning contexts, including long-distance learning, classroom practicing, homework solving and teacher-assisted learning.

Among all web-based systems, educational systems especially require a high degree of interactivity to empower the learning environment between the two parties: learner and system to enrich the learning process. Chou (2003) described interactivity as when a learner adapts to information delivered through a mutual give-and-take process between the learner and the system. And Beauchamp & Kennewell (2009) explained interactivity in learning systems, as the ability of the system to respond conditionally to the learner's actions. Yet, this interactivity concept requires a continuous monitoring by the designer to ensure its capability with different user needs.

One of the successful domains in interactive learning systems is Educational Games. (P., et al. 2008) expressed Educational Games as the combination between video games and learning materials. Consequently, a clear balance

between education and fun is to be achieved by the learner while using such games.

2. Aims and Objectives

This research attempts to identify the effects of involving learning games within the educational process on the students' skills, achievements and performance. This is accomplished through verifying scores gathered from an instrument designed to measure the effectiveness. The instrument is presented in a survey that is designed to assess three main factors that characterizes the student's learning achievements. An Addition learning game is developed using Scratch Software. This game is the tool used to implement this study and the survey is used as the instrument to assess students' performance and achievements. The survey statements are created using the Assessment strategy provided by the Math Teacher, and are divided into 3 main criteria: Student's Class Performance, Student's Learning Performance and Student's Addition Skills.

The claim in this research is to measure the effectiveness of Learning games on the students' educational skills, achievements and performance. There are two hypotheses whom are to verified at the end of the research:

H1: Students' educational performance is positively affected by learning games.

H2: Learning games improve the traditional learning process.

The research study is carried in a Primary School, specifically on 11 students in Grade 1.

3. Research Questions

The research problem can be formulated in the following questions:

- Using the learning game to practice would improve the student's educational skills?
- Will involving learning games in the educational process improve student's learning performance?

- What is the effectiveness of a learning game on the educational process?

4. Dissertation Outline

The research paper is divided into 4 main chapters. In Chapter 2, web-based learning environments and applications are briefly reviewed. Next, the importance of interactivity factor in those learning applications is discussed. The game-based learning is reviewed in through a number of learning games. Chapter 3 outlines the methodology followed in this research, including the development structure of Pooh's Math Game, development tool used…etc. Chapter 4 includes the research implementation stages. It also discusses the two types of studies applied: Quantitative and Qualitative. Finally, Chapter 5 concludes this research and discusses the final findings. As well as, it proposes the future plan of how this research be advanced and expanded.

Chapter 2

Literature Review

Over the past decade, technology has been gradually introduced into different educational fields to support the learning and teaching procedures. In the beginning of technology implementation it existed in video lessons that might require slight interactivity from the user (Sorathia & Servidio 2012).

Many researchers have reviewed the concept of interactivity and its consequences on web based educational systems.

1. Interactivity Impacts

Involving interactivity in educational systems would be a reason to have a great innovative and productive learning environment. Emerging interactive tools within the learning process would make students be more active and have the control on their learning activities (Dormido, et al. 2005).

Interactive learning environments are been widely spread and have shown their influence on the educational practices. Many researchers outlined the meaning of an interactive learning system. (Aleven, et al. 2003) defined interactive e-learning environments as computer-based instructional systems, which deliver a task environment and provide the required support to help users learn new skills and concepts. Whereas, (Moreno & Valdez 2005) described it as a two-way communication between two potential sources (learner and system), which stimulates the learner's engagement along the learning process.

(Moreno & Valdez 2005) carried an experiment on two groups of students to find the effectiveness of merging interactivity with learning. One group was asked to interact and organize a set of frames before starting any explanation or teaching. Whereas, the second group was provided with the explanation without any interaction required. The findings of this experiment showed that group one students were more effective than group two, as they had the chance to learn better when being asked to do tasks and interact with the learning system.

The most successful domain of an interactive learning system is games (Dyck, et al. 2003). The reason behind this outcome is that the designs of games are getting very creative and innovative allowing for having interfaces with a high

usability. The effectiveness of any learning game systems is measured through the criteria of raising the learner's knowledge (De Freitas & Oliver 2006).

(Fu, et al 2009) declared that learning games are explicitly focusing on expanding student's knowledge in a certain topic through learning as he/she plays. Not like other commercial games that are designed for entertaining purposes only.

Games include educational materials incorporated with illustrations, such as: images, text, audio, video and animation, involve several difficulty levels with different learning tasks and provide individual support for the users (Shin, et al. 2012). Such learning environments would allow users develop their self-instructing skills and change their roles from passive receivers into active constructors of knowledge (Oliver & Herrington 2001).

2. Individualized learning environments

Having an individualized learning environment will help the user to enjoy the learning process by having the control on what is being offered (Condie & Munro 2007). In addition, Lu (2004) highlighted that such systems will help the user by recommending certain learning materials depending his/her needs. This will ensure the user improves his/her learning and increases his/her educational achievements. Regarding to (Steed 2002, p. 10), three main issues are to be considered in any individualized learning system. First, it improves depending student's individual needs. Second, offers different learning activities to suit different students' learning styles. Third, continuous environment adaption based on the student's behavior and how he/she interacts with the system over time. Individualized learning systems assist students to accomplish their learning objectives successfully by technically supporting their needs (Chen & Hung 2002).

Most of the educational games focus on one subject, one of which is Math. Math is being a great field to study and explore the effects of game technology on students' learning and performance in different Math skills.

Several games were developed for this purpose and help in getting deeper assessments.

The literature on learning mathematical tasks using games have shown positive impacts on the learners' achievements, motivation and attitude towards accepting new mathematical knowledge. (Randel, et al. 1992). Yet, all the learning goals and rules have to be clearly set for the user to ensure the best learning environment.

3. Educational Games

(Shin, et al. 2012) presented a technology-based educational game called Skills Arena. This game was developed to teach students basic arithmetic skills using GameBoy entertainment system. Setting clear goals for the user to achieve, user control flexibility and different challenging levels that includes repetition were the core points in designing Skills Arena. (Garris, et al. 2002).

The main structure of Skill Arena is made of three game stages from which the user has the option to choose one. Those stages include: 1) Mental, 2) Extension and 3) Place, all are described in Table [1].

