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An Experimental Study on the Effects of a Gamified Software Intervention in Mathematics Achievement Among Sixth Grade Students

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by
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Approval Page

This applied dissertation was submitted by Janice Watson-Huggins under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

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Statement of Original Work

I declare the following:

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Janice Watson-Huggins
Name

September 17, 2018
Date

Acknowledgments

"*Education is the key to unlocking the world, a passport to freedom*." - Oprah Winfrey

First, I want to say thank you to the almighty God for giving me the health and strength to get this far. You never left me even when the tide seemed low. I am always encouraged by your Word in Chronicles 2 vs 17 that reminds us to be as we are, be strong and never give up, for your work will be rewarded. I dedicate this degree to my parents Jean Reid "Miss Jean" and Michael "Chokey" Watson (09-28-1958-09-11-2008) R.I.P Daddy. You taught me to go after what I wanted, and I did just that. I know that Daddy is smiling down on me right now as my guardian angel whose energy I feel every time I felt like giving up. My parents always made me appreciate what I had and taught me to make use of the little that was laid out in front of me from my humble beginnings in a one-bedroom house. I took a leap of faith and it has finally paid off. To my mom who cleaned people's houses for a living to ensure her children never went a day without food and that we never missed a day of school; I owe you a dearth of gratitude for your selfless sacrifice. I love you Mommy.

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inside ourselves already: we have the power to imagine better." All I needed was the continuous motivation from my friends and family. I always wanted to do my Doctorate, but I never imagined that it would happen right here at NSU. I shed a tear when this dream was realized. As the Jamaican proverb says "ef yu *bawn fi heng, yu cyah drown."* This means that whatever is your destiny in life, it will happen as your destiny is already ordained to be experienced. Jeremiah 22:11 reminds us that "For I know the plans I have for you declares the Lord; plans to prosper you and not to harm you, plans to give you hope and a future. "Thanks, is not enough to repay you all so I hope I also made you proud. I end with Neil Gaiman who said "*Now go, and make interesting mistakes, make amazing mistakes, make glorious and fantastic mistakes. Break rules. Leave the world more interesting for your being here. Make good art."*

The journey continues.

Abstract

An Experimental Study on the Effects of a Gamified Software Intervention on Mathematics Achievement Among Sixth Grade Students. Janice Watson-Huggins, 2018: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education. Keywords: Gamification, intrinsic motivation, extrinsic motivation, academic performance, mathematics, test scores, *Edufocal*©

Children have been playing computer games for many years. Today's children are very technologically savvy compared to 10 years ago. However, no concrete research was done in the Caribbean and in Jamaica to be specific, that investigates the impact of gamification on student academic scores and motivation. Gamification is used to describe the use of gaming mechanics in non-game contexts that can be used to influence behavior, improve motivation and increase engagement (Marczewski, 2013). The present study is an experiment to investigate the effects of a gamified software intervention in mathematics achievement among sixth-grade students.

The experimental method was used to collect data. A two-group pre and post-test design method was employed. The treatment involved a set of mathematical instructional games created using the Jamaican curriculum. Two sets of scores from standardized tests were analyzed; a diagnostic test and the final GSAT exam. An attitude survey was also conducted to investigate student motivation pre and post-gamification.

A Gain Score Analysis (GSA) with an independent sample *t-test* was conducted on the pre and final post-test scores. Upon analyzing the gain scores from students in the treatment group, the results saw (M=-2.67, SD=2.27) while in the control group, on the other hand, the mean difference was (M=-2.67, SD =2.39) and t (59) = -1.172. The results indicate that the intervention student scores had a negative correlation, and we fail to reject the null hypothesis as (p>.246). As such, the intervention did not statistically improve students performance in the short or long-term. The findings from the attitude analysis revealed that students in the gamified group had a more positive attitude towards math at the beginning of the year. At the end of the school year, students in the gamified group also had a more positive attitude toward math compared to the traditional control group. Based on the results from the test scores, the change in attitude was not consistent with the use of the gamified software.

This research is significant as an extensive study of this nature has never been done in Jamaica and by extension the Caribbean. The findings will be of benefit to educators, instructional technologists, administrators and the Ministry of Education in Jamaica. While the study focused on math scores, the results can be used to assist in future planning on whether or not to include some aspects of gamification in each institution as a way to improve student scores in other subjects.

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Chapter 1: Introduction

Background and Justification

The unsatisfactory performance of students in mathematics in the Jamaican educational system has been a cause for concern for both government and its stakeholders inside the public and private sectors. This is a major concern which requires urgent attention with the advent of Science, Technology, Engineering and Medicine (STEM) becoming a driving force for entering emerging job markets. In fact, the Jamaican Government developed the National Mathematics Policy in 2013 with the aim of raising the levels of numeracy and attainment while at the same time, responding to the crisis of falling scores in the area of mathematics (Ministry of Education, 2013).

In Jamaica, the sentiment is shared that an insufficient number of persons coming out in the society are not equipped with the proper skills and understanding required to function effectively in life after school. In effect, many are unable to apply the mathematics skills they learned in a meaningful way. This poor attitude is also evident among many students as some are of the view that mathematics will be of little use to them outside of school (Thompson, 2017).

Conversely, an increasing number of K-12 teachers in the United States have been using games in the classroom but have not explored the possibility of seeing whether it has improved scores adequately (Kapp, 2012). A study by Kebritchi, Hirumi and Bai (2010) found a significant improvement in the achievement of students who used the gaming applications over those who did not. However, no significant improvement was found in the general attitude and motivation between the two groups. The key difference was found between those students who played games in the classrooms or on computers

reporting higher levels of motivation compared to those who played only in computer labs.

It is also true that in today's society, computers and other gaming systems have fulfilled human needs that the real world is unable to satisfy (McGonigal, 2011). This is because, in the gaming world, you are able to score rewards, whereas you would not usually earn same in the real-world setting. The integration of technology can be good or bad which is depending on the reader's point of view (Adimabua, 2015). Today, we are living in a world that is moving at a fast pace where change is becoming accelerated in incomprehensible ways. Also, research in the field of education is not static as the desire for new and improved methods of learning means that research is always evolving (Schaaf & Mohan, 2014).

The University Centre for Innovation in Mathematics Teaching (UCIMT) in Jamaica has been working for almost a decade in conjunction with several government agencies, to provide e-learning mathematics courses in Jamaica (Thompson, 2017). In 2015, the Minister of Education in Jamaica pointed out that the continued decline in performance in mathematics, specifically in the Grade Six, Achievement Test (GSAT), points to math educators' continued challenges with teaching the subject to students. In fact, the Minister also maintained that insufficient math specialists in schools, poor teaching, and inadequate teacher qualification, remain some of the major factors that contribute to the country's poor performance in mathematics which is critical to the country's development (Thompson, 2017).

Hibbert (2016) reported that the 2017 sitting will be the last of the GSAT exam as it will be replaced by another island-wide test called the Primary Exit Profile (PEP). This

new National Standards Curriculum (NSC) Hibbert (2016) reported will be introduced from grade one to the current set of students that will matriculate to grade four. Therefore, the current set of grade-four students will be the first to sit the PEP exam in two years' when they matriculate to the sixth grade. With this new structure, the scores that students receive from grade four will contribute to the overall grade that they will receive at the end of grade six, in comparison to the GSAT exam where the final exam score is the only figure that is used to place students in high school. The areas of assessment, however will remain the same in the form of Mathematics, English Language, Science and Social Studies. Based on the above discussion, as well as the low scores that some students receive in the math component of GSAT, it is imperative to find out how the inclusion of game-based activities in the curriculum can seek to improve student math scores in the sixth grade.

The influence of games and gaming elements has been growing at a rapid pace (Kapp, 2012). However, there have been discussions surrounding how to design educational applications and games geared towards tablet users. There has also been a major shift in the field of education where teachers are moving from more traditional methods of learning to a more 21st century style of teaching, where the instruction is more learner-centered and where the learner plays a more active role rather than teacher-centered (Garris et al., 2002). Children in this era have become accustomed to tablets and other electronic devices. There is, however, no evidence that such familiarity has any bearing on how students perform academically if their curriculum should be converted to game format on its own. Miller and Robertson (2011) examined the effects of electronic computer games on a child's mental skills and their general attitude towards a subject.

While the study used only the Nintendo "DS Lite" gaming console as the intervention, the study's results did shed some light on the student behavior in such a setting, even while showing no significant performance difference in the control group versus the traditional group who did not use the gaming system.

The information in this study is deemed appropriate because the topic of gamification in the school system is still being developed in the Caribbean. Instructional technologists and educators alike have been exploring different ways in which technology can be used in the classroom. We now live in a "gamified" world where some classrooms are now redesigned to facilitate an online environment as a way to keep students engaged and interested in the course content. The process of gamification is one such method. While there has hardly been any academic attempt at a formal definition, Kapp (2012) defined gamification as a process whereby one uses "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems (p. 10)." An argument can be made, however, that "gamification" goes much further than that description.

From a broader spectrum, gamification can be looked at as an approach used by instructors to facilitate learning using gaming elements which force students to think. The definition provided by Marczewski (2013) tends to sum up all other definitions. Marczewski (2013) defines gamification as "the application of gaming metaphors in non-game contexts to influence behavior, improve motivation and enhance engagement" (p.21). The introduction of gamification and game-based learning is one example of the continuous renewal of educational practice (Nicholson, 2014). For the purpose of this study, the concept of gamification was used in a non-game context in education so as not

to obscure the term as used in a traditional game. This research is intended to see if gamification can be used to improve student scores in mathematics and their general attitude towards learning math.

While there have been many discussions from scholars on the effects of gaming systems and how such systems affect a student's academic performance, there has been little empirical research in the Caribbean to substantiate this claim. Technology is not a "one-size-fits-all" situation and can be very costly to implement. This is because "every technology has its own language" (C. Schlosser, 2018 Personal Communication). The interactive whiteboard is one such technology that can be very costly. New interactive technological strategies have also provided opportunities where educators create an environment where students are actively involved in problem-solving (Garris et al., 2002).

No research evidence has been conducted to substantiate the claim that special learning benefits can be gained from one specific medium over another when delivering instruction to students (Clark, 2012a). Clark famously declared in 1983 that the media are mere vehicles that deliver instruction but have no bearing on student achievement no more than a truck that delivers our groceries has any bearing on our nutrition (p. ix). In Schaaf and Mohan (2014), there exist five (5) main barriers that affect the adoption of digital game-based learning in the classroom. These are; funding, the stigma attached to using video games and game-like elements, lack of time, lack of professional training and development and one of the most argued is the fear of change by some teachers. In addition, little research exists which examine the perspectives of developing countries

such as Jamaica where implementing technology in the classroom for learning purposes is concerned (Facey-Shaw et al.,2015).

Research Problem

The issue of worsening math scores has plagued the Jamaican education system for several years at both the Primary and Secondary levels. This current research was designed to determine the effects of a gamified software intervention in mathematics achievement among sixth-grade students in a small inner-city elementary school. For 2017, it was reported by the Jamaica Information Service (JIS) that the average score for mathematics (GSAT) was 62.4 % while the scores since 2016 stood at 58.2% (Smith-Edwards, 2016). The pass rates since 2013 stood at 61%, 60% in 2014 and 56% in 2015. While the 62.4% pass rate was an increase compared to 2014-2015, the pass rate is still low. Against those statistics, the low pass rate is still a major concern for both administrators and educators alike.

To address this challenge, the National Comprehensive Numeracy Program (NCNP) was established at the Primary level to improve students' numeracy achievement, but the problem still exists (Smith-Edwards, 2016). The present study provides empirical data on the effects of the implementation of a gaming system as an experiment and also provides recommendations on how such a system could be implemented in the general Jamaican school system. While there are numerous studies that investigate the impact of gamification in higher education and high school settings, this current research focused on the impact of gamification in a primary middle-school school setting in a Caribbean third-world context.

Purpose of the Study

The purpose of this quantitative study was to determine if the use of gaming applications can contribute to increasing the scores of sixth-grade math students at a selected primary school. In a report published in 2012 by the International Mathematical Union (IMU) entitled *Mathematics in Latin America and the Caribbean: Challenges and Opportunities*, it was reported that the Caribbean region suffers severely from a shortage of financial and human resources. The report further opines that Jamaica has made advancements in education at both the Primary and Secondary level but, the concern lies in the fact that teachers are not preparing students adequately to perform well in standardized tests. The problem usually occurs in more remote rural areas where information network sharing between mathematics educators almost does not exist. It is anticipated that by the end of this study, the researcher, students, instructional technologists, educators and other scholars in the area of education and instructional technology would know more about successfully implementing gamification in their curriculum specifically in the area of math.

Two groups were used for the experimental study: an experimental group (using a gaming system) and a control group (taught via traditional methods). This study sought to compare the math scores of students who have used gaming applications (experimental group) and those who have not used the application (control group) to examine if there have been any changes in their math scores and attitude towards math using the amended Kaput Center attitude scale. By applying gamification in the classroom, students could be motivated to learn new ways, or they could enjoy tasks that they once found difficult. The final result discussed the relationship between motivation and its impact on student scores

in an online gamified learning intervention experiment. It is anticipated that the results will contribute to policy-making and also potentially promote further research within the field of Instructional Technology and Distance Education and also to the Jamaican educational system.

Study Objectives

The main objectives of the study are;

1. To determine if the implementation of gamification systems in the classroom can improve math scores of grade-six students.

2. To determine whether gamification can improve the motivation of students towards learning mathematics.

3. To provide recommendations on how to recreate the math curriculum in the future to increase students interest and scores in math using technology.

Research Questions

The following research questions guided the study:

1. What are the effects of a gamified software intervention on mathematics achievement among sixth grade students in a small inner-city elementary school as measured by a school district-wide benchmark exam and final GSAT exams?

2. What effects do gamified applications have on students' motivation, as measured by a math motivation survey developed based on the amended Kaput Center student attitude survey among sixth-grade students?

3.What are the students' perceptions of math before and after working with a Gamification Software, as measured by a math motivation survey developed based on the amended Kaput Center student attitude survey among sixth-grade students?

Research Hypotheses

Null-There is no significant difference in math test scores of the diagnostic and final GSAT test for students who used the gamified software compared to those who did not receive treatment.

Directional-Students exposed to the gamified intervention had a significantly higher gain score in standardized tests than students in the control group.

Independent Variable- treated status

Dependent Variable- academic performance

Definitions of Terms

Application. Mobile applications or mobile apps, are applications that are developed for small handheld devices, such as mobile phones, smartphones, PDA's and so on. Mobile applications can be preloaded on the handheld device as well as able to be downloaded by users from app stores or the internet. The most popular application platforms that support mobile apps today are Android, iOS and Windows Phone (Viswanathan, 2016).

Control Group. A control group is defined as the group in a study that does not receive treatment by the researchers and the results are then used as a benchmark to measure how the subjects in the experimental group performed (Bell, 2016). For this study, students who have never used gamification in the classroom were used as a control group.

E-learning. This term is intended to mean a learning method utilizing technologies to access the educational curriculum outside of a traditional classroom setting (Mayadas, Miller & Sener, 2015).

Experimental Group. An experimental group is defined as a group that is exposed to a treatment or condition in an experimental procedure. For this study, the experimental group is the group that used as a gaming application (Bell, 2016).

Gamification. Kapp (2012) defines gamification as a process whereby one uses "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems (p. 10)."

Traditional Classroom. The traditional classroom for this research means a classroom that has a teacher-centered delivery system of passing on information to students. The traditional classroom is basically concerned with the teacher being the controller of the learning environment (Hassan, Abiddin & Yew, 2014).

Chapter Summary

This chapter presented the purpose of the study, which sought to find out the impact of gamification and e-learning applications in the classroom on the math scores of students in the sixth grade. The applied nature and significance of the study is related to the issue of implementing gamification and other gaming systems in the classroom. The study site took place at a selected elementary school that has utilized gamification in their curriculum. There is also a lack of research addressing the issue of gaming applications in the classroom in the Caribbean region.

Chapter 2: Literature Review

Overview

The literature review focuses on different aspects of gaming systems, including: the definition of "gamification," gaming systems and students' academic performance; factors affecting educational technology participation; games and academic performance in mathematics; gender and performance in mathematics using computer games, gamification, math and motivation; and recommendations for improving mathematics scores via gamification approaches. The study further provides information on the extent to which gamification systems implemented in various schools have been successful and provide recommendations on how this strategy could be implemented in the Jamaican school system.