Stage Name	Difficulty level	Description	Example
Mental	Easy	Involves One digit number	10 + 3 = ___ 8 – 2 = ___
Extension	Moderate	More than one digit (2 or 3), involves zeros	100 + 20 = ___ 60 - 40 = ___
Place	Difficult	Multiple digits, don't involve zeros	234 + 511 = ___ 136 – 130 = ___

Table 1 Skill Arena Game Stages

Each of the three stages have the option of what arithmetic task to be applied, either addition or subtraction or both. All arithmetic equations will compose of numbers made of one, two, three or four digits. As soon as the arithmetic

equation is displayed on the screen, the user has to give the answer before time is out and the question fades out. The time allowed for each question is set by one of the six speed levels that the user will choose at the beginning of the game. Cartoon characters represent those speed levels.
When the user gives the answer, he/she will be provided with an immediate feedback whether he/she answered the question correctly or not. At the end of each game, a summary is displayed showing number of questions attempted and number of questions correctly answered by the user.

Whereas, (Tong, et al. 2014) explored a game that helps elementary students to practice their mental computational skills in Math. This game is called “The Card Game 24”. Normal playing cards are used in this game ranging from A to 10. Where the ace card is counted as number 1. Four cards are chosen randomly and the user is asked to develop a mathematical equation equals to the target number ‘24’ using those 4 cards and any arithmetic operations (addition, subtraction, multiplication and division). Each of the four cards has to be used only once in the equation. It’s a multi-player game and so the winner is who gives the correct answer first and fastest. To make the game more challenging the target number is randomly chosen between 0 and 50.

One of the most difficult topics in Math for being both learned and taught is Decimals. MathQuest is a game developed to help students learn decimals in an environment stimulating user’s satisfaction, motivation and interactivity (Ahmad, et al. 2010). A player is given a mission of saving a land by returning the mathematical knowledge to its people. For reaching this goal, user has to manage all the mathematical aspects across the whole game journey. This is accomplished by unraveling ancient puzzles and riddles, beating enemies using mathematical calculations and assisting people to resolve their problems. As long as people apply their mathematical skills, they will defeat against the malicious attacks and begin a peaceful civilization.

ActiveMath is a web-based intelligent tutoring system (ITS) specialized in mathematics reviewed by (Melis & Siekmann 2004). This system supports interactive and analytical learning techniques. As well as it supports providing

a personalized learning environment for students in a way to improve their motivation and educational performance. A student can adapt ActiveMath system’s content depending on his/her needs, such as topics to be presented, questions to be asked…etc.

Chapter 3

Methodology

This chapter will review every aspect related to the game developed " Pooh's Math Game". First, the game structure is described briefly and how many levels it includes. Second, the game details are discussed individually including variables, sprites and graphics used. Third, the methodology followed in building the game questions, levels and versions are outlined. It includes a review of the Math Syllabus taught for primary stages in an international. Later, the tool used in building this game "Scratch" is described. At the end, a survey is carried on a number of other Math Games to explore their functionalities and features.

Figure 1 Pooh's Math Game

1. Pooh's Math Game

This Math Game consists of four levels, as the user moves from level to another the questions' difficulty increases. When the user successfully finishes a level, he/she will be directed to the next level. If not, the user will be repeating the same level again until his/her score reaches 70 or above. Each level is created as a block (block is called a method/function in some programming languages), and so 4 blocks are created named: Level1, Level2, Level3 and Level4.

Each level is made of 2 types of questions. The first type is where the user has to find the sum value of the 2 values given (called *addend1* and *addend2*),

will be referred to as ‘Type 1’ in this report. (Anon, 2016) defined an addend as any two or more numbers or quantities that are being added together.
Whereas the second type, the user will be given the *sum* and *addend1* values and is asked to find *addend2*, will be referred to as ‘Type 2’. This is a way to ensure that the user has a full understanding of all the addition skills.

2. Reviewing School Math Syllabus

Before starting to design the game structure, the Math syllabus taught in an international school was reviewed. The main focus was on the primary stages where students start to learn basic addition.
Addition is being taught through two main phases: first phase using one digit numbers in the addition operations, whereas the second phase is using two digit numbers. This gives us a clue that the game can be designed within two difficulty levels.
To enhance students’ addition skills, teachers are providing them with two types of questions. The first type of operations is where the two addends are given and the student has to find the sum, while the second type only one addend is given as well as the sum and the student has to find the missing addend.

3. Main game structure

First, the five variables (*score*, *score2*, *sumScore*, *addendScore*, *gotoNext*) are initiated to ‘0’, then block ‘Level1’ is called to start the game. Next, 3 if-statements are created which will help to navigate through the game levels depending on the value of *gotoNext* variable. The value of *gotoNext* variable is incremented by 1 after completing a level successfully. The structure of the 3 if-statements is described below and illustrated in Figure [2] :

1. If *gotoNext* equals 1, that means that the user passed Level1 successfully and so Level2 block is called. Otherwise, Level1 is called again.

2. If *gotoNext* equals 2, that means that the user passed Level2 successfully and so Level3 block is called. Otherwise, Level2 is called again.
3. If *gotoNext* equals 3, that means that the user passed Level3 successfully and so Level4 block is called. Otherwise, Level3 is called again.

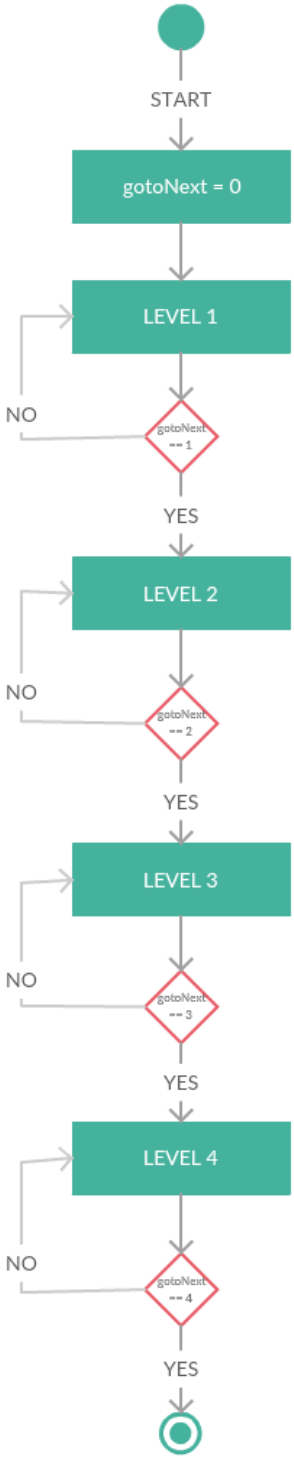

Figure 2 Game Structure Flowchart

3.1. Variables Used

In this game 9 variables are created, all are listed and described in the Table [2] below.

Variable Name	Variable Description
addend1	First addend value in the addition equation
addend2	Second addend value in the addition equation
addendScore	Score of questions requiring an addend value
sum	Result of adding the two addends
sumScore	Score of questions requiring a sum value
score	Total points gained after answering all primary questions
score2	Total points gained after answering all supplementary questions
question	The correct answer of the equation given
gotoNext	Incremented by 1 when successfully completing the current level

Table 2 Game Variables

At the beginning, variables (*score*, *score2*, *sumScore*, *addendScore*, *gotoNext*) are all set to value '0'. In Part 1, values of *addend1* and *addend2* are randomly set to a number in a given range, depending on the level reached, and the user is asked to find the sum. Whereas, in Part 2 *addend1* and *sum* values are randomly set to a number in a given range, depending on the level reached, and the user is asked to find *addend2*. The number ranges

are different from one level to another, and as the level increases the range increases as well as the difficulty level.

Variables created in any game are global, visible and modifiable by all sprites available.

3.2. Additional variable – Progress

To control Sprite2, which presents the game progress bar, an additional variable is created named Progress. This variable is global and is used by the two sprites in the game. When the game starts, progress variable is initiated to 0. Along the game, it is incremented by 1 when the user gives a correct answer in Sprite1 script. And in Sprite2 script, the value of progress variable is retrieved and compared to select the appropriate costume of Sprite2 to be displayed.

3.3. Sprites Used

A sprite is defined as a two dimensional object that appears on the game background called stage. It can be imported into the game project by either uploading it from an external file, or choosing from the sprite library provided by Scratch or the user can create his/her own sprite. Scratch allows using multiple sprites within the same project. (L.A., et al. 2015)

An important feature of a sprite is that it may have more than on appearance. In other words, one sprite can have more than one costume. Using certain function blocks, user can alternate between costumes easily.

In Pooh's Math Game, 3 sprites are created Sprite1, Sprite2 and Sprite3. Sprite1 includes Pooh's characters and consists of 5 costumes that characterize different appearances of Pooh and his friends. The sprite alternates costumes depending on the action happening. For example, if the user gives the correct answer then Pooh will appear smiling with his friend, but if the answer was incorrect then Pooh will appear alone and with a sad face.

For giving the user an idea about his/her progress throughout each level, a progress bar is created. The progress bar is made of 10 blocks presenting the 10 questions in a level. The blocks are gradient ranged colored, starting red and ending green. Such as if the user continues giving correct answers he/she will be moving into the save zone where he/she will be upgraded to the next game level.

In Sprite2, 11 costumes are uploaded that illustrates all stages of the progress bar. At the beginning of each level, the bar is empty and when a question is correctly answered it will increment by one block. Yet, if the answer was incorrect then the bar will not increment and stays as is.

Individually, every sprite has its own scripts by which it functions and behaves. However, the variables created in the game are global and can be used by all sprites.

The final sprite is Sprite3. Sprite3 is a text sprite that includes the text to be displayed under the loading bar, and it consists 3 costumes.

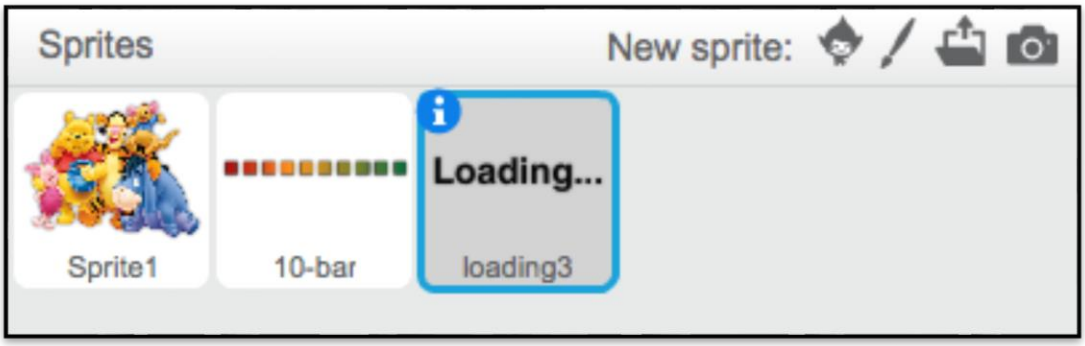

Figure 3 Sprites

3.4. Graphics Used

In this game, some objects are downloaded from the Internet and others are designed using the graphics software Adobe Illustrator CS5. One of those objects is the progress bar shown in Figure [4].

The figure demonstrates the different stages of the progress bar ranging from 1 to 10.

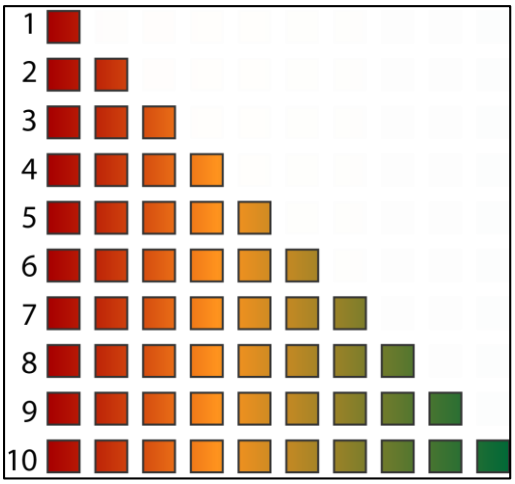

Figure 4 Progress Bar

Besides using different graphics in the game to improve user's interactivity, Gaines & Curry(2011) stated that colors have a great impact on student's learning behavior. Merging colors within learning materials would encourage students and inspire them to be creative in completing their tasks.

Studies have been carried by Engelbrecht(2003) and Imhof(2004) for finding the power of colors on students' performance in learning environments. Students' attention improves positively when using colored educational materials. Color reduces boredom and inactiveness **(**Imhof, 2004). In addition, merging colors in the educational environments will improve the learning performance and are more efficient when compared with black and white environments (Engelbrecht, 2003).

In order to take advantage of the above , colors are being merged in the game design. Different colored backgrounds are used in all game stages to prevent user's boredom and draw an attention while navigating through the game different levels.