The objective of the literature review is to provide information on how different schools have incorporated gaming in their math curriculum, how gaming has caused increases in student academic achievement, the place of gaming in the 21st century as well as how gaming can be incorporated in Jamaica and the wider Caribbean educational community. This section commences with the theoretical framework.

Theoretical Framework

The theory that was used to guide this research is the Self-Determination Theory of Motivation (SDT) (Ryan & Deci, 2017a). The self-determination theory is a theory of motivation, human behavior, and development. This theory of motivation was used to explain how students are motivated by using gamification to improve their math scores. The STD theory is focused primarily on varying types of motivation that were subsumed as part of this theoretical framework. In addition, the theory is also concerned with "how

social-contextual factors support or thwart people's living through the satisfaction of their basic psychological needs for competence, relatedness and autonomy" (Ryan & Deci, 2017a, p. 3). The SDT over the years has been refined and discussed by many scholars from different institutions (Ryan & Deci, 2017a). The hypothesis is that human beings in general require three basic needs: competence, autonomy and relatedness (Ryan & Deci, 2017a). Each concept will be individually discussed.

Competence. The self-determination theory of motivation postulates that human beings have the intrinsic desire to control and master their environment and the expected outcomes. As human beings, we are interested in finding out how things will "turn out," and what will evolve because of our actions (Ryan & Deci, 2017a).

Relatedness. The need for relatedness surrounds the desire of human beings to be connected to, and interact with, other people. Our daily actions involve interactions with other human beings, and this allows us to have a feeling of belongingness (Ryan & Deci, 2017).

Autonomy. This concept concerns the urge to be causal agents of one's own life by doing things that one genuinely wishes to do. This occurs mostly in the online environment, where the players feel connected to each other through video games (Kapp, 2012).

The theory further explains that, it is in our innate nature as human beings to attain greater degrees of healthy psychological, social and behavioral functioning. This allows us to realize our natural talents. This information elucidates what humans need from being in their psychological and social environments in order to be fully functional in order to succeed (Ryan & Deci, 2017). A similar approach was utilized for the study at

hand to gather information on participants. The focus of the study was to determine which factors in the natural environment motivate students to perform in mathematics, and by extension, whether the introduction of math as a game motivates participants to learn.

Motivation and Self-Determination

The primary use of SDT theory within this study was to help interpret why students cognitively behave the way they do, relating the findings to using games to improve math performance. The premise of the study is that the use of gaming technology in the classroom will increase intrinsic motivation of the students to learn, and by extension, their math performance will significantly increase. The SDT theory applies both to the learner's motivation and their intention to learn using technology (Fathali & Okada, 2017). The researcher examined the student's individual ability to choose how to satisfy their individual needs, and further investigate their actions in the classroom that requires some degree of self-regulation. Therefore, the use of technology as a non-traditional learning method is described by SDT as an out-of-class learning method (Ryan & Deci, 2017). This study investigates how well motivational factors described by SDT applies to and explains sixth-grade student learner's intention to use technology and gamification in their classroom to improve their math scores.

Fathali and Okada (2017) used the SDT of motivation in their study to investigate Japanese EFL learner's intention to continue technology-enhanced out-of-class learning language (OCLL). The study involved 164 undergraduate students who participated in general English classes that were equipped with technology both inside and outside of the classroom. The findings suggest that there was a positive effect on the motivation of the

student learners who participated in the study. The study results further suggest that satisfaction of a learner's basic needs related to competence, autonomy and relatedness which are factors that facilitates intrinsic motivation, can show a positive influence on a learner's intention to use technology to enhance learning (Fathali & Okada, 2017). If educators wish to motivate students to learn math, Brahier (2011) surmised that focus should be placed both on student's beliefs and expectations in addition to their actions. These actions include "the student's ability to plan, manage and persist at tasks such as homework and challenging problems (p. 32).

Motivation and Learning Mathematics

It is important to define the meaning of learning in order to discuss the educational benefits to be derived from playing videos. Wilson and Peterson (2006) define learning as the process of active engagement where knowledge is acquired through experience, study or being taught. Learning can also be defined as the development of new knowledge, skills or attitude as an individual interacts with information and the environment (Simonson, Smaldino, Albright & Zvacek, 2012). The intention of this study is to demonstrate whether gamification can be used as a method of learning and thereby improving math scores. Math test scores by students in the Jamaican system have been very low. In 2017, GSAT recorded passes in math stood at 50.2% while the results for 2016 showed a 2.5% decline compared to the current year. This can be explained largely due to lack of motivation to learn the subject which in effect, affects their grades (IMU, 2012). The self-determination in this respect examined how a student's natural tendencies (their natural self) behaved in effective ways (Ryan & Deci, 2017). The study hypothesizes that when students are intrinsically motivated (i.e. they are driven to do

something because they enjoy it and it peaks their interest), this leads to higher-quality learning and attention from the student (APA, 2004). The SDT theory assumes that human beings have evolved to be "inherently curious, physically active, and deeply social beings" (APA, 2004, p. 4). Gaming elements such as rewards and badges can be used as additional support for the autonomy of learners in order to enhance motivation and in effect learning attitudes (Landers et al., 2017).

In this study, the SDT theory was used to explain how student grades may or may not improve in the context of the environment that satisfies their human needs for competence, autonomy and relatedness. Students in this study used the *Edufocal* gamification software to solve math problems by playing games and earning rewards. To successfully implement a gamified structure in the classroom, one must first gain the attention of learners, so they are interested in the content, and that content must be relevant to a larger goal. In addition to this, the learners must feel confident that they can be successful in the subject. If students feel they can achieve success in a particular game, then they will feel more motivated to succeed in this game (Kapp, 2012). Finally, a student must feel satisfied and feel like they are learning.

Several sources highlight the importance of self-determination and motivation in enhancing student's desire to learn and participate in class (Brahier, 2011; Ryan & Deci, 2017a). Per the American Psychological Association APA (2004, p.3), "students experience competence when they are challenged and given prompt feedback." In the gamified world, the students receive prompt feedback when they answer a question correctly and they are also given explanations on why an answer was marked incorrectly. The CET also suggests that where feedback is timely, informative and non-controlling, it

will lead to higher levels of intrinsic motivation (Ryan & Deci, 2000b). Brahier (2011) explained that teacher's and by extension, student motivation to do math and increase test scores will require that they develop "skills and self-efficacy for applying those skills" (p. 26). Using SDT, students experience independence and self-sufficiency when they feel they are supported and that someone is there to listen to their problems (Ryan & Deci, 2017a).

In the gamified setting, it is hypothesized that students experience the feeling of independence where they are in control of their surroundings as described by SDT Theory of motivation. This feeling of superiority will allow students to feel motivated to solve problems on their own, and to gain rewards from solving problems correctly. Digital games can also serve as a motivating factor that encourages people to play (Schaaf & Mohan, 2014). The SDT theory is concerned with the goals of a particular behavior and further, what energizes this behavior. However, Landers et al. (2017), explained that in a web-based setting, the learner may adjust the pace at which they learn i.e. if the learner is already familiar with the content, they may choose to spend less time on that section while on the other hand, if the learner needs more time to get familiar with the content, then they may choose to spend more time in that area.

This introduces the idea of self-efficacy, which is the belief about what one can learn to do. Earning rewards can serve as a reinforcement of things that the student already learned (Marczewski, 2013). McKoy and Anderson-Chung (2016) shared that the inclusion of gamification elements has the potential to motivate students to perform routine online activities that they are usually reluctant to carry out (p.126). This it was argued, can be done by using gamified elements to make mandatory tasks and routine

activities more satisfying in the gaming world. The results obtained from the study showed that the inclusion of gamification in the classroom can increase learner engagement. It can also be argued that gaming can result in an imaginary world where activities have no direct impact on real life situations (Garris et al., 2002). This can also lead to an increased level of independence albeit in the game alone. While this study was done in the higher education context in Jamaica, the results can be used to apply to the present context.

In the present study, the researcher was interested in finding out what motivates students to learn math and whether gamification in the curriculum can motivate them to learn and further improve their scores. Therefore, the researcher investigated a student's willingness to tap into their intellectual capacities when solving mathematical equations and make informed decisions. This is concerned with the issue of autonomy as explained in the SDT theory.

Gaming in the Classroom

There has been little research on the effect of gaming applications in the classroom (Sung, Chang, & Liu, 2015). The *e-learning* Jamaica platform was developed with the aim of encouraging students to study through gamification, essentially allowing them to practice for exams while having fun at the same time. With gaming applications, students are able to complete hundreds of questions, receive feedback on the items they missed, and also to see how well they are doing on the score sheets as compared to their peers (Davis, 2016). The Caribbean Examination Council's (CXC) CSEC mathematics exam is the main means used to assess a student's knowledge in mathematics which is usually held at the end of five years of secondary education in Jamaica.

E-Learning Jamaica was developed in 2005 as an electronic learning initiative with the main objective of facilitating web-based and computer-based learning and virtual classroom utilizing information, communication and technology (Elearnja, 2016). The project targeted students at the secondary (high school) level with application and processes of an electronic nature geared towards the improvement of performance in the regional examinations (Elearnja, 2016). In 2016, The Government of Jamaica spent nearly $50 million US to equip schools and teachers with technology and training to help with improving teaching conditions in the classroom. In addition, two interactive whiteboard solutions for each school were delivered; one to be fixed in a resource room, and another taken within individual classrooms to raise the level of participation in lessons. It is intended that these additions will help students to become more interested in the subject and in effect their grades will improve (Elearnja, 2016).

In 2011, *e-learning* Jamaica launched an online mathematics textbook entitled the Mathematics Enhancement Program (MEP Jamaica). This program was intended to improve the success rate of students in the Caribbean Secondary Education Certificate (CSEC) exam by facilitating self-study, as well as the reinforcement and improvement of teaching in the classroom. The *e-learning* Jamaica Company was established in 2005 as a limited liability company with the aim of implementing e-learning projects in collaboration with the Ministry of Education (Saunders, 2011). Technologically, learning has evolved with the addition of information from the earlier generation who were accustomed to the traditional face-to face setting, and the recent inclusion of distance education in the classroom.

Recently, the implementation of the computer tablet in school's project, which distributed tablets free of cost to selected schools in Jamaica, was designed to improve student academic performance. The tablets included applications that were pre-downloaded and included access to an online study zone. This study zone is organized around seven key concepts of math: computation; number theory; consumer arithmetic; sets, measurement; statistics; algebra; relations functions and graphs; geometry; and vectors (See appendix G). In the study zone, a new topic and supporting questions are added each week (Elearnja, 2016). The project is also aimed at encouraging schools and administrators to become comfortable with integrating technology in the teaching/ learning process.

Edufocal © Jamaica, launched in March 2012, is an online social learning community focused on using technology to enrich a student's learning experience outside of the classroom in addition to designing innovative ways to promote the use of technology in education (Swaby, 2017). The *Edufocal* © social learning community offers students the opportunity to access over 15,000 questions to prepare for the CSEC and GSAT examinations. The program presents the questions akin to popular methods whereby student's role plays in games. Using this method, the students complete the questions and are awarded with points which will allow them to upgrade to each level based on the number of questions they have correctly answered (Davis, 2016). The more points a student accumulates, the higher they will go in the levels, and they will be able to unlock a larger number of rewards. This research examined whether or not gaming systems such as *Edufocal*© can seek to encourage and improve the math scores of

students in elementary schools using the 6th grade mathematics setting as an epitome of the larger elementary setting.

In addition to *Edufocal* ©, *Miramorai* is a company in Jamaica that created interactive, visually-based learning solutions, such as culturally relevant books, games and other educational mobile applications that seek to serve as critical tools to assist students in their schoolwork. The company merges customized content with present technologies specifically designed for individual and group learning environments that utilize tablets, computers, interactive displays, and other hardware. The website uses figures, puzzles, and trivia that seek to transform classrooms, boardrooms and training rooms into engaging eLearning environments with interactivity through the use of technology that seeks to motivate learning and also encourages participation (Hill, 2015). Mohan and Schaaf (2014), opined that the interaction of students within the games can serve as a challenge to game players as it forces them to think swiftly and make hasty decisions. This level of interaction it was argued, challenges the players which forces them to think at a higher level which provides a rich learning environment. This is possible whether or not the student fails that specific lesson. The aim of the research was, therefore, to find out whether the implementation of specific gamification programs designed by companies such as *Edufocal* in the classroom can improve the math scores of students at the elementary level. In Garris et al. (2002), it was also argued that a central component of gameplay is not that users abandon the game after they have finished playing for other users but in reality, a child is usually instructed to stop playing that game.

The focus will now turn to different aspects of gaming systems. The discussion surrounds gaming systems and its impact on a student's academic performance, factors accounting for low performance in mathematics, electronic games and academic performance, cost of technology, gender and performance in mathematics and recommendations for improving mathematics.

Gamification: A Definition

Although educators have been looking at new and different techniques that can be used in the classroom to improve teaching and learning using technology for a long time, the concept of gamification is still considered a new concept albeit gaining attention in recent times. Gamification as a concept was coined in 2002 by Nick Pelling (Marczewski, 2013). However, the term was first used publicly in 2008 and since then, it has been used on numerous occasions (Scepanovic, Zaric & Matijevic, 2015). Gamification is also used to explain the integration of gaming elements, frameworks and mechanics into non-game scenarios (Johnson, et al., 2014). Gamification is usually used in game contexts to engage people and to solve problems. It is argued that with gamified systems in the classroom, this can increase the participation and the motivation of the learner (Sahin & Namli, 2016). Gamification should also be differentiated from game-based learning because gamification takes the entire learning process and turns it into a game (Al-Azawi, Faliti & Al-Blushi, 2016).

Frost, Matta and MacIvor (2015) argued that the term "gamification" is not to be confused with playing a typical game. This is because playing a "typical" game can be regarded as voluntary, while gamification to complete coursework such as tests and assignments are not. In the real-world setting, the gamer is determined to achieve a higher

score against the odds that are presented in the game. Kapp (2012) defined gamification as a process whereby one uses "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (p. 10). The definition further includes the idea of incorporating game-based elements and game mechanics to learning content. Gaming mechanics describe the key essentials that are common to other games such as leaderboards, rewards/points, and badges (Burke, 2014). These game-based elements typically include stories, challenges, feedback, rewards, etc. to create learning opportunities in the form of a game setting.

It is argued that gamification is currently driven by the success of video games. However, on a broader spectrum, gamification also involves the implementation of different psychological theories, including the theories of motivation and self-determination (De-Marcos, Dominguez, De-Navarrete & Pages, 2014). The benefits to gamification include but is not limited to: (a) increased engagement (b) higher levels of motivation (c) providing instant feedback (d) reinforced learning and increasing time spent on tasks and (d)increased interaction and communication with users (Al-Azawi, et al., 2016). For gaming in the classroom to be successful, it must possess several elements, which we describe next.

Gaming Mechanics and Elements

In this section, we examine the different elements and mechanics of a game in order to understand how gamification works. Mathematics is a subject-area where technology has not been used to its full potential. Kapp (2012) noted that each activity involved in the game must have an intrinsic goal (such as learning to solve a problem) and extrinsic elements (such as points and rewards) with a clear end point in mind,

designed to elicit a specific outcome (such as perform better on a specific skill). One of the main elements and features of video games and other types of games is the frequency and intensity of the feedback provided from games. This feedback is oftentimes provided in real-time where the player is informed of his/her progress throughout the game. There are also strict rules inherent in most games. In Marczewski (2013), he noted that rules are a vital component of any game. No matter the mechanics of the game, there will always be rules that must be adhered to.

Some games also have what is called a leaderboard. On a leaderboard, players can see where they are ranked in relation to their peers, as well as how much progress has been accomplished (Kapp, 2012). When you are extrinsically motivated, it is because you wish to obtain something such as a main goal or anything positive that you can obtain (Chou, 2016). There are two types of leaderboards in gamification; absolute and relative leaderboards (Marczewski, 2013). In the absolute leaderboard, the score is displayed in relation to the number of persons who participated in the same challenge. This however can be looked at in two ways. If you are at the top of the leaderboard, you can feel motivated to continue to stay on top by working harder to master each challenge. On the other hand, it can serve as a demotivating factor for those who are listed at the bottom of the leaderboard. This is because, you may feel that you will never be able to master a particular area or subject and eventually will feel to drop out of the challenge (Marczewski, 2013). In the relative leaderboard, this shows the users position on the board in relation to others who are in the same levels. In this setting, the user will feel a sense of motivation as you are not concerned with who is above or below on the board (Marczewski, 2013).