3.5. Loading Bar

As the run button is pressed, a loading bar is displayed. This bar is created manually using a user-defined method named "LOAD". This method functions the pen tool for two tasks, to draw the loading bar and the bar background.

First, the pen tool is prepared to draw the bar background by setting the color to grey color and size to 15. The background is then drawn.

Next, the pen color is changed to green and size to 10. Then the loading bar is drawn. The position of the pen is changed after drawing each single block of the bar.

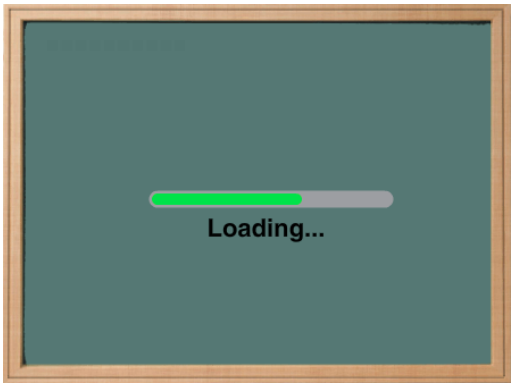

Figure 5 Loading Bar

4. Game versions

Two versions of the game are developed; one is designed with two levels and the second with four levels. The two-leveled version is designed to implement the teaching structure reviewed. Such as the first level will provide users with random numbers with the range 0 to 9 for both addends and sum, and random numbers within the range of 10 to 99 are used in the second level.
Whereas the four-leveled version is the structure proposed in this research to try simplifying it for students.
In the Table [3], each level and its number range are listed.

Level No.	Number Range
Level1	0 to 10
Level2	10 to 40
Level3	40 to 70
Level4	70 to 100

Table 3 Game Levels

Each level is divided into two main stages. In the first stage the user will be given 10 questions, 5 from Part 1 and 5 from Part 2. Points gained from solving correct answers are stored in *score* variable. Each correct answer will add 10 points to *score.* In addition, each question correctly answered from Type 1 will increment *addendScore* by 1 and from Type 2 will increment *sumScore* by 1.

When finishing this stage, if the user got a score greater than 70 then *gotoNext* is incremented by 1. But if the score was less than 70 then he/she will be given 10 more questions from the type that got the fewer score. For example, if the user got 4 correct answers from Type 1 and only 2 correct ones from Type 2 which means *addendScore* is greater than *sumScore* and so the additional 10 questions will be from Type 2. The score of those questions will be stored in *score2* variable. Next, *score* and *score2* values are compared; if *score2* is greater than *score* then *gotoNext* value is incremented by 1.

5. Levels of Questions

At the beginning of all the four levels, user will be given 10 questions equally divided between the two types of questions 'Type 1' and 'Type 2'. Those questions are referred to as the 'Primary Questions' in the game. Next, depending on the score gained, user will be given a set of additional questions or not to gain the score required to be qualified for the next level. Additional questions are referred to as 'Supplementary Questions'. These questions are created upon the user needs, such as…

- if the user scored a low *sumScore,* then all the additional questions will be from 'Type 1', or
- the user has scored a low *addendScore,* then all the additional questions will be from 'Type 2', or
- the user got a low *addendScore* and *sumScore*, then the user will be advised to redo the level again, otherwise
- no additional questions are needed and the user will be directed to the next level.

Not like the other 3 levels, Level1 has an additional feature presented in giving the user a second chance to answer Primary Questions in the case where the first given answer is incorrect.

6. Tool used – Scratch

Scratch is described by both (Maloney, et al. 2010) and (Meerbaum-Salant, et al. 2013) as a visual programming environment, which enables users from different ages and with different educational backgrounds to develop media projects. Those projects are designed using wide range of media elements such as videos, music and animation. (Scratch.mit.edu, 2016)

Scratch project started in 2003, and the Scratch's software and website were officially released after 4 years in 2007. (Maloney, et al. 2010)

A Scratch project is made of a fixed background called stage and a number of portable sprites. Each object encompasses its own set of graphics, sound effects, variables and scripts. (J.H. et al. 2008). Every sprite can change its appearance through switching between the set of costumes imported and attached to this sprite. (L.A., et al. 2015)

7. Surveying Other Addition Games

Game Name	Difficulty Levels	Navigation between levels	Communicating with user	Correcting wrong answers	User requirement adaptation
Sushi Monster	Yes	Yes	No	No	No
A+ Math	Yes	No	No	Yes	No
Alien Addition	Yes	Yes	No	No	No
Canoe Puppies	No	No	No	Yes	No
Math Practice	Yes	Yes	No	No	No

Table 4 Addition Games

Recently, the number of mathematical educational applications developed has increased. Some applications focused on presenting more than one topic, where others only on one. Addition was the most chosen within the mathematical field.

In Table [4], some of those applications are listed and compared upon 5 features that empower any educational application. From a user perspective, a learning system that enables user interactivity and personalization is highly desired (Melis & Siekmann 2004). This would result in improving student's learning motivation and performance.

As revealed, all applications delivered the game in different difficulty levels, which gives the user the option to choose the appropriate level, except Canoe Puppies. This game provides the user with a set of addition questions from different difficulties. It also corrects the wrong answers and displays it to the user. Yet, it lacks any form of user communication and requirement adaption.
Similar to Canoe Puppies, A+ Math corrects wrong answers and don't provide the user with the option of navigating between levels within the same game.
Furthermore, all applications lack any form of user requirement adaption that would provide the user with a more personalized learning environment. As well as, none of the applications interconnects and communicates with the user throughout playing the game.

Chapter 4

Research Implementation

In this research, two types of studies were implemented: Qualitative and Quantitative research studies. This chapter will present research preparation, data collection and execution procedures of both studies. In the Appendices, some of the research tools and requirements are indicated.

1. Research Setting

The research case study was held at a Primary School in United States of America. In specific, students aged between 6 and 7 years old whom are currently enrolled in Grade 1 were the data sources in this research. Those students have recently completed the Addition chapter in the Math subject.

To get an authorized permission from the school to allow implementing this research, an official letter was requested from BUiD and sent to the school principal. The letter is shown in Appendix A.

When approved, a set of meetings was scheduled with Grade 1 Math Teacher. Within those meetings, a timeline for the research was drawn and all requirements for both studies are listed.

2. Quantitative Study

The first part of the research was a quantitative study. The experiment is described in details including participants, instruments, requirements and procedures involved.