In Schaaf and Mohan (2014), it was cited that a properly designed game can give players an opportunity to experience intrinsic rewards at different levels of play. This is more likely to occur when students apply enough effort and apply the problem-solving skills that they learnt in order to elevate to the next level on the leaderboard. If done effectively, the impact of gamification can be used to align the interest of the designer with the interest of and how motivated the players are (Buckley & Doyle, 2014). Garris et al. (2002) views the gaming cycle as an interactive process whereby players are allowed to repeat their play without judgment and make corrections based on the feedback. Feedback in this aspect is important because it informs the player/learner if he/she did the right thing or used the wrong approach and suggests different ways how they can correct it without stating the answer. A major advantage of this feature is that in the gaming world, feedback is immediate. This may occur as soon as you have completed a level and notified (Marczewski, 2013). The way to reap the benefits of games is to view games not as mere tools and accessories for teaching but rather artefacts and content to be studied whereby you can learn something (Whitton, 2012).

The question can be asked, is gamification a “now” hype or a system that can be commercially viable for many years to come? In discussing the capabilities of gamification in improving math scores and student motivation to learn math, it is imperative to examine Gartner's hype cycle for emerging technologies. The Gartner hype cycle tracks technologies overtime and see how they evolve or not. The chart describes how technology progresses with the “hype” of having the newest product (over enthusiasm) to be disinterested or a period of disillusionment (Gopaladesikan, 2012) (see Figure 1).

In the first stage i.e. the technology trigger stage, a potential technology is introduced which comes with the "hype" in the market. After this, you may get to the stage called the "Peak of inflated expectations." At this stage according to Gartner, the technology can either produce a high level of success accompanied by a host of failures as the expectations were not met. At the stage of Trough of Disillusionment, issues usually arise where the technology is overemphasized and pushed beyond its limits as the technology does not live up to the "hype." This then leads us to the Slope of Enlightenment where the technology will either live up to its name or the relaunching of second or third generation phases of the product. In the final stage which is the Plateau of Productivity, this is when the technology "takes off" in the industry and is adopted in the mainstream business (Gopaladesikan, 2012). Sandusky (2015) however surmises that "gamification in education and e-learning is still considered as an emerging technology." This is the opposite of what the Gartner hype cycle suggests. So, based on this, will the "hype" of gamification live up to its name?

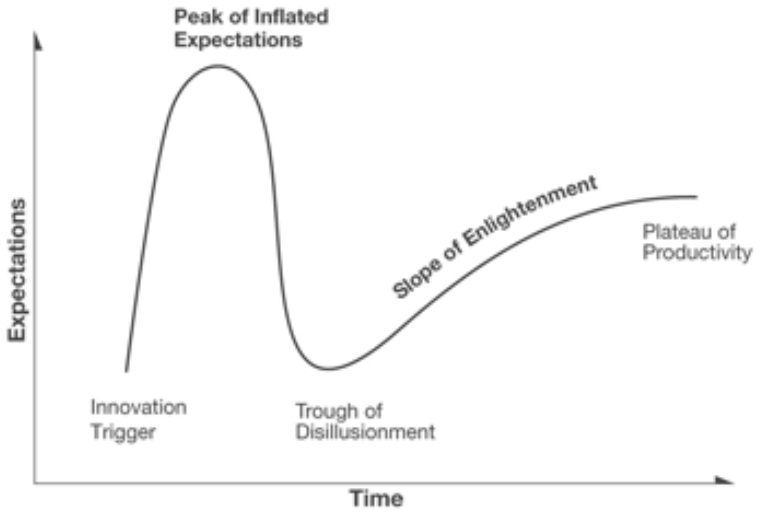

Figure 1. Gartner's Hype Cycle.

Gamification is at the stage of Peak of Inflated Expectations based on the 2012 version of Gartner's Hype cycle. This is because, some businesses have also adopted using gamification and game-like elements in their training and development exercises (Marczewski, 2013). In November 2012, Gartner had predicted that by the year 2015, at least 40% of global organizations will adopt gamification as their primary mechanism of conducting business (Kumar, 2013). However, it was also reported that by the year 2014 at least 80 % of gamified applications will fail to meet the "hype" (Fenn & Raskino, 2008). This Gartner surmises will be mainly due to poor design and the added focus on badges, rewards and leaderboards. In a recent article published by Gopaladesikan (2012), it was reported that gamification has done its time at the peak stage and is on its way to the Trough of Disillusionment. We will see if this is in the case in the preceding chapters.

Chou (2016) discusses eight (8) core drivers of gamification. These include; (1) epic meaning and calling (2) development and accomplishment (3) empowerment of creativity and feedback (4) ownership and possession (5) social influence and relatedness (6) scarcity and impatience (7) unpredictability and curiosity and finally (8) loss and avoidance. These, the author argues are the main tenets which contribute to the push to adopt gamification in the classroom. In this sense, it is surmised that if an activity is not motivated by the eight tenets listed above, then students will not be motivated to play these games.

Gaming Systems and Students' Academic Performance

The implementation of a gaming system in the classroom is not an easy feat, as it involves several factors including the design and implementation of the gaming system itself. Katmada, Mavridis and Tsiatsos (2014) discussed the design of digital game-based

learning and the principles that influence the design of a learning gaming system. Katmada et al. (2014) argue that the most important elements in designing a learning game are; analysis, design, development, implementation, evaluation, challenge, fantasy and curiosity. These, researchers argue, are essential to how motivated the learner is towards the subject. It has been concluded that in designing a successful game, it should be straightforward without any distractions. In this sense, it would make it easier for the educator to implement the game in the classroom, and students would better understand the material.

Johnson et al. (2014) alluded that gamification is appearing more in online learning environments. The example was given where Kaplan University gamified their IT degree program after running a successful pilot program on their Fundamentals of Programming course. The result was that students' grades improved by 9% and the number of students who usually fail the course decreased by 16%. Kapp (2012) noted that several organizations have begun using gamification elements to train workers, educate students, solve problems and assist in "generating new ideas and concepts" (p.19). Sandusky (2015) opined that incorporating gamification in the curriculum would be helpful to students if it can assist the learners to remember 90% of what they learnt. A study by Nicholson (2014) also showed that online gaming environments yield a positive effect on students learning outcomes. This study presented gamification in a positive light and how it can impact student's learning.

Authors De-Marcos et al. (2014) also agreed that the use of gamification may possess the potential displayed in the traditional learning environment. This is evident whereby students are often demotivated to learn, and teachers fail to engage students in

class activities. Results from Frost, Matta and MacIvor's (2015) study theorized that language and storyline contributed the most to the extent that a student may be interested within a gamified setting. It was recommended that the material should be interesting and fun in order to engage the student. This was also alluded to by Al- Azawi et al. (2016) who argued that game-based learning makes people believe they are playing video games but in an educational context. Per Facey-Shaw et al. (2015) technologies can seek to enhance learning as (it) has the potential to provide students with different learning experiences and further act as motivational tools for learning. Schaaf and Mohan (2014) further added that video games can serve as a mechanism to assist in developing the ability referred to as "hyper-extrapolation" which the authors describe as the use of prior knowledge and available data stored in the brain to make swift decisions.

The issue was also brought to the fore on whether the implementation of video games can boost a student's confidence towards mathematics by Ku et al. (2014), who introduced the issue of game-based learning, and that students who experienced higher levels of confidence usually show improvements in their confidence towards mathematics. What was interesting from the findings was the fact that there were two groups engaged in the study: one using the traditional paper-based setting, and the other using the game intervention. When determining whether to implement technology in the classroom, it was recommended by Parker (2012) that educators ask the following questions: (a) What will learning look like in the 21st century? (b) What will literacy look like in the 21st century? and (c) What will knowledge look like in the 21st century? These questions are very important as technological changes are taking place at a rapid pace and will continue to do.

The growth in the use of tablet computers has spurred discussions on how to design educational applications and games geared towards tablet users. This has generated disagreements, as limited research exists regarding the use of tablets in elementary mathematics classrooms (Carr, 2012). Hodges, Feng and Pan's (2015) study was part of a joint project to design an application geared towards assessment of K-12 learners, specifically those studying science and math. The iPad tablet and the applications in the Apple store was the main focus of the thesis and how these application design techniques can improve the scores of learners doing mathematics using the tablets. The main finding was that instructional designers should pay close attention to the development of applications and their different specifications, including a student-friendly characteristic.

Children in this era have become accustomed to tablets and other electronic games. There is, however, no evidence that this familiarity has any bearing on how children perform academically if their curriculum were to be converted to a game format. Miller and Robertson (2011) discussed this issue in their study that focused on the effects of electronic computer games on a child's mental skills and their general attitude towards a subject. While the study only used the Nintendo DS Lite gaming console as the intervention, the results did shed some light on the student's behavior. The results showed that both the control and the experimental group improved in speed and accuracy of calculations during the intervention. The findings showed no difference in student performance between the control group and the traditional group which did not use the gaming system.

Factors Affecting Educational Technology Participation

While it can be argued that a student's background can affect how they perform academically, other factors may also explain this gap. This is specifically in relation to where a student attends school and how he or she performs in mathematics. As demonstrated in Perreaud (2015), the effects of funding (private and public), poverty, resources available to teachers and the student's situation at home have all been identified as factors that contribute to the gap in mathematics achievement. Stone and Hamann (2012) added to this discussion on how to reduce the achievement gap between Native American students and those who are not of native heritage who was enrolled in school in the Great Plains city school district of Arizona. The authors deduce that homework plays a major role in how students performed in math, more than the game itself.

The National Council of Teachers of Mathematics (NCTM) explained the issue of the learning gap when they stated that a student's achievement in math would require support from both educators and administrators. It was further explained that every student regardless of their different social settings (background, personal traits etc.) should be provided with equal opportunities to learn mathematics (Stone & Hamann, 2012). Kelly, McCain and Jukes (2012) however bel the most important issue facing schools today is not necessarily how to incorporate new technologies, but rather, how to adjust to new ways students' thought pattern in this age of globalization.

Perreaud (2015) made the general conclusion that teachers with the support of school administrators are trying their best by working together to implement new techniques and measures to stem the achievement gap in mathematics across the country. The author, however, fails to mention the role of socialization and the parents'

educational backgrounds. In a report published in 2012 by the International Mathematical Union (IMU) entitled *Mathematics in Latin America and the Caribbean: Challenges and Opportunities*, it was reported that the Caribbean region suffers severely from a shortage of financial and human resources (IMU, 2012). This is a major factor in explaining the falling scores in mathematics that have been reported over recent years. The report further discusses that Jamaica has gained advances in education at both the primary and secondary level, but the concern lies in the fact that teachers are not preparing students adequately to sit standardized tests, and this also explained the low scores that they earn as a result. The problem usually occurs in more remote rural areas where information network sharing between mathematics educators almost does not exist.

Where a student is located geographically as it relates to urban/rural placement can affect how they perform academically. Authors Kachepa and Jere (2014) opined that some urban area schools share common learning disablements such as high absenteeism rates of students, small classrooms which results in overcrowding, reading impediments by some students and vandalism by both students and the community which further results in their poor performance. Ku et al. (2014) introduced the issue of ability versus confidence and its impact on student performance in mathematics. The authors further explained that the issue of low confidence is one of the main reasons why students believe that math is difficult to learn, and this negative feeling could eventually lead to a student having no confidence in math. Other issues include inadequate teaching facilities, inadequate learning materials, reverting to old-style teaching practices and understaffing. In Garris et al. (2002), it was also argued that playing games can lead to certain reactions from users such as an increase in interest in the topic, increased involvement or increase

in overall confidence. These actions it was further argued, can lead to greater persistence or increased effort which in effect lead to increased performance.

Mobile phones are regarded as a new but very important technological device that used by many students. The study done by Kachepa and Jere (2014) discussed how students can learn mathematics by playing games on their mobile devices. While the study was conducted in Namibia, the results are useful in the Caribbean context, as many students in the Caribbean have access to cell phones, and the younger generation uses cell phones primarily to play games. The research subjects were high school students from grades nine and ten and first-year students at Namibia Polytechnic. Although the study is focused on secondary students, the authors provide a useful discussion on how students would feel to use their cell phones as a mode of learning as mathematics is widely regarded as a very difficult subject to learn. It can also be argued that games are naturally intriguing to children.

The issue of support by administrators in the implementation of technology in the classroom has also been discussed in the literature. Lee (2012) surmised that principals and administrators play a major role in improving a student's math scores. The suggestion was made that school administrators and leadership should work together in incorporating computer gaming technology in the math curriculum. Technology has a high potential to transform the classroom, but its capabilities have not yet been realized to its full potential. The reason, as explained by Parker (2012), is that there are many other dire issues that need to be addressed such as low dropout and attendance rates before considering an issue such as implementing technology in the classroom. The author further explained that one of the most important issues facing schools today is the

reluctance of those in control such as School Administrators to let go of traditional methods of learning. As Burke (2014) stated, gamification like most emerging trends in the technology field is suffering from "growing pains" (p.10).

Kim (2011) discussed extensively pleasurable learning engines that offer students different skills that can be used to master each level where the reward will be more work. This is because the higher up you go, the more reward you may receive which will also mean the content will become more difficult. The rewards are used as a motivating tool. In Amy Jo and Kim's Players journey, (Figure 2), players would benefit more from rewards at the onboarding level. This is the initial stage of the process where they are considered as newbies with little to no experience. In this case, rewards will serve as a booster to complete more tasks and also serve as expectation of what to expect at higher levels. Rewards can also be used at the habit-building level. This is the level where feedback becomes more important and also the stage where the newbies from stage one will now be regarded as regulars. Students usually aim to be at the mastery level where they are seen as enthusiasts and also leaders on the leaderboard. These specifics serve as standard motivating factors which can influence a student to learn.

In order for games to be successful, it is recommended that they follow the sequence proposed by (Kim, 2011) whereby the students move from newbie to regular and then to the mastery level.

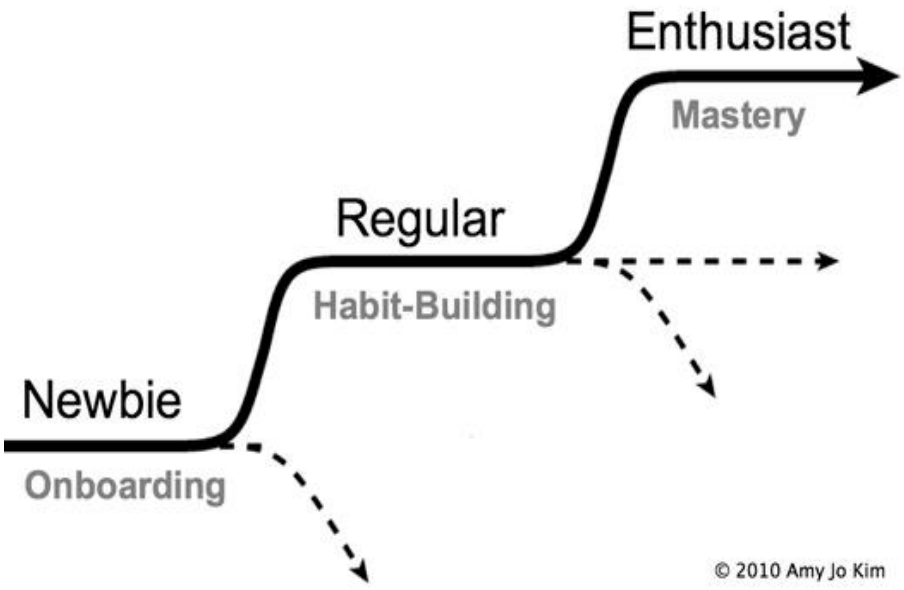

Figure 2. Amy Jo Kim's player journey.