- ***Participants***

The experiment participants are 11 students in Grade 1. All are aged between 6 and 7. They completed the Addition chapter in the Math class successfully with different levels of achievements. In Table [5], the students' achievements in Math are listed. Later, a sample made of 13 students in Grade 1 in the previous academic year is used as a control group and will be compared with the Quantitative Study findings.

Student Name	Math Degree
Student A	C
Student B	A
Student C	C
Student D	A
Student E	A
Student F	B
Student G	B
Student H	B
Student I	A
Student J	B
Student K	C

Table 5 Participants Math Achievements

As shown above in Table [5], 4 students got ‘A’ in Math Subject. Students with ‘A’ Math Degrees have high instructional abilities. They perform effective learning methods and approaches in the class. They have a high self-confidence to succeed Math examinations. In other words, A Grade students have high mathematical skills.

Similarly, 4 students got ‘B’ in Math Subject. Students with ‘B’ Math Degrees have an intermediate quality classroom instruction. Their mathematical abilities differ from skill to another. Yet, those students have a good self-assessment practice in the Math class. Also, they are willing to be introduced to alternative learning approaches.

Meanwhile, the remaining 3 students got ‘C’ in Math. While students’ with ‘C’ Math Degrees have low instructional abilities in Math. They show weak learning practices in the classroom. Weaknesses in their mathematical skills are observable in both class performance and examinations.

- ***Procedures & Requirements***

At the beginning of this study, several meetings are made with the Math Teacher to get a deeper understanding about Grade 1 students' performance and achievements in Math class. The assessment criteria used by the teacher is outlined to help in creating a measurement instrument to be used in this quantitative study.

A survey is used as a main instrument to measure students' performance in Math subject. This survey is created using the assessment criteria provided by the Math Teacher. The teacher listed in these criteria all the fundamental measures used to assess the student's educational performance in Math. And as the research focuses only on the Addition chapter, the measures are selected to be focusing on this portion in Math. Then those measures are rephrased to statements to build the survey with. As shown in Appendix B, all the survey statements are grouped into three primary sets:

1. Student Class Performance
2. Student Learning Performance
3. Student Addition Skills

The Student's Assessment Survey developed is to be used twice at the beginning and at the end of the study.

Next, the Math Teacher was introduced to Pooh's Math Game and was given the chance to navigate through all the game levels. This step is considered as essential to validate the game functionality. As well as, revise the mathematical queries generated by the game. Furthermore, verify the structure of the game levels and difficulties.

- ***Execution***

To conduct this experiment, a PC is required for every participant and so the lower grades Computer Lab was reserved for this purpose.

First, a game demo is presented to all participates to introduce them to Pooh's Math Game. Next, they were encouraged to navigate through the game and get familiar with its structure and environment. Meanwhile, the Teacher completed the pre-experiment survey copies for each of all participates.

After ensuring that all participates clearly understood the game structure, they were asked to start using the Math game.

The first attempt score of every game level for every participant using the game was recorded. Average score of the four levels for each student is calculated and illustrated in Figure [6]. Those values are to be used later with a comparison with the final attempt scores.

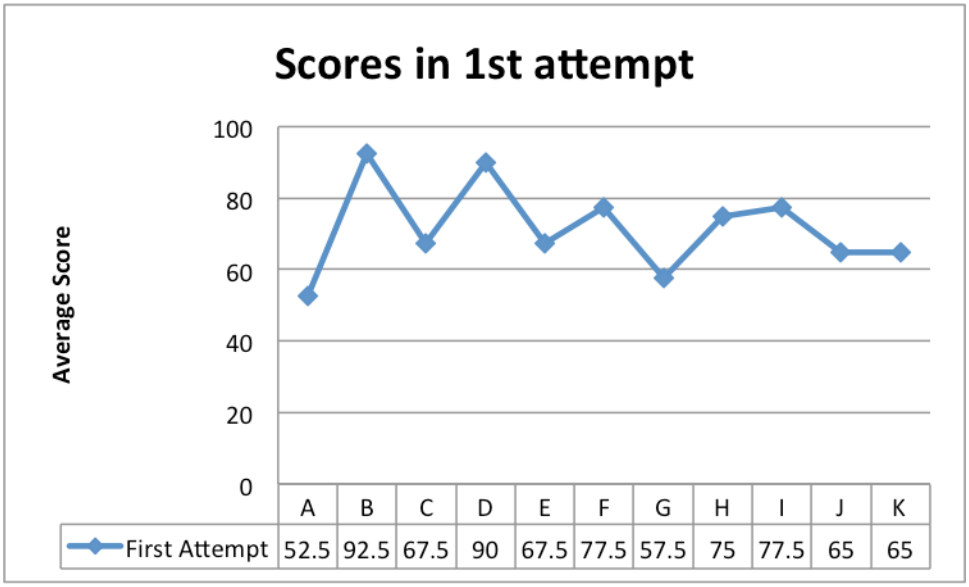

Figure 6 Students Achievements in first attempt

Participants' performance was monitored while using the application. The speed of completing each level differed from one student to another. Also, number of wrong answers varied from one to another.

Yet, as participates spend more time on practicing using the game, their addition skills is noticeably improving. However, this improvement varied from student to another.

After spending a 2-hour session using the game application, students had to attend a class discussion with their Math Teacher. She will review the Addition chapter with the students through giving them math equations to solve, randomly selecting students to explain an addition equation and how to find is solution. Almost all the students were actively participating and showed strong addition skills. The Teacher had the chance to examine every student

individually and get an insight on difference in the students' class performance, weaknesses and strengths.