Games and Academic Performance in Mathematics

The literature surrounding computer games in the classroom is vast (Ke, 2009; Kachepa & Jere, 2014; Perraud, 2015), but more research still needs to be done with the hope of informing policymakers and administrators as it regards to best-practices to use game-based technology in the classroom. While there have been many discussions from scholars on the effects of gaming systems and how this impacts a student's academic performance, there has been little research to substantiate this claim (Lister, 2015). Ke (2009) argued that with the recent bombardment of gaming systems in the classroom, it has not met the anticipated potential it carries as a motivation and learning tool. It was argued that technological teaching aids can help to enhance a student's ability which will eventually increase their confidence in learning a subject. Authors Hudson et al. (2010) note from their intervention study that some students felt more comfortable and confident in their math scores than before the intervention of the game. Schaaf and Mohan (2014) argue that "digital game-play in the classroom can be motivational, interactive, and

versatile in content and delivery" (p.3). The argument was further made that a well-constructed video game accompanied by effective inclusion of game-based elements can be used to promote higher and even lower-level thinking skills during student's use of game-based learning.

Recently, educators have been developing creative ways to teach mathematics using technology. Faghihi et al. (2014) developed a quantitative study which examined how video games and technological tutoring techniques can assist teachers to teach mathematical topics specifically, college level math such as quadratic formulas and factorization. The general conclusion from the study was that video games and intelligent tutoring systems are tools that can be used to boost a student's confidence in math and boost their scores to some extent, even though to date no specific game exists for teaching college level math.

Sahin and Namli (2016) argued that games can be used as an effective tool to enhance learning and understanding complex issues. The study utilized a quantitative method using pre-test and post-tests to determine relationships between college student's academic achievement and online follow-up tests. The results concluded that gamification can motivate students to participate more in the classroom, but teachers should be given the correct tools and proper training to guide the students effectively. A similar study was conducted by Rouse (2013) who studied the relationship between educational games, and a student's level of motivation. Rouse concluded that there was a correlation between these factors and levels of achievement. The study, although focused on a community college classroom, gave light to the fact that there are significant

differences between the levels of motivation of students who participate in gamified applications and those who do not.

Gender and Performance in Mathematics Using Computer Games

The issue of gender differences and how a student performs academically have been on the forefront of educational research for some time. Kappers (2009) in her study stated that no statistical relationship exists between the academic achievement scores of males compared to their female counterparts when using the educational video games as a tool in class. However, Kim and Chang (2010) study found that male students who played math computer games in class more frequently perform better than those who never played computer games. It was recommended from the study that educators and administrators should consider issues such as the characteristics of the learner when attempting to implement gaming systems into classrooms.

It has been argued that gamification, when employed correctly, has the capacity to engage, inform and educate students (Kapp,2012). Kim and Chang (2010) conducted a study on how playing games can affect the grades of fourth grade students, focusing specifically on a student's gender and membership of marginalized groups. The study particularly made note of the fact that marginalized male students who played computer math games received higher scores when compared to other males who have never played before. While this is an important observation, the study by Ke (2009) found that no relationship exists between a student's performance in school academically as it relates to the math scores of students in elementary schools. Hartmann and Klimmt (2006) conducted two surveys using 317 and 795 German females (average age, 21). The study found that females were less inclined to participate in competitive games. This

opened the discussion that there are specific preferences between both gender as it relates to the features inherent in video games. Shin, Norris and Soloway (2006) in their study concluded that they observed no significant differences in results as it relates to a student's gender and difference in test scores.

There has been little consensus on which specific features inherent in a computer game actually contributes to learning, the specific processes involved where games are used to engage learners or even the specific learning outcomes that can be derived from playing games (Garris et al.,2002). There have also been opposing viewpoints on whether playing video games in the classroom can lead to poor grades. Chan and Rabinowitz (2010) in their study noted that significant use of the internet, technology and videogames can lead to Attention Deficit Hyperactivity Disorder (ADHD). A surprising point which deduced from the study was that students grade point averages were substantially lower in students who depended on technology, compared to students who did not. Using the internet to enhance the learning experience will therefore require a general shift in thinking.

Technology, Gamification and Motivation

Using technology in the classroom can serve as a motivating mechanism for students using gamification. Lister (2015) noted that the combination of the points system and instant feedback among other factors is effective in motivating students. Nicholson (2014) also sees competition as a form of motivation. Nicholas (2014) sees the leaderboard as the form of "competitive element." Students may be motivated in a gamified setting because they are safe spaces where learners can play at their own pace, explore different options at their leisure and also have fun (Whitton, 2012). In the study

by Dominguez and Saenz-Herraiz (2013), it was found that students who participated in the gamified experiment performed positively in their overall scores. However, while their motivation to participate increased, the scores from written assignments did not bare the same finding.

In Mekler, Bruhlmann, Opwis and Tuch (2013), it was argued that the awarding of points can serve as an effective means of increasing intrinsic motivation of students. This may be due to the fact that points and other rewards can motivate the student to work harder so they can get more points. However, not all researchers agree that gamification has positive effects on student learning outcomes. Whitton (2012) argued that computer games can be problematic in that; games are often designed for enjoyment, not closely tied to the curriculum, teachers are not properly trained to use the systems and they are often very expensive to purchase. The inclusion of gaming in the curriculum should connect with the curriculum and can also relate to real-life situations.

If students are not motivated, they will not be motivated to learn the content (Sandusky, 2015). In the study by Hanus and Fox (2015), it was also found that students in the gamified classroom were less motivated than those in the non-gamified classroom. However, it was also shown that students in the gamified classroom scored lower in final exam scores than those in the non-gamified class. Sandusky (2015) also concluded that learners participate in gamified activities because of intrinsic motivation. However, some learners transition between extrinsic and intrinsic motivation because of different gaming mechanics used in the gamified environment.

Richard Clark Grocery Truck Analogy

Author Richard Clark in 1983 argued that media do not influence learning under any possible conditions. He is known for his famous quote that "media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers grocery causes a change in our nutrition" (Clark, 1983b, p. 446). Richard Clark subscribed to the view that there are no direct learning benefits associated with media and urged that we should not continue the trend of wasted efforts in attempting to answer the question of whether media directly impacts learning until a new theory is developed (Clark, 1983b). Clark (2012a) also added that media don't influence learning, but it does influence the efficiency of learning costs and access to education.

Improving Mathematics Scores Using Technology

Several recommendations have been made to improve the falling math scores in the region. Faghihi et al. (2014) recommended that governments should work on improving access to information that provides links to resources and opportunities for educators. The recommendation was also made to create a network of institutions that would provide schools with the opportunity to facilitate student exchanges who could travel and study different systems. Williams (1993) indicated that when computer games were included as interventions to improve the math's cores of adolescents, the findings revealed that the intervention of the games had a greater effect on some students more than others. The recommendation was suggested to study how different media types can promote or hinder a student's math scores. It was also recommended that when using interventions (i.e. computer games), that those interventions focus more on teaching math geared towards evidence-based instructional strategies. Other suggestions posed by

Williams (1993) are that educators should practice mathematical solutions and strategies which spans several days focusing on specific skills/problems while solving different problems.

Although gamification is a fairly new approach to learning in the traditional classroom, as new technologies and innovations emerge, it is still developing each day (Al-Azawi et al., 2016). Sahin and Namli (2016) argued that gamification can lead to real impacts by increasing research-based and theory-driven gamification projects, but it must be done in a way to ensure that the impact of gamified systems is a positive one. This should be done in a way that it will impact students' lives in a positive way and motivates teachers by providing them with the appropriate tools so that students can become high scorers in real-life tests.

Scepanovic, et al. (2015) suggested that learning via gaming should always be optional, as some students may not want to participate in gamified lessons. It was also suggested that more testing should be done from the teacher's point of view and study the experiences of teachers in a gamified classroom. Parker (2012) argued that one of our main goals as educators was to ensure that we have a proper understanding of how our youths respond to technological changes. The discussion it was said, should always focus on learning, literacy, and knowledge rather than merely concentrating on the implementation and integration of technological devices. Most of the studies suggest that gamification has potential that may eventually be included in most classrooms in the future. However, creating an effective educational game goes far beyond simply creating and building a game. It involves creating a mindset for students to think independently and not afraid of losing but also having fun in the process (Al-Azawi et. al., 2016).

A recommendation Williams (1993) made was to create a network of institutions which would provide institutions with the opportunity to facilitate student exchanges who could travel and study the different systems. Williams indicated that when computer games were included as interventions to improve the math scores of adolescents, the findings revealed that the intervention of the games had a greater effect on some students than others. A recommendation was made to study how different media types can promote or hinder a student's math scores.

It was also recommended that when using interventions (i.e. computer games), that those interventions focus more on teaching math geared towards evidence-based instructional strategies. Other suggestions posed by Williams (1993) are that educators should practice mathematical solutions and strategies which span several days focusing on specific skills/problems while solving different problems. Landers, Armstrong & Collmus (2017) suggested that while implying gamified systems can be very expensive if the game design is carefully attached to the learning objectives then its full benefits can be realized.

Overall, the literature discussed both sides of the debate which provided both the pros and cons of gamification. It was recommended that administrators should also play a role if these changes are to be made regarding making informed decisions about purchasing technology such as iPad's or games when teaching mathematics (Carr, 2012). The current research that exists on the topic has many gaps, but the topic has the potential to overtake the classroom in the 21st century. The majority of the studies were also of a quantitative nature and so, there was not much in-depth explanations provided via qualitative examination.

Several recommendations were also suggested trying to explain how to improve the falling math scores in the region. IMU CDC LAC Report (2014) recommended that governments should work on improving access to information that provides links to resources and opportunities for educators. The recommendation was also made to create a network of institutions which would provide the opportunity to facilitate student exchanges who could travel and study the different systems. Williams (1993) indicated that when computer games were included as interventions to improve the math scores of adolescents, the findings revealed that the intervention of the games had a greater effect on some students more than others. The recommendation was suggested to study how different media types can promote or hinder a student's math scores.

It was also recommended that when using interventions (i.e. computer games), that those interventions focus more on teaching math geared towards evidence-based instructional strategies. Other suggestions posed by Williams (1993) is that educators should practice mathematical solutions and strategies which spans several days focusing on specific skills/problems while solving different problems. Watson (2015) noted that administrators should assess which technologies are used daily at a higher rate than just purchase what is available to them.

Research Questions

There is a myriad of factors that impact how students perform academically specifically in the subject area of mathematics. Considering this reality, the research questions to guide the study are as follows:

1. What are the effects of a gamified Software intervention on mathematics achievement among sixth grade students as measured by a school district-wide benchmark exam, end of year Christmas term exams, mock exam and final exams?

2.What effects do gamified applications have on students' motivation, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey among sixth grade students?

3.What are the students' perceptions of math after working with a Gamification Software, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey among sixth grade students?

Chapter Summary

This chapter dealt with the theoretical framework and the methodology that was used in the study. The Self Determination Theory of Motivation (SDT) by Ryan and Deci (1970) was used to guide this research. The SDT is a theory of motivation, human behavior and development. This chapter also discussed the literature that was found on different aspects of gaming systems, including: the definition of "gamification" gaming systems and students' academic performance; factors affecting educational technology participation; games and academic performance in mathematics; gender and performance in mathematics using computer games, gamification, math and motivation; and recommendations for improving mathematics scores via gamification approaches. Overall, the literature discussed both sides of the debate. Administrators will also play a role if these changes are to be made regarding making informed decisions about purchasing technology such as iPad's and other games to be used in teaching

mathematics (Carr, 2012). This was geared toward answering the research questions listed above.

Chapter 3: Methodology

Overview

This chapter describes the primary approach that was used to conduct the research. It involves a discussion of the methodology, characteristics of the population used, the size, composition and selection of the sample, a description of the proposed sampling methodology and a description of the relevant demographic variables. This section also discusses a detailed description of the instruments that were used to collect the data for the study as well as information on the reliability and validity of the instruments of data collection, method of analysis and finally the ethical principles that were adhered to in the study.

Participants

Demographics. **Lane Mout Primary school was selected for the study because of its unique characteristics. The school is located in an Eastern Kingston inner-city community on the border of Kingston and St. Andrew. A large percentage of the population in the community are low-income earners. The school is also a reflection of the typical racial, cultural and religious diversity that is reflected in West Indian populations. In the latest Jamaican Census (2011), the majority of the population is made up of black with a mixture of East Indian, white, mixed and "others." Others in this sense mean those who fits in neither of the categories above. The site was ideal for the study because it possesses all the characteristics as described by Rossman and Rallis (2003) as; possible entry to the study site, inclusion of a mixed population with all characteristics such as access to the *Edufocal*© gamification software, inner-city school with low and

improving math scores, gaining ethical approval and the likelihood of the study being used to inform the school's math curriculum.

Recently, the school average has shown improvements. This is evident with the strong support received from the local school board and the Parent's Teacher's Association (PTA). The literacy and numeracy rates saw major improvements in 2013 up 23% and in 2015, the school recorded a 95% literacy rate and 76% numeracy rate respectively showing improvements in all subject areas (**Lane Mout Profile, 2016).

In 2014, **Lane Mout Primary invested in a software called *Edufocal* that would allow the students to adequately prepare for their exams. Students are able to subscribe to the software and log in on a daily basis. **Lane Mout Primary since then has been including technology in their curriculum and the teaching/learning process which may account for a rise in numeracy (Ministry of Education, Jamaica, 2016). The school's unique population gave the researcher an opportunity to examine whether or not the intervention using *Edufocal*© software contributed to improving math scores and in essence, student's motivation to learn math. In addition, an experiment of this nature has never been conducted at the institution or the general Jamaican Primary school system.

The *Edufocal*© gaming software was developed in 2010 as an online learning community focusing on using technology to enhance the learning experience outside of the classroom. The learning software has over 15,000 preparatory questions for the GSAT exam that is presented in a manner that is akin to the traditional role-playing game. When students answer each question correctly, they are rewarded with points and medals which allows them to "level up" in the game. The higher the ranking, the more

difficult the questions become. The more answers you get correct, the more rewards you are able to unlock, and the more prizes you will win (Edufocal, 2017).

The questions for the software were created and put together by qualified educators in the field ranging from different subject areas such as; Social Studies, Mathematics, English Language and Communication Studies, which are the main subjects taken in GSAT. The software also includes questions from past papers where students are able to work solution for hundreds of questions. This research only focused on the math component of the program.

Population. According to data provided by the Ministry of Education, Jamaica (2017), the present enrollment for **Lane Mout Primary School stands at approximately 809 students, 453 boys and 356 girls with a staff complement of 34 teachers including the Principal and Guidance Counselor. This number was used as the target population for the study from which the researcher selected the sample as illustrated in table one.

Table 1

*Number of Students Divided by Classes at the **Lane Mout Primary School, Jamaica*

Grade	Number in class by gender		
	Boys	Girls	Total
Grade 1	55	40	95
Grade 2	70	59	129
Grade 3	101	66	167
Grade 4	85	62	147
Grade 5	68	58	126
Grade 6	74	71	145

Source- Principals Office, *Lane Mout Primary School, 2016 Enrollment

Sample. The researcher randomly assigned students in two classes based on their respective grades that they receive from the pre-test (diagnostic math test) at the

beginning of the school year (September 2017). This diagnostic test was used as the pre-treatment. Grade Six was purposefully selected because, at that stage in Jamaica, students are preparing to sit the GSAT exam. From the scores, students were randomly placed in two Grade Six classes. From this, one grade was exposed to the gamified software treatment while the other class was used as the control group and receive traditional math lesson. There were four classes in total. The treatment group was given complete access to the *Edufocal* © gamification software while the other classes (control group) did not have access.

Instruments of Data Collection

Diagnostic Test for Entry to Grade 6. This diagnostic test is given at the beginning of the semester (usually in September) to all students entering Grade Six at the institution. The test according to the National Mathematics Policy Guidelines (2013) is administered to evaluate a student's mastery of concepts which is critical to the student's ability to successfully manage and pass the Grade Six curricula. The diagnostic test is used to find out a student's level of understanding on the different strands. This is mainly done for Language Arts and math. The strands that are tested for math are; numbers, measurement, geometry, statistics/probability and algebra (see appendix F). Students are given questions based on these strands to find out what level they are based on the results. Teachers are also able to know how to place the students, how to approach teaching, what level they are at and which areas they need to improve more on. Diagnostic tests are also done on language arts as well to find out where students are as it relates to their writing styles and sentence construction among other things. The organization of this test also follows the said GSAT curriculum that is used to place

students in their respective classes. The results from this test were used to randomly place students in both the controlled and the experimental groups.