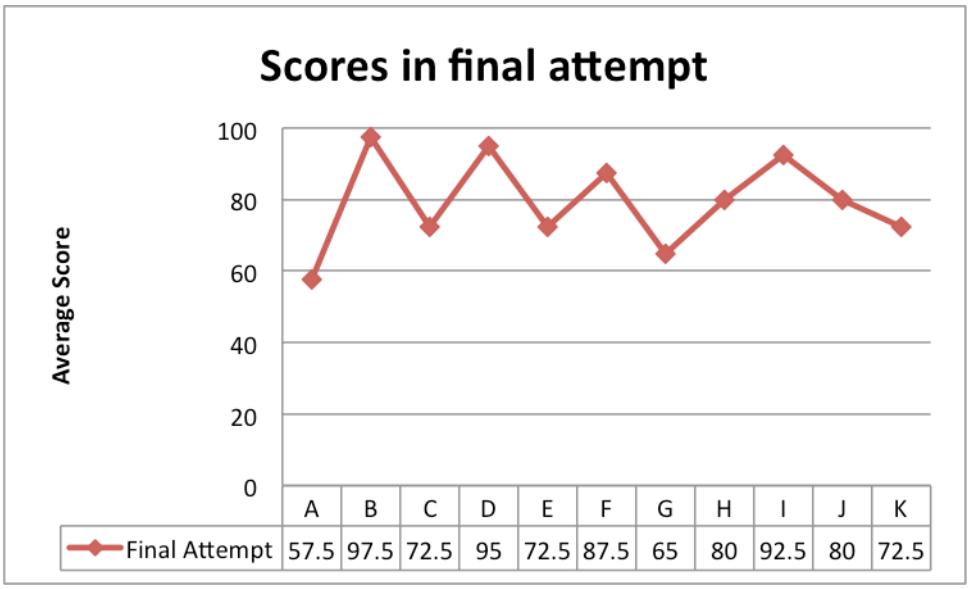

Figure 7 Students Achievements in final attempt

At the end of those previous phases, students are asked to start a final game attempt all at the same time. The scores achieved in all game levels are recorded for all participates. The average score of all the 4 levels is calculated for each student. Figure [7] shows those values. Meanwhile, the Student's Assessment Survey was conducted again to figure out the differences on the students' performance and achievements in Addition after using Pooh's Math Game. Notably, the same survey was conducted for all participants before using the game application.

- ***Discussion***

While the students are using the game application, their performance was noticeably improving. This is clear through the scores they achieved in the game levels at the first and final attempts using the application. As shown in Figure [8], the average scores achieved by the students in the final game attempt are higher than those in the first game attempt. The increase in scores differs from student to another. Such as, Student F, Student I and

Student J got the highest increment in their score achievements greater than 10 points.

Whereas, students like Student B and Student D had the lowest increment in their score achievements. Yet, both average scores were higher than 90 in both the first and final attempts. While all the other students got an increment in their score achievements in the range of 5 to 9 points.

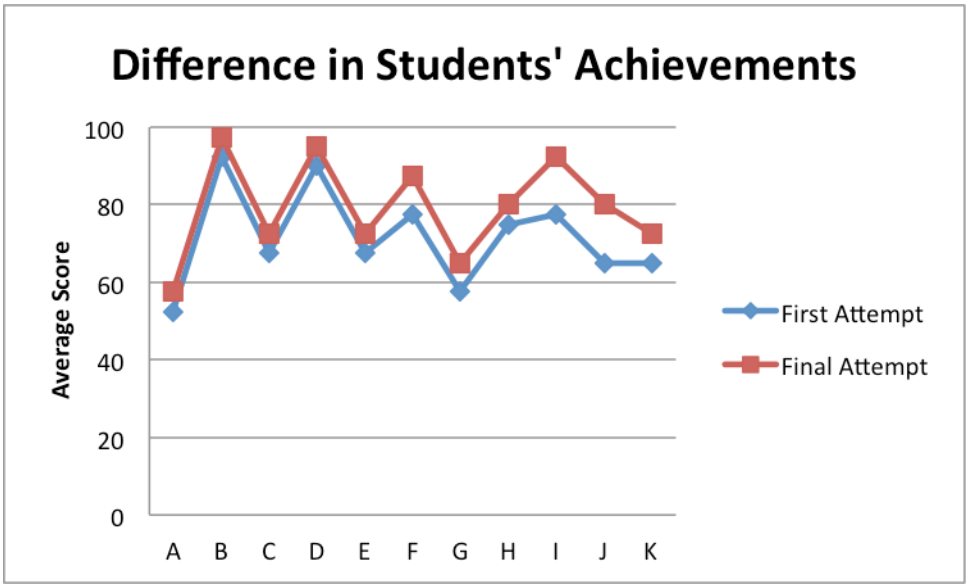

Figure 8 Students Achievements in both attempts

Each student has two versions of the Student Assessment Survey, one conducted before and the other after carrying the experiment. The Grade 1 Math Teacher conducts the survey. Table [6] reveals the difference in the students' performance before and after using Pooh's Math Game. It shows how each skill category is affected after conducting the experiment.

The survey statements focus on assessing different abilities and skills existing in students. As clear from Table [6], the difference in the assessment results before and after implementing the experiment differs from student to another.

Student Name		Class Performance	Learning Performance	Addition Skills
	K	65.7%	76%	76%
		60%	64%	64%
	J	91.4%	80%	76%
		82.9%	76%	64%
	I	91.4%	100%	88%
		88.6%	100%	80%
	H	71.4%	68%	64%
		65.7%	52%	52%
	G	88.6%	72%	64%
		71.4%	68%	56%
	F	80%	72%	76%
		71.4%	60%	64%
	E	94.3%	92%	88%
		88.6%	84%	84%
	D	100%	100%	92%
		97.1%	100%	84%
	C	68.6%	64%	56%
		48.6%	56%	52%
	B	97.1%	100%	84%
		94.3%	92%	72%
	A	65.7%	72%	56%
		51.4 %	60%	52%

Table 6 Students' Assessment Percentages

By comparing the percentages of the 3 assessment criteria marked for all students, the following points are noted:

- Class Performance of students incremented by an average of 8.6%.
- Learning Performance of students incremented by an average of 7.6%.
- Addition Skills of students incremented by an average of 8.7%.

Both Class Performance and Addition Skills showed a similar improvement, however Learning Performance showed a slight lower improvement.

Student A – showed an improvement in both class and learning performance. The student motivation in solving more addition questions has increased. Unlikely, the student's addition skills got a slight improvement specifically when dealing with one digit numbers.

Student B – the improvement all the assessment criteria is clear, especially in the learning performance. The student had a high motivation in completing any addition tasks given, practicing different techniques of addition and explaining how they are done.

Student C – showed a good class performance in Math, has a good level of explain what the Teacher has taught. Yet, the addition skills need to be improved.

Student D – highly improved in class and learning performance. As well as, the additional skills improved but extra practicing is required in the 2-digit numbers addition.

Student E – the learning performance in class has noticeably improved, and has a good self-assessment while practicing addition techniques. Requires additional practice on questions require finding the missing addend value.

Student F – showed an equal increase in all the assessment criteria, addition skills improved but still require more practicing in addition questions including 2-digit numbers and missing addend.

Student G – the addition skills slightly increased when compared with the class and learning performance. The main weakness was finding the value of the missing addend. Nevertheless, showed easiness in explaining and practicing what the Teacher gives.