The Grade Six Achievement Test (GSAT). The GSAT is an exam given to students in Grade Six and the results are used to evaluate the performance of students to determine their suitability for High School placement. The GSAT exam was replaced by the UK's Common Entrance Exam in 1999 (Bourne, Baxter, Pryce, Francis, Davis et al., 2015). In 2018, the GSAT was administered in over 1,000 schools with over 39,000 students. Of that figure, 18,875 males and 20, 254 females were eligible to sit the exam. Prior to the GSAT, there was the Common Entrance Examinations that was introduced in 1957. The difference between the Common Entrance Exam and the GSAT is that the Common Entrance was a pass or fail test while the GSAT is a placement test focused on placing students from the primary level to their high school of choice based on their final scores.

In Jamaica, the GSAT exam is regarded as a very important test since the population places great value on the high school that you are selected to attend. According to Bourne et al. (2015), students who are viewed as intelligent, successful, and having that urge to choose careers such as an Attorney or Physician, desire to attend a traditional high school. This is because, the traditional high schools require a high score to gain acceptance. The non-traditional high schools are usually frowned upon and associated with students who receive lower grades in the GSAT exam. This exam also comes with it psychological stress from the pressure that is placed on students to receive high scores. Bourne et al. (2015) focused on how psychological stress influences the performance of students on the GSAT exams.

Attitude Survey. Several procedures were undertaken to develop the questions for the questionnaire. The researcher first contacted the administrator of the institution who showed a keen interest in the study. After the discussion, the researcher acquired the Student Attitude Survey (SAS) survey created by the KAPUT Center for Research and Innovation in STEM Education. The original instrument was created to measure students' beliefs about math and learning mathematics. Respondents were asked to report on the extent to which they agreed or disagreed with each statement on a scale of one (*strongly disagree*) to five (*strongly agree*). This instrument was developed using an advisory board that assisted with the design, refining, validating and piloting the instrument with students. Because of this, permission was sought via email from the original authors of the instrument on July 10, 2017 requesting to use several questions from the instrument and rewording to be specific to the study (see appendix E). These questions focused specifically on motivation towards learning math.

The overall structure of the final instrument was created and modified after several iterations. After the summative procedures were completed, the instrument was forwarded to a peer of the researcher (Mr. P*) who is also a statistician whose focus is on econometrics, survey development and statistics. The draft instrument was initially forwarded to Mr. P who suggested that the questions should be written in a scale format measuring students' attitude similar to the original SAS survey. This took several back and forth emails from the researcher to Mr. P, phone calls and several live video sessions. It was recommended that the questions be put in a similar Likert scale using similar strands (1-5) that would then be tested using the Cronbach's *alpha* test of reliability. The order of the questions was changed so that similar questions asked in a different format

were asked in sequence. Several questions on the technology to use math scale were also reworded to include the name of the gamification software or reworded in a simple format so that Grade 6 students would understand without difficulty.

Demographic questions were deleted, added and modified so that only questions that contribute directly to the study were included on the instrument. This is because the questions that were originally asked will be known by the researcher such as GPA and average math score from the previous year. The original SAS instrument did not include a demographic section. That left the demographic section of the final instrument with a total of two (2) questions. The final instrument used a total of 27 questions focusing on motivation to do math and 23 questions on the use of technology to do math scale. The questions were formed using a scale ranging from strongly disagree, disagree, neutral, agree and strongly agree.

Procedures

Design. A two-group pre and post-test design was employed for the current investigation. The primary focus of the design application was to test the effects of the *Edufocal* © gaming intervention on math achievement. Within this design, additional process measures of achievement were collected in addition to students' motivation. Random assignment was used to assign participants to the experimental and control conditions. Using this procedure, the researcher was able to investigate the causal effects of the gamification intervention on both groups paying careful attention to learning behaviors. Landers et al. (2017) explained that "it is only through careful, systematic exploration of specific game elements and their likely psychological mediators and moderators" that we will be able to see whether an intervention works (p. 480).

The random assignment was based on the scores from the diagnostic test. Gender assignment is very important as it creates a balance of both genders in each class and further eliminates any gender biases in both groups. All students that participated in the study were from Grade Six and preparing to sit the GSAT exam in March, 2018. Therefore, when the researcher assigned students to their respective groups (experimental vs control group), the more similar characteristics they share, the more these attributes can be controlled for in the experiment (Creswell, 2014). To ensure that all respondents in the experimental group have unlimited access to the program, the researcher opted to pay the cost for the subscription. This controlled the condition in order to better evaluate the effectiveness of the intervention.

Gamification Intervention. The treatment for this study involved a set of mathematical instructional games created using the GSAT curriculum. The game includes different subjects covered in GSAT. These are; Mathematics, Language Arts, Science and Social Studies. The researcher however focused on the math component with the following topics based on the GSAT syllabus: (a) numbers (b) measurement (c) geometry (d) statistics (e) algebra and (f) probability.

The game teaches students math by incorporating game-like elements to make it more enjoyable. Students are able to earn points for each correct answer, compete against their peers and also other *Edufocal*© subscribers who are included on the leaderboard of point standings. When a student answers each correct question in each test, they are rewarded with valuable points that allow them to "level up." The more points that a student earns from completing each test, the higher up in the levels they are able to go. The higher score you receive, you will be able to unlock rewards from *Edufocal*© such as

movie tickets and phone cards. The student is also able to see their overall points and what number they rank among their peers (Swaby, 2016). Students used *Edufocal* © software three times per week for one hour to reinforce information that was taught during that week.

Fidelity. Within the software, students are able to view their experience points, create a profile and also view their overall rankings compared to other students in their age groups. Teachers and parents also have the ability to view a student's complete report card of how often their child uses the software and the grade they receive on each test. The study focused on the section on mathematics. The mathematics tab is divided into six topics as explained above. Under each topic, the student is able to watch videos before attempting each test. These videos are conducted by professional math teachers interacting and working each equation step-by-step with explanations. Once the video is viewed, the student is able to take a test on each topic. If a question is answered incorrectly, then the student will be given feedback on how the correct answer was derived. There is also an option to report a question if something does not seem correct. The report card feature also shows the average scores a student receives on each test, the highest and also the lowest score. It can also provide information on the number of tests taken, the time used to complete each test including the fastest and slowest times. The report card is also broken down into different topics. Therefore, parents and teachers are able to see how each student has performed on each subject. This can be used to identify a student's strongest and weakest areas. The student's level of use was tracked weekly using this feature. This method was used to ensure that the program is implemented as intended.

Method of Data Collection

The researcher undertook several steps in order to complete the study. The first step involved a meeting with the Principal and Administrators of the institutions where the study was conducted. This was conducted after all ethics and Institutional Review Board (IRB) approvals were given (see appendix A). Ethics is defined as the general guidelines and principles whereby researchers are able to uphold the things that they value i.e. right from wrong. Research ethics is, therefore, the set of values and doctrines developed which assists researchers in their quest to gather information (Johnson & Christensen, 2014). The researcher acquired permission from the **Lane Mout Primary School Board. With this, the researcher administered a signed informed consent form from both Nova Southeastern University (NSU) IRB and Lane Mout Primary local ethics board's request (see appendix A). A copy of the informed consent forms was administered to the Principal and Administrators of the data collection site. This was applicable because all research subjects are under the age of eighteen years old and are therefore not able to sign or give consent for themselves. The consent forms once signed by all parents were kept in a safe place and separate from the data. The researcher also acquired the child's assent form that was read by all students who participated in the study. These procedures were followed to prevent unintended harm to others that can result in a loss of the data. Although the researcher focused on students' scores, IRB approval had to be obtained since the research involves interactions with human subjects whether directly or indirectly (See Table 2).

Table 2

Procedures and Timeline For Data Collection

Timeline	Procedures
September 2017	School administers diagnostic math tests for Grade 6 placement at beginning of the semester. (pre-test). The math test covers 5 strands Administer pre-survey instrument.
March 2018	Administer post/final survey instrument before sitting GSAT. This was to see how students feel about taking the exam after using the software. Students sit GSAT exam and access to software ends. Await final results of GSAT.

The researcher gathered math scores from two different tests. This was measured by collecting scores from students at two different periods (pre and post) using two different tests measuring the same strands. These tests are;

- Diagnostic test for entry to grade 6
- GSAT exam (see Appendix F)

At the beginning of the term, both groups were given; (a) math motivation and attitude towards math survey to identify student attitude towards math (A1) and (b) school district benchmark diagnostic test (pre-test). Only the experimental group used the treatment (Z) which is access to the *Edufocal* gaming software. The procedure for the experimental group was as follows; (a) math motivation and attitude towards math survey to identify student attitude towards math (A1) (b) school district benchmark diagnostic test (pre-test) (A2) used to place students in each group/class (note, the treatment for this group is traditional classroom instruction throughout) , (c) intervention of the treatment (Z) (A3), *(d)* GSAT final exam (post-test) (A4) for math assessment. To measure the effect of the treatment Z on the math achievement and motivation of the group towards

using technology to improve math scores, the researcher compared the test results of the experimental group at the beginning of the study and the end of the study to the control group. A similar set of tests measuring the same six strands used at the beginning of the study was also administered at the end when the post-test exam is taken (A1+A4) (see Table 3).

Table 3

Assignment of Respondents to Groups

Assignment	Group	Pretest	Treatment	Posttest
R	1 (*n* = 35)	A1+ A2	A3 (Z)	A1+A4
R	2 (*n* =26)	A1+ A2	—	A4

Note: A1- math motivation and attitude towards math survey; A2- school district benchmark diagnostic test (pre-test); A3-Edufocal gaming software (intervention) Z; A4- GSAT final exam

Within the software, students are able to view their experience points, create a profile and also view their overall rankings compared to other students in their age groups. The study focused on the section on mathematics. The mathematics tab is divided into six topics as explained above. Under each topic, the student is able to watch videos before attempting each test. These videos were conducted by professional math teachers interacting and working each equation step-by-step with explanations. Once the video is viewed, the student is able to take a test on each topic. These tests always ask various questions on each topic. If a question is answered incorrectly, then the student will be given feedback on how the correct answer was derived. There is also an option to report a question if something does not seem correct. The report card feature also shows the average scores a student receives on each test, the highest and lowest score. It can also provide information on the number of tests taken and time used to complete each test

including the fastest and slowest times. The report card is also broken down into different topics. This can be used to identify a student's strongest and weakest areas.

Ethical Considerations

In the quest to conduct quality research, it is sometimes necessary to infringe on people's right to privacy as we may be tasked to ask questions that are deemed as personal or observe human behavior. Johnson and Christensen (2014) explained that by observing human behavior, this is the only way whereby researchers are able to collect important information that may be required for improving the field of study. When the researcher understands the ethical responsibilities involved in conducting their research, they are able to prevent any abuse or harm that may occur as a result of the study. Research involves collecting data from human beings and about human beings and so, we must do everything to ensure that the participants are not harmed whether psychologically or physically in the process and protect the participants at all cost (Creswell, 2014). However, when our responsibilities are understood from the outset, risks to participants are minimized (Johnson & Christensen, 2014).

Creswell (2014) surmises that ethical responsibilities should be a primary consideration that is taken at the beginning of the research rather than as an afterthought when the researcher meets upon stumbling blocks in the quest to collect data. When conducting research with human subjects, there are ethical considerations that must be considered. These include; informed consent, no risk of harm to participants, confidentiality, anonymity, deception and, freedom to withdraw. The researcher deliberately collected information at the beginning, middle and at the end of the school year when students are preparing for final standardized tests. No identifying information

was included on the survey instrument that can point to a specific student. This study involved intense and keen data collection procedures in order to maintain anonymity and confidentiality.

For this study, several connections were made with students and administrators. Therefore, it is important to request all relevant permission from participants at the beginning of the study. With this, the researcher was required to make initial contact in the quest to gain entry to the research site. The researcher was first required to obtain consent from the school administrators (local school board) and then the parents and guardians of the students whose grades were used for the study. Student grades could not be accessed until all consent forms were returned with the relevant signatures. Johnson and Christensen (2014) noted that student records such as grades that are collected for the purposes of conducting research and tracking student performance must not be released to the researcher without the student's consent. The students that were involved in this study are between the ages of eleven and thirteen and therefore, consent had to be sought from their parents. This is applicable because, since the research subjects are under the age of eighteen years old, they are therefore not able to sign or give consent for themselves. The consent forms once signed were kept in a safe place and separate from the data. This process involved building a relationship with the school community and by extension, the surrounding community around the school where most students reside.

In gaining informed consent, Johnson and Christensen (2014) noted that the researcher should be aware of the research purpose, procedures, risks, benefits, alternative procedures and any limits to confidentiality. The informed consent form

outlined the topic, research questions and what the research findings were used for. The researcher selected ***Lane Mout Primary School (pseudonym) as the research site.

Managing and Storing Data. The researcher collected the data over a period of seven months on four separate occasions. The first occasion was the diagnostic test that was conducted at the beginning of each school year (September 2017). The results from the diagnostic math tests were used to place students in their respective classes based on the average scores they receive. After this test was completed and graded, the researcher then collected the scores and stored it in an encrypted Microsoft excel data file. The names of the students were not used to store the scores. Each student however, was assigned a special number starting from one that only the researcher could identify. The researcher then collected the remaining data from the GSAT exam in March 2018 with scores released on June 7, 2018. Each set of scores were collected and labelled based on the specific test and timeframe. The researcher then created separate tabs to store the individual scores to create ease of access in analysis. This arrangement helped tremendously in keeping the data in order and also to keep the data confidential. Ethical responsibility is involved as the researcher must take care that the responses are not linked to a specific student.

Method of Data Analysis

Data retrieved from the questionnaire were analyzed by way of frequencies and bivariate parametric and non-parametric tests using the Statistical Package for the Social Sciences (SPSS) and STATA. STATA is a complete integrated, statistical software package that is used to provide data analysis, data management and graphics (STATA, 2018). This software was used to present the information in a detailed and professional

manner. Frequencies or univariate analyses were conducted on the demographic questions measuring only one variable. In addition, data retrieved from the math scores were analyzed in SPSS using the gain score analysis and an independent sample *t-test.*

With this test, the outcomes were observed for two groups over specific time periods. In this situation, one of the groups was exposed to a treatment during the time period. In this study, the treatment (Z) is using *Edufocal*©. The second group (control group) was not exposed to the treatment during the time period. The researcher calculated the mean outcome in group A in both periods and calculated their difference. The researcher then obtained the mean scores from group B in both the pre-and post.

There were two survey instruments used pre and post intervention. Section A was distributed to students in both groups while Section B was distributed to students in the experimental group only. The first survey instrument consists of two (2) sections. Section one (1) consisted of three (3) demographic closed ended questions which asked about student's gender and the second section consisted of a five-point likert scale where the values were assigned with one representing strongly disagree and 5 representing strongly agree. This section asked questions about student's attitude towards mathematics. The second questionnaire was divided into three (3) sections. The first section consisted of one demographic question. Section two (2) consisted of two (2) five-point likert scale questions. The scales represented students' attitude before using *Edufocal*© and after using *Edufocal*©.

The scores were collected by way of email directly from the math teacher each time the students completed a test. On each occasion, the scores were coded with a number representing each student and exported into Microsoft Excel. A spreadsheet was

created and organized by dividing up into several headings. Each row represented the students' individual number, teacher name, gender, diagnostic scores, treatment status and final GSAT exam results. After each row was labeled, the student scores were entered horizontally under each test.

Chapter Summary

This chapter discussed the method used to conduct the study. The intervention was incorporating the *Edufocal*© gaming technology into the traditional curriculum to determine whether or not student scores increased on standard district-wide tests compared to the traditional control group. The study examined students' scores to find out whether or not those who used *Edufocal*© scored higher on standardized tests than those in the control group. The research objective also focused on finding out the effect of the use of the *Edufocal*© software on the motivation of students towards learning math. The method of analysis was also discussed in its entirety.

Chapter 4: Results

The focus of this chapter is to present the findings from the experiment and a survey on student attitude towards learning math. The study utilized the experimental approach that was described in chapter three of the methodology. The analysis was divided into two sections. Section one will begin with a brief overview of the study, participant responses, reliability analysis, overview of method of analysis, results from the experimental group on student attitude towards math pre and post-intervention and control group pre and post intervention. Section two will highlight results on student scores pre- and post-intervention of the software and results from control group pre and post intervention. Graphs and charts were used to display the data in a visual format.

Overview

The primary focus of the current study was to investigate if the use of gaming applications can contribute to increasing the scores of sixth-grade math students at a selected elementary school. The overall aim was to find out if by using the software, student scores on standardized examinations in the Caribbean region and in effect, their attitude towards learning math, will change. Two groups were used for the experiment. An experimental group (using a gaming system) and a control group (taught via traditional methods). This study compared the math scores of students who have used the gaming application *Edufocal*© (experimental group) and those who have not used the application (control group) to examine if there have been any changes in their math scores and attitude towards math before and after the use of the software.

Research Hypotheses

Null- There is no significant difference in math test scores of the diagnostic and final GSAT test for students who used the gamified software compared to those who did not.

Directional- Students exposed to the gamified intervention had a significantly higher gain score in standardized tests than students in the control group.

The descriptive data was analyzed using the Statistical Package for the Social Science (SPSS) data analysis software. Data collection lasted seven months from September 2017 to March 2018. Data involved student scores that were given using standard diagnostic tests and final GSAT exam grades. All tests were designed from the standard curriculum provided by the Ministry of Education in Jamaica. The researcher examined the effectiveness of a gamified software intervention in mathematics achievement among sixth-grade students in a selected elementary school. The intervention involved the use of *Edufocal* © gaming software to solve math questions.

A Gain Score Analysis (GSA) was conducted on the pre and final post test scores. The general approach involved computing the gain scores (post-test- pretest) and further analyzing the scores using the independent *t test*. Any gains from the pretest to the posttest was computed by subtracting each respondents pretest score from the post test score. This was done in SPSS using a computing formula (gain=posttest-pretest). The results in Table 4 suggest that there is no significant difference in math test scores between students in the experimental group.

Table 4

Mean Differences Between the Experimental and Control Groups

		Pretest	Posttest
Condition	*n*	*M* (*SD*)	*M* (*SD*)
Experimental	35	56.4(9.95)	67.11 (10.97)
Control	26	24.5(7.89)	37.65 (12.47)

An independent sample *t*-test was utilized to compare the gain scores of students who used a gamified software (experimental) and those who used traditional teaching methods (control) pre and post GSAT test. These results suggest that we fail to reject the null hypothesis at the .05 level of significance and hence, the gamified intervention did not statistically improve students performance in the short- or long-term. The mean gain scores between the two groups was 2.67 with (*M*=10.714, *SD*=1.26) experimental and control (*M*=13.38, *SD*=2.03) (See Table 5).

Table 5

Gain Score Between Experimental and Control Group

	Gain Score		
Condition	*n*	*M*	*SD*
Experimental	35	10.714	1.26
Control	26	13.38	2.03

Upon analyzing the gain scores from students in the experimental and control group the mean difference was still not significant t (59) = -1.172, p = .246 as represented in Table 6. This means that students who received treatment (experimental) on average scored about two points higher than those who did not use the software. The calculation

did not see a significant increase in gain scores between the experimental group compared to those who used traditional modules. The results also indicate that the intervention students scores were negatively affected. This means that as usage of the software increases, the test scores decrease or as usage of the software decreases, then scores increase. Thus, the researcher failed to reject the null hypothesis at the 0.05 level and hence, the intervention did not statistically improve students performance in the short- or long-term.

Table 6

Experimental, Control and 95% Confidence Interval for Gain Score

	Experimental		Control				95% CI	
Condition	*M*	*SD*	*M*	*SD*	*t*	*p*	*LL*	*UL*
Gain Score	10.7	1.26	13.38	2.03	-1.172	.246	.-7.23	-7.49

Reliability Analysis

Data were also collected on student attitude towards math using the amended Kaput center student attitude survey and the amended Kaput center student survey on student attitude toward using technology to learn math. Complete copies of both data collection instruments are located in Appendix B and C.

SPSS was used to test the reliability of both instruments; attitude towards learning Math and attitude towards using Technology to learn math. The instruments distributed to the experimental group was divided into three sections; section one asked two (2) specific questions about the *Edufocal*© software, section two included a Likert scale asking student questions about their attitude towards learning math, while section three also included a Likert scale asking students specific questions about their attitude towards

using technology to learn math. When using Likert-scale type questions, it is important to calculate and report the Cronbach's *alpha* coefficient for internal consistency reliability for any scales or sub scales that were used in the study (DeVellis, 2012). This test was conducted to ensure that all questions in both Likert scales conformed to the requirements of Cronbach *alpha.*

Alpha was developed by Lee Cronbach in 1951 to provide a measure to internal consistency of a test or a scale as expressed by using a number between 0 and 1. The internal consistency describes the extent to which all the items in the test measure the same concept or construct. A reliability coefficient of .80 or higher is considered as acceptable in most Social Science settings (Gliem & Gliem, 2003). A 70 score is acceptable reliability coefficient. The results from the reliability analysis conducted on both scales from both the experimental and control group is presented in the table below.

There were two groups; an experimental and a control group. Each group used the same attitude scale pre and post while the attitude towards using technology to use math scale was distributed to the experimental group only mid-term and at the end of term. Students gained access to the software in October 2017. The total population was approximately 61 students with 35 students assigned to the experimental group and 26 used for the control group. All students were between the ages 12-13 and each student in the experimental group were randomly placed based on scores at the beginning of the term (see Table 7).

Table 7

Attitude Scale-Cronbach's Alpha

Year	Experimental	Control Group
September 2017	.86	.82
March 2018	.86	.77

When the Cronbach *alpha* was performed on the attitude towards math scale at the beginning and end of the school year, the results showed that there was high consistency between the questions as presented by scores of .86 and over. Likewise, when the *alpha* test was performed on the said scale distributed to the control group, the results also showed a high internal consistency between the questions with scores ranging between .86 and over. When the *alpha* test was performed on the attitude towards using technology to learn math scale, the results presented scores of .86 and higher (see Table 8). This means that all scales conformed to the requirements of the internal consistency test.

Table 8

Experimental Group Technology Scale

Year	Experimental
December 2017	.87
March 2018	.88

Attitudes Towards Math. This section of the analysis will begin with the results from the experimental group on their general attitude towards using the *Edufocal* © software to learn math. Students were asked the following question: *Do you enjoy playing Edufocal© games?* This was represented by question number two (2) on the questionnaire. The response options were one (1) representing yes and two (2) representing no. This question was asked in December 2017 and also repeated in March

2018 by the experimental group. On the other hand, in March 2018, the results were similar to that of December 2017 in that, an overwhelming majority representing 88.9% stated that they enjoyed playing games on *Edufocal* © while the remaining 11% said no (see Table 9).

Table 9

Question 2-Do You Enjoy Playing Edufocal © Games?

Year	Response	*N* %
December 2017	Yes	29 (84.2)
	No	5 (15.8)
March 2018	Yes	30 (88.9)
	No	4 (11.1)

The modal value for both times the questionnaire was distributed was the number one (1) which represents yes. This therefore corresponds with the above explanation that majority of the respondents selected yes to the question. The median value is also represented by the value one (1) which is the middlemost number organized in numerical order. The mean value is represented by 1.15 in December 2017 and 1.11 in March 2018 which suggests that on average, the mean is a typical representation of the distribution of the scores.

As it relates to the *SD,* this provides a more accurate evaluation of how well a mean summarizes a distribution (Creswell, 2014). Thus, the greater the scores deviate from the mean, the more the mean is unable to provide a proper representation of what is typical. The recorded *SD* in this case is .369 and .318 which is a very small variation; thus, it can be concluded that the mean is a typical representation of the sample as represented in Table 10. Therefore, it can be concluded that students enjoyed playing the math games on *Edufocal* ©.

Table 10

Do You Enjoy Playing Edufocal© Games?

Year	*N*	*Mean*	*Median*	*Mode*	*SD*
December 2017	34	1.1579	1.0000	1.00	.37
March 2018	34	1.111	1.000	1.00	.32

As it relates to the different components of the game, students were asked: *Which parts of the game did you enjoy the most*? as represented by question three (3) on the questionnaire. This was an open-ended question which allowed students to write in their individual responses. Open-ended questions as postulated by Creswell (2014) are free-form questions which require a respondent to write their own knowledge or feeling towards the question. The responses were then recorded then recoded into five (5) different categories. This was because some responses were similar in meaning and thus each answer was placed in a specific group. The final five categories were as follows*; (a) tests, (b) different subjects, (c) leaderboard, (d) feedback and (e) everything*. After recoding, the final analysis aided the following response. As represented in Table 11, the results show that in December 2017, an overwhelming majority of students representing 42% or (*n* = 15) indicate that they enjoy the tests while 34.2% (*n* = 11) said they enjoyed the different subject's choices that the software offers. However, only 7.9% and 5.3% respectively stated that they enjoy the feedback and also everything that the game offers.

Table 11

Which Parts of the Game did you Enjoy Most?

Categories	Dec 17	Mar 18
	n (%)	*n* (%)
Tests	15 (42.1)	6 (19.4)
Different Subjects	11 (34.2)	11 (30.6)
Leaderboard	2 (5.3)	5(13.9)
Feedback	3 (7.9)	5 (13.9)
Everything	4 (10.5)	8 (22.2)

In March 2018, the results also showed that majority of students representing 30.6% said they enjoyed the different subjects in the game while another 22% said they enjoyed everything about the game. The remaining 13% shared that they appreciated the leaderboard with scoring and the feedback from tests. This means that on both occasions that the survey was distributed, students preferred the variety of tests that the software offered and also the access to different subjects. This is displayed in Table 12.

Table 12

Which Parts of the Game did you Dislike Most?

Year	*N*	*Mean*	*Median*	*Mode*	*SD*
December 2017	35	2.11	2.0000	1.00	1.33
March 2018	35	2.89	2.500	2.00	1.47

As it pertains to which aspects of the game the students disliked most, the question was asked; "*Which parts of the game did you dislike most?"* as represented by question four (4) on the questionnaire. Students were provided with five (5) responses; four (4) closed-ended and one (1) open-ended. The responses are as follows; *(a) design (b) feedback (c) rules and (d) dynamics*. Respondents were also asked to write in their response if it was not represented by selections a-d. Majority of the written responses

were recoded to mean nothing or the response fell within the answers provided in a-d (see Table 13).

Table 13

Which Parts of the Game Did You Dislike Most?

Categories	Dec 17	Mar 18
	n (%)	*n* (%)
Design	5 (13.2)	14 (38.9)
Feedback	11 (28.9)	7 (22.2)
Rules	17 (42.1)	6 (16.7)
Dynamics	4 (10.5)	2 (5.6)
Nothing	2 (5.3)	6 (16.7)

When students were asked what part of the game they dislike the most, the results in December 2017 were quite surprising. It showed that overwhelming majority representing 42% or (n = 17) stated that they did not like the rules while a surprising 28.9% or (n = 11) said they did not like the feedback. The remaining 13.2% said they did not like the design while 10% said they did not like the dynamics represented in the game. In March 2018, the results showed different results where 38.9% or (n=14) did not like the design aspect followed by 22.2% and 16.7% who dislike the feedback and rules respectively. A minimum 5% said the dynamics. It was surprising to note that 16% represented nothing which means that they liked everything that the game had to offer. This is represented in Table 13.

Attitude Towards Math—Experimental

In order to determine student attitude toward learning math, respondents in the experimental group were asked a number of questions representing a total of 27 items using the amended Kaput center attitude towards math survey. The responses were initially entered into the SPSS software and then recoded. Attitude scale was represented

by questions 2a-2aa which totals 27 items. Students were asked to tick the appropriate response based on the key that was provided as follows; (1) *strongly disagree,* (2) *disagree,* (3) *neutral,* (4) *agree* and (5) *strongly disagree*. This means that if a student strongly disagreed to a question, their response would be a score of (1) *disagree (*2) *neutral* (3) *agree (*4) and (5) *strongly disagree*. These questions represent research question number three which speaks to student's attitude before and after using the *Edufocal* © software.

The responses were then calculated, and the following summary formed. If a student answered 1 to all responses, they would receive a minimum score of 27 while on the other hand, if they selected 5, the maximum score they could receive was 135. The scale was then recoded in SPSS to represent the following; a score between 0-40 represented disagree, 41-80 neutral, 81-100 agree and 101-135 strongly agree. After recoding, the final response was as follows; 0 disagree, 1 neutral, 2 agree and 3 strongly agree. This means that if a student received a score between 0-40 it means they disagreed, 41-80 they remained neutral, 81-100 they agreed and 101-the maximum score of 135 they strongly agreed. The scale asked questions such as; I am not afraid to answer questions in math class, math interests me, I practice math questions at home and I want to perform well in math (see questionnaire in appendices B and C). The scale was further recoded where those who disagreed had a negative attitude, stay neutral and those who agreed and strongly agreed had a positive attitude towards math.

From the recoded total, the responses were as follows; Table 14 displays results to student's attitude towards learning math. At the beginning of the term before the start of the experiment, 67.5% of students strongly agree that they can learn math while 26.8%

agree that they can learn math. The remaining 5% remained neutral while no one disagreed. This means that an overwhelming majority of students at the beginning of the term believe that they have the ability to learn math.

In March 2018, the results were also similar where 63.9% and 33.3% stated that they strongly agreed and agreed respectively that they have the ability to learn math while the remaining 2.8% remained neutral. In summary, this means that at the beginning, mid-term and end of the term, an overwhelming majority of students strongly agreed and agreed respectively that they can learn math while only a small percentage remained neutral. These results are represented in Table 14.

Table 14

Attitude Towards Learning Math- Experimental Group

Year	Disagree	Neutral	Agree	Strongly Agree
	n (%)	*n* (%)	*n* (%)	*n* (%)
December 2017	0 (0)	2 (5.0)	9 (26.8)	24 (67.5)
March 2018	0 (0.0)	1 (2.8)	11 (33.3)	23 (63.9)

Attitude Towards Math- Control

The same attitude scale was also distributed to the control group mid-term and end of term (see Table 15). This was done to compare the attitude of students who have used the *Edufocal* © software and those who have not used the software. These students were provided with standard classroom assignments. The scale comprising of 27 items was also recoded similar to the scale used by the experimental group. After recoding, the results were as follows; in mid-term, an overwhelming majority representing 53.7% of students indicated that they strongly agreed that they can learn math while similarly, 42.7% agreed that they can learn math. The remaining 3.7% indicated a neutral response

while no one disagreed. At the end of the term on the other hand, the results show that more than half the students representing 54% agreed that they can learn math while 40% strongly agreed. The remaining 3.6% of respondents remained neutral. This means that overall, both mid-term and end of term, students were of the opinion that they can learn math as an overwhelming majority either strongly agreed or agreed to the group of questions measuring their attitude towards learning math.

Table 15

Attitude Towards Learning Math-Control Group

Year	Disagree	Neutral	Agree	Strongly Agree
	n (%)	*n* (%)	*n* (%)	*n* (%)
September17	0 (0.0)	1 (4.2)	6 (29.2)	15 (66.7)
March 2018	0 (0.0)	1 (3.6)	12 (54.0)	9 (40.0)

Attitude Towards Using Technology to do Math-Experimental

A second scale was created that was distributed only to students in the experimental group. The questions on the Likert scale were developed using the amended Kaput Center attitude towards using Technology to do math instrument. The scale consisted of 23 items representing questions 3a-3w asking questions soliciting student opinions on attitude towards using technology to learn math. The instrument was distributed twice in the term (mid-term and end of year). The responses were as follows; (1) *strongly disagree, (2) disagree, (3) neutral (4) agree* and (5) strongly agree. This was used to measure research question three which measured students' perceptions of math before and after working with a gamification Software,

The scale was then totaled and recoded. If a student answered one to every question, the minimum score they could receive was 23 while if a student selected 5 to each question, the maximum score they could receive was 115. After recoding, the new

scores were as follows; 1-25 disagree, 26-50 represented neutral, 51-70 agree and 71-115 strongly agree. The Likert scale focused on questions relating to students' view of using technology to do math such as; technology has made math easier to understand, I am comfortable using technology to improve my math scores and using *Edufocal* © has increased my motivation to learn math (see copy of questionnaire in appendix B).

After recoding, the results as represented in Table 16 are as follows; at the end of year when students were asked the same questions, the responses shifted slightly where an overwhelming majority 86% strongly agreed while 13.9% agreed that they have a positive attitude towards using technology to use math. This means that after the sum total of all survey responses were analyzed, majority received score between 51 and 115 on the Likert scale.