Student H – all assessment criteria somehow increased equally, but still requires more practicing. The student requires Teacher assessment to solve addition question including 2-digit numbers.

Student I – the class performance and addition skills improved, has a high self-confidence to complete any addition worksheets given. The student learning performance remained high as is.

Student J – although it has incremented, addition skills requires more practicing. The student had a good capability to explain and perform what is taught.

Student K – a small increment happened to the three assessment criteria, but still the student's addition weaknesses are observable through the class practices and solving any given tasks.

When the students started using Pooh's Math Game, almost all of them faced difficulties in completing the whole levels from the first try. Some got use of the second chance given to find out the correct answer. Meanwhile, some students needed to repeat the level at least and others repeated for several times. By practicing the game several times, students started to show different types of improvements.

As clear from Table [6], students' showed an improvement mostly in their learning abilities and Addition skills, still it differed from one to another. Most of them faced difficulties in applying addition techniques to 2-digit numbers or in finding the value of a missing addend in the addition question.

Giving the students the opportunity to use the Pooh's Math Game, improved their class and learning performance by practicing and exploring what has been taught in the Math class. Consequently, H1 is been successfully approved.

- ***Comparison***

To have a more reliable exploration to the results collected through the previous study, the Math achievements of the previous year Grade 1 students in Math is used as a control group. These students continued using the traditional learning method in the Math class throughout the academic year. Table [7] lists the Math Degrees of all these students in the first two assessment terms through which they studied the Addition chapter.

Student Name	Term 1 Math Degree	Term 2 Math Degree
Student A	A	A
Student B	B	B
Student C	B	A
Student D	B	B
Student E	A	A
Student F	C	C
Student G	A	A
Student H	A	A
Student I	C	B
Student J	A	A
Student K	A	A
Student L	C	C
Student M	B	A

Table 7 Students Achievements in previous year

In both terms, most students got ‘A’ in their Math studies and the rest got either ‘B’ or ‘C’ degrees. Those students were learning addition by the traditional learning techniques, including worksheets and textbooks for both class and home works. Scores gained by the students in the Math assessments in Term 1 and 2 are illustrated in Figure [9].

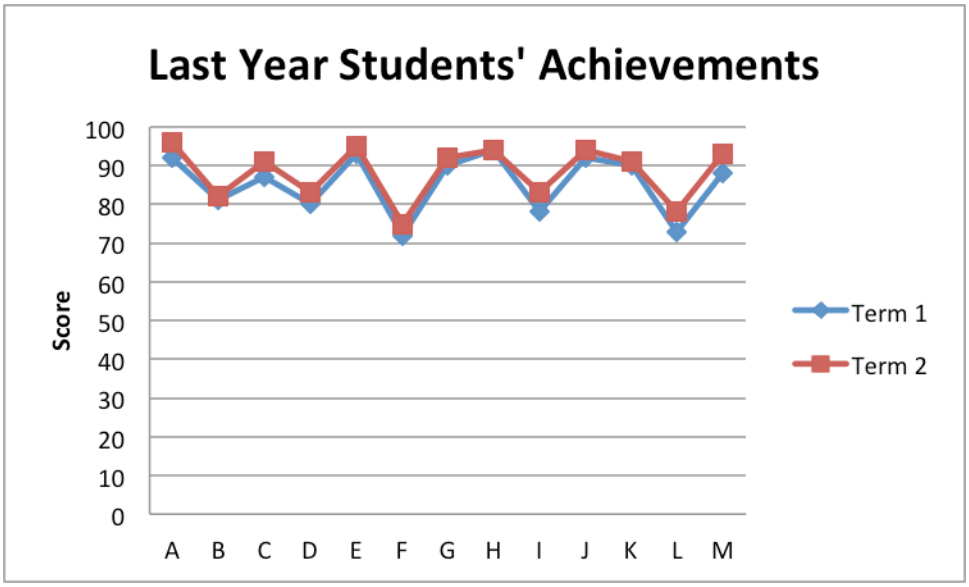

Figure 9 Last Year Students' Achievements in Math

The blue line presents Term 1 scores, whereas the red line present Term 2 scores. As clear, most of the students slightly improved in their Math studies like Students A, C, D, I, L and M. While, Students B, E, F, G, H, J and K their improvements are barely observed.

When talking in numbers, last year students had an improvement average in their Math studies equal to 2.84%. However, this year students (research participants) showed an improvement average in all Math assessments equal to 8.3%.

The difference in both averages shows how introducing learning applications to the students and merging it within the traditional learning and teaching processes would positively affect the students' performance and achievements.

3. Qualitative Study

The second part of this research is a qualitative study. The structure of this study is discussed below, including participates, requirements and procedures involved.

- ***Participants***

The participants are four students, whom are randomly selected from Grade 1 students. Those students have used Pooh's Math Game, and they got a clear idea about what a learning game structure is like. Students selected have different grade degrees in Math subject. Two students got 'A', the third got 'B' and the fourth got 'C'.

- ***Procedures and Requirements***

In this study, a questionnaire developed to be used as the instrument to check out the students' acceptance of emerging learning games within the traditional educational process. This questionnaire includes 10 questions that will help in getting the students feedbacks and understandings regarding learning games, especially Pooh's Math Game. Sometimes, questions were expressed and rephrased while interviewing students to fit their age verbal level.

- ***Execution***

Every student of the four has been interviewed individually; to avoid getting interrupted by other students and their opinions. The interview duration ranged between 10 to 15 minutes. Students were encouraged to express their opinions freely to try getting an accurate study as possible. Students are identified using the name labeled for each in the quantitative research.

Student D – expressed a learning game as a game that offer us things that we can learn from, and includes levels first is the easiest and the last is the hardest. Never heard or used a learning game before. Really enjoyed using Pooh's Math Game, and found it not boring and willing to use it again. Found it interesting to compete with friends, practice addition techniques and like to

use it for both classwork and homework. Will be great to apply learning games on all school subjects.

Student I – described a learning game as a game that we learn from and help us practice what we learn. Pooh's Math Game was the first learning game been used. Liked the game and found it interesting, especially the sound effects available that encouraged them to complete all the game levels. Prefers to use learning games rather than traditional worksheets, as they are boring and not attractive as the games. Willing to use in all other school subjects and finds it an interactive way to do homework and compete with friends.