Table 16

Recoded Technology Attitude Scale-Experimental

Year	Disagree	Neutral	Agree	Strongly Agree
	n (%)	*n* (%)	*n* (%)	*n* (%)
September 17	0 (0.0)	1 (2.6)	12 (34.2)	22 (63.2)
March 18	0 (0.0)	0 (0)	5 (13.9)	30 (86.1)

Chapter Summary

This chapter presented the results from the data collected pre and posttest from students in the sixth grade at a selected elementary school. Students were divided into two groups; experimental (students who used the software) and control group (traditional students). Data was collected from traditional standardized tests leading to the final GSAT exam at the end of the school year and also via a survey to analyze student attitude pre- and post-intervention. The data showed a failure to reject the null hypothesis at the $p = 0.05$ level and the conclusion that the scores were not statistically significant.

Chapter 5: Discussion

Overview

This chapter presents the discussion of the findings and provides insight and explanations to results from the research on gamification. Games, as defined in this research, is a method whereby games and game-like elements that make them interesting such as levels, scores, and points in doing things unrelated to the game. In this case, games were used in the classroom to solve math problems. The first section of this chapter presents a summary of the results from the descriptive analysis, the gain score and independent sample *t-test* analysis. A summary of the findings was then discussed to determine if the implementation of gamification systems in the classroom can improve math scores of sixth-grade students. The study also examined whether gamification in the classroom can improve the motivation of students towards learning mathematics and to provide recommendations on how to design the math curriculum in the future to increase student interest and their overall scores in math using technology at a selected Elementary school.

Research Question 1

What are the effects of a gamified software intervention on mathematics scores among sixth-grade students in a small inner-city elementary school as measured by a school district-wide benchmark exam and final exams?

The total population was approximately 61 students with 35 students assigned to the experimental group and 26 used for the control group. To examine the effects of a gamified software intervention on mathematics achievement among students, scores were collected at two different points in the school term. Tests were administered using

standard math benchmark strands; (a) numbers, (b) measurement, (c) geometry, (d) statistics, (e) algebra, and (f) probability set by the district (see appendix F). When the diagnostic scores were analyzed for the experimental group, the mean gain scores between the two groups was 2.67 with (M=10.714, SD=1.26) experimental and control (M=13.38, SD=2.03). From this analysis, it was apparent that due to the random assignment to conditions, the groups were considered probabilistically equivalent. Nonetheless, there was no statistical difference between these two groups. This is essentially saying that students in the control group scored 2.67 more points compared to those in the treatment group, but it may not have been as a result of any external forces.

An independent sample *t-test* was conducted to determine if there was any difference in mean math test scores between September 2017 and March 2018 between the gamified and traditional control group pre- and post-gamified intervention. The *t-test* was conducted using SPSS software. We failed to reject the null hypothesis at the 0.05 level as p =.246 hence, the intervention did not statistically improve students performance in the short- or long-term.

Interpretation of Findings

There are a number of reasons in the literature to explain this important finding. As argued by Gopaladesikan (2012) in Gartner's hype cycle for emerging technologies, gamification was described as a "now" hype and the findings from the present research would present gamification at the stage of trough of disillusionment. At this stage, it is argued by Gopaladesikan (2012) that the technology i.e. gamification is overemphasized in what benefits it can actually provide to learners in the classroom and is pushed beyond

its limits as it does not live up to its name. Based on the result from the study in the pre and post final exam periods, the "hype" of gamification did not live up to its name.

Gartner further explained that this fall in the "hype" may be as a result of poor game design or added focus on badges, rewards, and leaderboards. The benefits to gamification is vast but is not limited to: (a) increased engagement, (b) higher levels of motivation, (c) providing instant feedback (d) reinforced learning and increasing time spent on tasks and) increased interaction and communication with users (Al-Azawi, et al., 2016). However, continuing the point made by Gartner, Marczewski (2013) argued that student achievement on a leaderboard can be seen as only short-term accomplishments on their own as in the long run, they may serve as the exact opposite by demotivating the user when trying to complete a simple task in the real world.

Since the results from the pretest revealed that no statistically significant correlation exists between usage of *Edufocal*© and improvement in test scores, it is important to argue from the standpoint of what caused this result. Seatre (2013) surmised that mathematics is a subject-area where technology has not been used to its full potential. It can then be argued that other factors apart from gamification exist that can cause an improvement in student scores. One reason could be that the gaming technology was not properly implemented in the experiment. Ke (2009) argued that with the recent bombardment of gaming systems in the classroom, it has not met the anticipated potential it carries as a motivation and learning tool. The study concluded that there exists an overall significant impact of technology on student achievement, attitude and motivation towards math, but the results vary based on the intervention method used. The nature of

the intervention in the present study is designed in a way so that it is impossible to rule out the effect of the independent variable causing the effect on the dependent variable.

Technological teaching aids can help to enhance a student's ability which will eventually increase their confidence in learning a subject. Turgut and Temur (2017) in their study inferred that the use of game-like elements to teach mathematics can have a positive effect on how they perform academically. Using any type of technology to learn can be less effective or ineffective when the learning objectives are unclear, and the focus is on the use of the technology itself and not the curriculum. Martha Stone Wiske, co-director of the Educational Technology Center at the Harvard Graduate School of Education argued that "One of the enduring difficulties about using technology in education is that a lot of people think more about the technology first and the education later" (OECD, 2010 p.12). It was argued that to effectively implement technology in the classroom, instructional technologists should pay closer attention to the learner, the learning environment, professional competency, system capacity, community connections, technology capacity and accountability. Once these factors are taken into consideration, then the technology can be used as an effective tool to enhance the learning experience (Schacter, 1999). However, Higgins, Huscroft-D-Angelo and Crawford (2017) study focused on using technology as an intervention tool in mathematics which in effect can influence student outcomes, attitude towards learning and student motivation to learn.

Huang and Soman (2013) argued that when different gaming elements are not used correctly, then this may backfire on the instructor and by extension the student. This is because, in order to get to certain stages of a specific game, the student must be

motivated to continue and to learn new things. Therefore, special attention must be paid to the elements of the learning technology, overall objectives of the subject matter and available resources (Huang & Soman, 2013). Gaining any positive results from implementing technological games in the classroom will depend on how accurately one of the above factors is implemented.

Katmada et al. (2014) opined that the most important elements in designing a learning game are; analysis, design, development, implementation, evaluation, challenge, fantasy and curiosity. These, researchers have argued, are factors essential to how motivated the learner is towards the subject. It has been established that in designing a successful game, the game should be straightforward without any distractions. Garris et al. (2002) noted that differences in personality traits such as level of curiosity, level of competitiveness or even game design preferences may affect how someone gravitates towards gameplay. As educators, one of our greatest tasks is to capture the attention and interest of the learner, keep them highly engaged and capture their attention, so that they will be motivated to keep coming back for more (Buckley & Doyle, 2014).

The point can be made that gaming is no more effective than teaching the content. This point was also argued by (Clark, 1983b) when he noted that "media are mere vehicles that deliver instruction but have no direct influence on student achievement no more than the truck that delivers our groceries causes a change in our nutrition (p.445)" The main point that Clark is making, in essence, is that we cannot seek to justify the use of instructional media based only on the claims of the unique contributions to learning that the media has offered over the traditional brick and mortar methods (Clark, 2012a, p. xiii.). In essence, media can improve instruction, but it is not the main determinant that

explained why a student learn i.e. it is not the media that influences learning. In the paper entitled "Reconsidering research on learning from media," (Clark, 1983b) stated that "studies clearly suggest that media do not influence learning under any conditions (p.445)." Clark's perspective is that no matter how many media tools the instructor invests in, it is the contribution of the material/content, the methods used and the way in which it is designed that causes a student to learn.

While many educators warn against viewing technology as the cure-all, it should not go unrecognized that media and technology plays a very important role in the classroom as students are no longer limited to the confines of the classroom. Through computer networks and the internet, the world then becomes each student's classroom (Simonson et al., 2012). In the present study, the correlation was negative but not significant. This could essentially mean that students may have gotten accustomed to using the software in the middle of the term which also changed to a positive view of math as a result. On the other hand, it could also mean that students in both groups studied at the same rate. We are reminded of Kozma's (1994) debate where he noted that the media can be used as more than a vehicle of delivery, as postulated by Clark in 1983. Kozma (1994) further added that using the correct medium will influence a student's cognitive skills as the author believes that both the method and the medium have a crucial impact on how instruction is designed.

When the question was asked; "*Which parts of the game did you dislike most?"* at the end of term, an overwhelming majority representing 42% stated that they did not like the rules in the game. However, in March 2018 after six months of using the game, majority representing 38.9% disliked the design while only 16.7% mentioned the rules.

This result can be as a consequence of a variety of factors. Game playing involves several rules that must be adhered to in order to complete a specific lesson/quest or journey. When a user violates these rules that govern game-play, where the gamer responds out of the normal characters, the game is either stopped or reset from the beginning. Remember, it is the rules embedded in a specific game that governs the overall structure of the game (Garris et al., 2002). Rules are very important in any setting as, without rules, there would be chaos and confusion (Marczewski, 2013). Marzewski believes that when rules change, this can create negative feedback from users especially if the rules were forced upon them in the middle of a mission. Playing games is associated with errors, trials, failures and eventually success which is acquired through experience and feedback (Buckley & Doyle, 2014)

Sahin and Namli (2016) stated that games can be used as an effective tool to enhance learning and understanding complex issues. The study utilized a quantitative method using pre-test and post-tests to determine relationships between college student's academic achievement and online follow-up tests. The results concluded that gamification can motivate students to participate more in the classroom, but teachers should be given the correct tools and proper training to guide the students effectively. Lee (2012) surmised that principals and administrators play a major role in improving a student's math scores. The suggestion was made that school administrators and leadership should work together in incorporating computer gaming technology in the math curriculum, as technology has the potential to transform the classroom. It's capabilities however, have not yet been realized to their full potential. This was similar to Katmada, Mavridis and Tsiatsos (2014) where the authors share that specific games can

be successfully incorporated into the curriculum by educators as a supplement to the traditional learning tools.

One of the main objectives of a game is its design and the instructional content that is inherent in the game. Another important element is the behavior of the user and how they respond to the gaming elements, the feedback provided from answering each question and also the judgment of the user based on what they thought of the game. Finally, a well-designed game should have specific learning outcomes that correspond to course content (Garris, et al., 2002). This idea is presented in figure 3 in the input-process-outcome game model adopted from Garris et al. (2002). Sandusky (2015) opined that incorporating gamification into the curriculum would be helpful to students if it can assist the learners to remember 90% of what they learned.

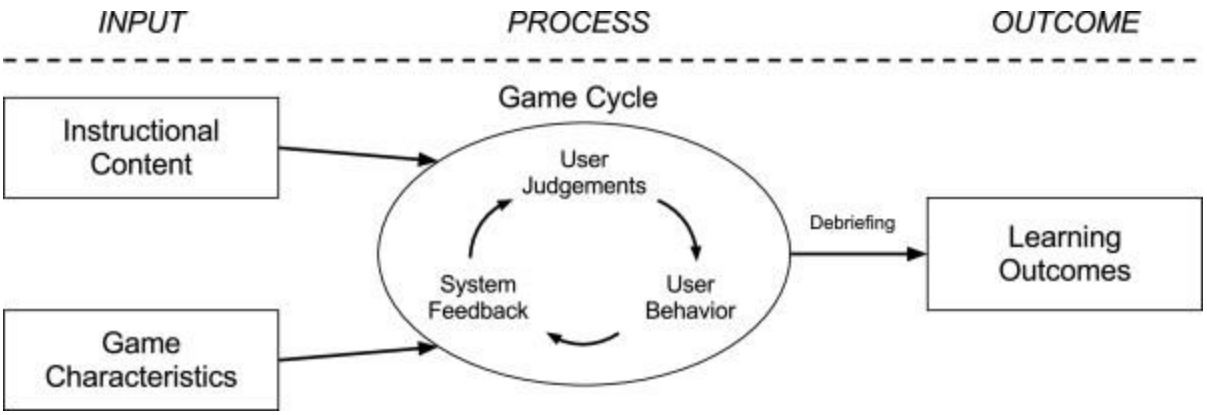

Figure 3. Input-Process-Outcome game model. adopted from Garris et al. (2002).

When respondents were asked; *Which parts of the game did you enjoy the most*? in December 2017, an overwhelming majority (42%) said they enjoyed doing the tests while only a mere 7.9% preferred the feedback. On the other hand, when the same question was asked in March 2018, 13.9% said they enjoyed the feedback while only

19.4% said they enjoyed tests compared to the period before. This is very surprising as it has been argued in earlier literature that feedback creates a form of empowerment and creativity for students. This form of expression is seen when users are engaged in a process where they are repeatedly experimenting with new technological devices as they are confident in the feedback that will be given if it is correct or not (Chou, 2016). The feedback they receive will allow them to adjust accordingly. The example was given of playing with Legos where it is fun, but you also have to use your brain to create art. In Marczeski (2013), he argues that instant feedback to the user gives them a better understanding of the task, what they are doing and their overall progress.

The use of the leaderboard is also an important element that was investigated in the study. Marczewski (2013) argued that leaderboards can be used as an effective way to show users where they currently rank in comparison to their peers. The leaderboard can be used as a motivating factor as it is usually displayed on the front page where the user is in full view of their activities. However, it can be concluded from these results that the leaderboard did not serve as a motivating factor for students to play games on *Edufocal*©. When a leaderboard displays your score along with those of your peers, it may encourage peer pressure as you may feel influenced that you must get to the top. When a user rises on the leaderboard, it can serve as a motivating factor as this may mean that you are succeeding at the tasks that you set out to do (Marczewski, 2013). This could be one of the reasons why the results were not significant at the 0.05 level.

Research Question 2

What effects do gamified applications have on students' motivation, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey among sixth grade students?

In order to find out the general attitude towards using the *Edufocal*© software to learn math, students were asked the following question: *Do you enjoy playing Edufocal© games?* In March 2018, the results showed that overwhelming majority representing 88.9% stated that they enjoyed playing games on *Edufocal* © while the remaining 11% said no. This, however, did not essentially mean that they were motivated to learn math. Chou (2016) surmises that intrinsic motivation which is derived from the activity itself is not concerned with future outcomes. Therefore, if a person performs a task with the expectation of receiving a reward, then it is not based on intrinsic motivation but rather extrinsic. In addition, Katmada, Mavridis and Tsiatsos (2014) study fielded similar results where student's opinion about a specific game in learning math was positive.

When students in the experimental group were asked to state their attitude towards math pre- and post the intervention, the results were astounding. At the beginning of the term before the start of the experiment, 67.5% of students had a positive attitude towards learning math while 26.8% agree that they can learn math while 5% remained neutral. It was argued by Chou (2016) that some students are extrinsically motivated to complete a course or in this case, to play games not necessarily because it is interesting, or they want to do it but because they have to. This is sometimes driven by the reward or accomplishing a specific goal which will motivate students to complete a specific task. Chou (2016) also explained that students may be motivated because the

extrinsic reward is appealing to them and this reward creates an impression that you are enjoying the activity. Lister (2015), whose study was done in Canada, concluded that computer games have become part of the daily activities of students of all age groups and it also affects student motivation and learning. However, extrinsic rewards may not be the sole reason to answer to issues of engagement and game use (Marczewski, 2013).

At the end of the term in March 2018, the results were also similar to September 2017 where 63.9% and 33.3% stated that they strongly agreed and agreed respectively that they have the ability to learn math while the remaining 2.8% remained neutral. In summary, this means that at the beginning and end of the term, an overwhelming majority of students strongly agreed and agreed respectively, that they can learn math. However, these results were not displayed when the analysis was conducted on test scores. When a similar study was conducted by Wand, Chang, Hwang and Chen (2018), it showed that students who used the gamified software were more motivated to learn math compared to those who used conventional approaches.

Motivation and Use of Technology to Learn Math

Research question two (2) sought to examine the effects of gamified applications on students' motivation. The results from both the experimental group and the control group were slightly similar. For the experimental group, the results show a 94.3% positive rating for September 2017 and 97.2% for March 2018 before the GSAT exam. This is essentially saying that students had a positive attitude towards learning on both occasions. Note however that this result is without the use of technology. On the other hand, a separate scale was distributed soliciting students' views on using technology to do math, the results were also similar. The results show that 100% of students in the

experimental group had a positive view in March 2018. This could essentially mean that students have a positive view on incorporating some type of technology in the math curriculum. Wang et al. (2018) also agree that game-based learning is a potential approach to addressing the issue of motivating students to learn math.