Student J – expressed a learning game as a game that teaches us material and provides us with fun too. Never used a learning game before except Pooh's Math Game. Found it strange when first using it, but then found it fun to practice what she learned in Math. Liked the cartoon characters used and the colorful game display. Willing to use in classwork and homework tasks rather than using traditional worksheets. Looking forward to introduce learning games in other subjects and adding the facility to use it with her friend as 2 players.

Student K – defined a learning game as a game that teaches us something with fun. First time to use a learning game, and found it an encouraging and attractive way to learn and practice. Finds it a great idea to use such games in all school subjects. As well as, using the learning game in solving classwork and homework. Sound effects and cartoon characters are the two features that mostly attracted in the Pooh's Math Game. Finds it an encouraging way to compete with friends.

- ***Discussion***

It was the first time for all four students to use a learning game. They tried to define it using the definition of both words 'learning' and 'game'. The expressions give by all students were all related to learning and fun.

They had the opportunity to use an example through Pooh's Math Game. All students found it interesting and are willing to use them within their current traditional learning process. They all agreed on that using games would make learning a more attractive activity and is encouraging to compete with friends. Attractive contents are very essential elements in learning games, as all students mentioned the colorful backgrounds and cartoon characters used as what they mostly liked in Pooh's Math Game.

All students are enthusiastic to apply the learning games structure on all the school subjects. As the find it a more interesting way to practice what the Teacher taught in class. Consequently, H2 is successfully approved as all agreed in merging the learning games with the traditional learning methods.

Chapter 5

Conclusion & Future work

Web-based applications have been widely introduced in the educational sector. It is available it different forms and web-based learning games is one of them. Such games provide the user with education with very attractive ways combining knowledge and fun together.

In this research, a study is carried to find out how the usage of learning games within the traditional learning process affect the student's educational performance. A learning game is developed named 'Pooh's Math Game'. From its title, the game is concerned about Math subject specifically Addition chapter. This game is used to identify the effectiveness of using learning games on the students' class and learning performance and achievements.
The research participates involved 11 students from Grade 1. This research aimed to find answers for the research questions outlined in Chapter 1.

Using the learning game to practice would improve the student's educational skills?
It was observable through carrying the study that all students' were willing to use the learning games to practice what they learned in class. They found it a more attractive way than using the printed worksheets. They never get bored using Pooh's Math Game, even when giving wrong answers they were excited to start it all over again.

Will involving learning games in the educational process improve student's learning performance?
Two types of studies are applied in this research: Quantitative and Qualitative studies. The Quantitative study findings showed that students improved in all three-assessment criteria (class performance, learning performance and addition skills) after using Pooh's Math Game. Moreover, students got higher average scores in the final game attempt than they got in the first attempt.
The Quantitative study confirmed that students' educational performance is positively affected by learning games. Whereas, the Qualitative study

confirmed that introducing learning games to the traditional learning process would improve it and make it more attractive to students.

What is the effectiveness of a learning game on the educational process?

First, the Quantitative study showed that the students' achievements in Math improved and this was proved in the changes in the percentages of the 3 assessment criteria, listed in Table [6]. Secondly, when focusing on the student's learning performance, this assessment showed that the average increment in learning performance among all students is 7.6%. And when take Student A and Student K as examples, they both got the second highest increment in the learning performance criteria. Finally, the Qualitative study provided students' feedbacks on implementing learning games within the traditional learning process that point out to be boring when compared with educational games. Students were willing to use the game continuously and were attracted by the media features available in the game. Those features, which include sound effects, colorful display and cartoon character, ensured to provide a friendly and attractive learning environment for students. Resulting in building an effective learning environment for students.

As a future plan, involving a larger number of students could expand the study's platform. As well as, increasing the experiment time duration to get more reliable results in all assessment instruments through carrying the comparison between the 2 groups of students whom have and haven't involved the learning applications and games in the traditional learning process. Additionally, the experiment can be carried on more than one educational subject, not only Math.

Furthermore, including educational materials to be provided for students along with the game might advance such games. For instance, a student facing difficulty in a certain topic would find it useful to briefly review it through the same learning game in an attractive manner.

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Appendix A

Parents Permission letter

Dear Parents/Guardian

I am Sara Alhaddad, registered as a part-time student on the Master of Science – Information Technology Management in The British University in Dubai, UAE.

I'm currently working on a research to assess the effectiveness of using learning applications on students' educational achievements specifically in Math subject. Students are to be aged between 6 and 7 old. I'm also studying the factors that increase or decrease the success of such applications. Mrs. Sharon is also involved in this research and will supervise participating students.

I would be most grateful for your cooperation in approving your child's participation to complete my dissertation research.

Please do not hesitate to contact Mrs. Sharon or me for further details.

Best wishes
Sara Alhaddad
2013128047@student.buid.ac.ae

Pupil Name: _____

I **do** / **don't** give the permission for my child to participate in the research under the supervision of Mrs. Sharon.

Sign: _____

Date: _____

Appendix B

Student's Assessment Survey

	Lowest				Highest
	1	**2**	**3**	**4**	**5**
Student Class Performance					
Student practices what is taught in class easily					
Student has the capability to explain what has been taught in class					
Student has a self-confidence to succeed addition examinations					
Student has self-efficiency in developing addition models					
Student's weaknesses in addition skills are not observable					
Student has a good class performance in Mathematics					
Quality of classroom instruction is high by the student					
Student Learning Performance					
How to rate the student's addition ability					
Completes the given addition tasks easily					
Student has the motivation to solve more addition questions					

Student has a good self-assessment practice in the learning process					
Student willing to learn alternative approaches to assess learning outcomes					
Student Addition Skills					
Student finds the amount of simple addition that result less than 10					
Student is able to find the missing addend easily					
Student deals with addition of one digit numbers smoothly					
Student deals with two digit numbers and finds the missing sum and addend easily					
Student is aware of the two different ways of addition (find missing addend, find the sum)					

Appendix C

Student's Feedback Questionnaire

1. 'Learning Games'… What do you understand from this phrase?

2. Have you ever used a learning game before?

3. How did you find using such games in your Math class?

4. What did you like most in Pooh's Math Game?

5. After using Pooh's Math Game, do you prefer to practice what is taught in class using worksheets or learning games?

6. Did Pooh's Math Game help you in more understanding what your Teacher has taught in class?

7. Are you likely to use such learning games to compete with your friends?

8. Do you prefer using learning games in your classwork and homework?

9. Are you willing to use learning games in other school subjects?

10. What features you wish to find in any learning game?