A number of reasons could be used to explain this result. The SDT theory of determination was used as the guiding theoretical framework for this study. The theory essentially describes learning using technology as a non-traditional learning as an out-of-class learning method (Ryan & Deci, 2017). It can be seen from the outset that those who used the software are more motivated to learn. However, it does not have to be the software itself that motivates a student but their individual abilities. These actions can include "the student's ability to plan, manage and persist at tasks such as homework and challenging problems (Brahier, 2011, p. 32). Byun and Joung (2018) also believe that video or computer games are an effective method that can be used in the classroom to improve student performance and motivation in mathematics.

One motivating factor inherent in gaming is rewards and badges. Some essential elements in gaming such as rewards and badges it is argued can be used as support mechanisms to support the independence of learners which inherently leads to a higher level of motivation to learn (Landers et al., 2017). Rewards should serve as influencing the achievement of the user and not to become the achievement (Marczewski, 2013). This, it was argued, is because the issuing of "random" rewards for all activities can become addictive and will be expected in all circumstances. However, some students perhaps do not possess the innate ability to perform academically in math. This innate

ability allows students to organize their thinking and use it to recall data and that will affect their success in recalling what they have learned throughout the term.

While the study showed that students are motivated to learn math, the scores however, speaks volumes as the technology did not make a difference in mean gain scores between the experimental and control group. This was similar to the findings in the study done by and Saenz-Herraiz (2013), where it was found that students who participated in the gamified experiment had a positive view of learning the subject but, while their motivation to participate increased, the scores from written assignments did not bear the same finding. In *Edufocal* ©, the rewards were given at the end of the school year and not when the student actually completed a challenge. This means that there were no immediate incentives to use the software from the student perspective. Therefore, the rewards system in the gaming software did not make a difference in a student's innate ability to pass math. As a result, it could be argued that there were weaknesses inherent in the gaming system that was not tied to the curriculum in more ways than one.

If the content is not properly aligned with the learning outcomes outlined in the gaming system, then the benefits to be gained from game-based learning will be limited. This point was also supported by (Vandercruysse et al. 2017 & Wang, Chan, Hwang & Chen, 2018) who argued that the way the content is integrated into the software will affect the expected outcomes such as motivational and learning gains. If the teachers and students work together in properly implementing the software in the classroom, then greater benefits will be achieved.

Whitton (2012) argued that computer games can cause a number of problems in that; games are often designed for enjoyment, not closely tied to the curriculum and

teachers are not properly trained to use the systems and are often very expensive to purchase. Using any type of technology to learn can be less effective or ineffective when the learning objectives are unclear, and the focus is on the use of the technology itself and not the curriculum. A student's degree of experience in effectively using the software can also pose a major cause for the results. Games have the potential to improve student achievement and increase motivation, but it can distract from the learning experience (Mayer, 2014). Katmada, Mavridis and Tsiatsos (2014) also shared that with major improvements, games can be used as an effective learning tool. This is one reason to explain the disparity in the results.

Hanus and Fox (2015) concluded that students in the gamified classroom scored lower in final exam scores than those in the non-gamified class. However, this was not the same for the current study. In examining students' attitude from the perspective of the control group, it showed that 96% had a positive attitude in September and 94% positive attitude in March. Where scores are concerned, it shows a gain score of only 2 points between both groups. With that result, it can be concluded that the use of the gamified software did not statistically improve students performance in the short- or long-term.

Ku at al. (2014) introduced the issue of ability versus confidence, and its impact on student performance in mathematics. The authors further explained that the issue of low confidence is one of the main reasons why students believe that math is difficult to learn, and this negative feeling could eventually lead to a student having no confidence in math. Other issues include inadequate teaching facilities, inadequate learning materials, reverting to old-style teaching practices and understaffing.

Research Question 3

What are the students' perceptions of math before and after working with a Gamification Software, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey among sixth grade students?

An attitude towards learning math using technology scale was created and distributed to the experimental group three months after the introduction of the intervention. The results showed that at the beginning of the year, 34.2% agreed that they can learn math using technology while the remaining 2.6% remained neutral. On the other hand, at the end of the year when students were asked the same questions, the responses shifted slightly where an overwhelming majority 86% strongly agreed while 13.9% agreed that they had a positive attitude towards using technology to use math. Gressick and Langston (2017) agreed with the findings as it was posited that games can serve as a motivating force in the classroom while promoting required mastery skill, knowledge creation and the potential to optimize learning.

These results were similar to those reported earlier without the introduction of the technology. The major difference was the end of year in March 2018 immediately before the sitting of the GSAT exam where students reported an overwhelmingly positive attitude towards learning math using technology representing 86%. The results from the *t-test* also showed that the use of the *Edufocal*© software caused some change in scores (2 points) but it was not significant based on the p-value. Therefore, students found the introduction of gamified elements in the curriculum to have a positive impact on their levels of motivation to learn math, but this result was not significant at all levels. These results are similar to the conclusion drawn in the research conducted by Bowman (2015)

whose study focused on investigating the impact of gamified elements on student motivation in sixth-grade students. The recommendation was made by the author to continue incorporating gamification elements in the curriculum and study the results over time.

In comparing the results, it can be seen that both groups showed some level of motivation to learn math at the beginning and end of the school year. Student attitude in March 2018 showed that 86% of students in the experimental group were extremely motivated compared to only 40% in the control group. One reason to explain the disparity in the results is that students who used the technology could have been motivated prior to using the technology and not actually an effect of the technology itself. These results can be explained using the SDT theory where students experience independence and self-sufficiency when they feel as though they are supported and the feeling that someone is there to listen to their problems (Ryan & Deci, 2017). That someone in this context could be either the game or other factors outside of the game. The SDT theory applies both to the learner's motivation and intention to learn using technology (Fathali & Okada, 2017).

Gender Differences in Test Scores and Gamification

Gender has played a major role in how students perform academically over the years. Kappers (2009) in her study stated that no statistical relationship exists between the academic achievement scores of males compared to their female counterparts when using the educational video games as a tool in class. In Veltri et al. (2014), it was argued that males are more likely to be attracted to computer games compared to their female counterparts. Kim and Chang (2010) study found that male students who played math computer games in class more frequently perform better than those who never played

computer games. However, it could also be argued that individual personalities affect whether or not someone likes a game. Ke (2009) also found that no relationship exists between a student's performance in school academically as it relates to the math scores of students in elementary schools. Shin, Norris and Soloway (2006) in their study also concluded that they observed no significant differences in results as it relates to a student's gender and difference in test scores. This reasoning could explain the research findings.

Some authors such as Tiedemann (2000) argue that boys tend to be more logical thinkers compared to girls which would essentially lead them to perform better in mathematics which is a subject that requires logical thinking. This premise could explain the disparity in the results gained from the current study. This could also be true as boys tend to act differently from girls when technology is introduced in the classroom (Heemskerk, Dan, Volman & Admiraal, 2009).

In Veltri et al. (2014), it was argued that males are more likely to be attracted to computer games compared to their female counterparts. However, it could be argued that individual personalities affect whether or not someone likes a game. In the present study, there were only slight variations in the difference in mean score across both genders. In Veltri et al. (2014), it was also argued that boys exert a higher interest in playing computer games than girls as they have a tendency to play for longer periods of time. This is also represented in the society where males are overrepresented in computer jobs. This difference was not shown in this study as both genders in both the pre- and post-periods agreed unanimously that they enjoyed playing games on *Edufocal*© software.

Another reason explaining the absence of a correlation could be the sample size that was used. Thirty-five (35) students were randomly selected for the experimental group and 26 students in the control group. The characteristic of the individual learner is a major strategy of how they retain information. It was recommended by Kim and Chang (2010) from the study that educators and administrators should consider issues such as the characteristics of the learner when attempting to implement gaming systems into classrooms. It is important for the instructor to find out who are the learners? It is equally important for educators to know their students and it is also important for the student to know their instructor. Simonson et al. (2012, p. 131) noted that taking the time out to learn about the learners in the class generally yields a more productive learning environment. This will allow the instructor to be knowledgeable of the learner's cognitive abilities so that the instructor can observe how students relate to the content of the classroom.

Another probable explanation for the result is that students were possibly doing better academically but the study did not capture this. A number of reasons could account for this. GSAT consist of a total of five subjects including math. Students were asked in the survey what parts of the game they enjoyed most and at least 30% highlighted on both occasions that they appreciated the different subjects that it offers. It could be that students performed better in the other subjects and scored the lowest in math. That was not captured in the study. A similar study was conducted by Fien, Doabler, Nelson, Kosty, Derek and Clarke (2016) whose results favored the experimental group but the results however, were not statistically significant.

The analysis also concluded that technology does not play a role in facilitating student learning. The argument is that the inclusion of technology should not serve as a replacement to the traditional face to face curriculum but rather an enhancement to the learning process. In Buckley and Doyle (2014), it was found that gamified learning intervention had a positive effect on student learning. However, while the impact was found to be positive, the effect varies between each student such as their level of motivation and willingness to participate. Clark's (2012a) perspective is important in this debate because, no matter how many media tools the instructor uses and invests in, it is the contribution of the material/content, the methods used and the way in which it is designed that causes a student to learn. In addition to this, the learner's must feel confident that they can be successful in the subject. If students feel that they can achieve success in a particular game, then they will feel more motivated to succeed in this game (Kapp, 2012).

In order to ensure the positive impact of gamification, researchers must ensure that the learning activities are directly tied to the learning outcomes (Nicholson, 2014). Clark, (2012a p. 48) on the other hand, argues that no specific evidence is found that can be used to generalize that there are no specific learning benefits that can be gained from employing any specific medium to deliver instruction to students. Clark (2012a) argued that the use of instructional technologies in the classroom does not have a direct impact on student achievement. What instructional technologies do provide is access, sometimes more rapid access, often a motivational dimension but not direct impact on learning. Instructional design, the way the instruction is designed, may have an impact, but if one

is only looking at gross outcomes, such as achievement, as the result from the study indicates, then little or no generalizability will be discovered.

The Influence of External Factors

Where a student is located geographically as it relates to urban/rural placement can affect how they perform academically. There were unanticipated events that occurred in the middle of the term that limited student's exposure to the gamified intervention. Note that the institution is located in an inner-city community where the majority of its residents are living below the poverty line. On more than one occasion, there were frequent flare-ups of violence in and around the surrounding community where the school is located. In addition, teachers also experienced industrial action for three days in the term that reduced the number of time students spent in the classroom and using the software.

Authors Kachepa and Jere (2014) opined that some urban area schools share common learning disablements such as high absenteeism rates of students, small classrooms which results in overcrowding, reading impediments by some students and vandalism by both students and the community which further results in their poor performance. Papp (2017) also shared the same sentiment in his study where students reported a regular absence from classes and the inclusion of school events such as Sports Day and Public Holidays during the time that they should have been using the software. This inconsistency in software use could have possibly lead to some students gaining more positive learning experience and outcomes form the software than other students. This point is substantiated with the fact that some students did not have computer and internet access at home and thus, the time allotted during the regular school days were the

only means of exposure. This could possibly explain the low impact of the technology on the student scores in the final GSAT exam.

Parental influence is also an underlying factor that may affect how a student may perform in their tests. Parents educational background could play a major role in this case. Poverty is a major factor that affects how a student performs academically which can also lead to high school dropouts (Leroy & Symes, 2001). One assumption is that students who used the software, have more influence from outside forces such as friends, colleagues, parent's, family and also adults from the general community. Then, there are students who have no influence from neither parents nor colleagues. Another assumption could be that students who perform better have parents who are more involved in their schoolwork. These parents attend every meeting and keep up with student progress. While the study did not highlight this factor, it is however, possible as the software includes an option where parents can track student progress daily without the knowledge of the student. Lee (2012) surmised that parental influence, principals, and administrators play a major role in improving a student's math scores. This highlights the fact that some students in the study may have additional access to resources at home such as the internet and parental assistance and other learning resources. This could be another determinant to explain the results.

As demonstrated in Perreaud (2015), the effects of funding (private and public), poverty, resources available to teachers and the student's situation at home have all been identified as factors that contribute to the gap in mathematics achievement. Stone and Hamann (2012) added to this discussion on how to reduce the achievement gap between Native American students and those who are not of native heritage who was enrolled in

school in the Great Plains city school district of Arizona. The authors deduce that homework plays a major role in how students performed in math, more than the game itself.

From the study, the analysis showed that overall, the intervention did not statistically improve students performance in mathematics whether in the short or long-term. One possible explanation could be that the tests at the end of the year became repetitive and thus students were regurgitating what they already learned from the first time they used the software and thus got disengaged after awhile. It could be that after an entire semester, students were already exposed to all the questions and were familiar with the answers and no new questions were introduced that challenged their learning abilities. This was especially evident when it was closer to the exam in March 2018. In order for the game to be effective in the learning process, it should present at minimal an optimal level of difficulty in tasks and its interaction with the learner (Chen, Yeh & Chang, 2016).

The time in which the data was collected could be a possible explanation for the reduced motivation scores during the different time periods compared to student grades. Papp (2017) study was similar in that data was collected in the final months of the school year when students were busy studying for final exams. This is also a time when student interest in the subjects is reduced compared to the beginning of the school when they were very enthused to learn especially being in a new class with a new teacher. However, at the end of the school year, it was also argued could be the most ideal time to collect data as this could capture whether or not students levels of motivation and engagement have increased (Papp, 2017).

Students learn in different ways, and that affects how they perform academically in certain subjects. Kozma (1994) stated that learning is not simply looking at what the instructor does and regurgitates the literature. It is more than that. It involves a process where the learner creates new knowledge by interacting with the information in the environment and integrating this knowledge with what was learned in the classroom. Mathematics includes learning a number of strands which requires a number of distinct skills and expertise in order to grasp each topic. Lameras and Moumoutzis (2016) also explained the point that learning and understanding mathematics requires an extreme level of knowledge, creativity, resilience, and skills in order to effectively apply the concepts in solving mathematical equations. This higher-level of thinking may be limited in some students which explained why they may perform poor in math but better in other subjects.

Morrison (1994) critiqued both Clark and Kozma's debate by arguing that it is not the capacity of the media that facilitates learning but rather the creative development of the instructional strategy that actively engages the learner. Kozma (1994) noted that media, method, and solutions are interrelated in complex ways and recommended that researchers should move away from the question of; 'Do media influence learning?' He noted that we should instead focus more on the questions of; 'In what ways can we use the capabilities of media to influence learning for students, tasks, and situations?' (p.17). Therefore, the conclusion can be made that it is not the computer/media that affects learning directly but rather the teaching methods with an effective inclusion of media that causes any change. This could be one plausible explanation for the results in the analysis.

Information obtained from the study was that at some points in the game, students were bored when repeating each test repeatedly. In Huang and Soman (2013), it was noted that gamification works best when the learning program pays special focus on the course content rather than game design and the information is not easily predictable to the student. If the user finds the task to be boring or unappealing, then the introduction of a reward will not change that feeling as they may be further de-motivated in the long run (Marczewski, 2013). Extrinsic rewards can serve as a motivating factor if used in the correct way. The rewards should not be the main motivating factor for achieving the task to be completed (Marczewski, 2013). Gamification works by making the use of technology more engaging by encouraging users to engage in specific behaviors or participate in prescribed tasks with the aim of completing at the mastery level. Marczewski (2013). Nicholson (2014) found that "gamified learning interventions have a larger impact on students who are intrinsically motivated" (p.35).

According to Simonson et al. (2012), online learning is the most "recent" that is being offered as a new approach to learning. In the 1980's, the chalkboard was the way of passing on the information to the student, and the printed text was more popular. Also, online and use of the internet for learning at that time was seen as taboo. Traditional teaching methods at the time involved the teacher/ instructor who was the controller of the learning environment. These methods included the use of the chalkboard, dictating notes to students and talking to students directly. However, we can see where all schools have incorporated at least some form of technology in delivering the material to students. The study by Hieftje, Oendergrass, Kyriakides, Gilliam and Fiellin (2017) also supports the view that using educational games can promote academic achievement especially in

the early years of learning at the primary level. While the study results were not significant, it is important to properly implement the technology in the classroom in order for it to be effective.

The use of the media in learning is very important because it is flexible and can be used for all levels of students in all subject areas. Media has transformed how students learn as the use of media brings simulations and other activities, and students are no longer confined to the walls of the classroom. We are now open to the World Wide Web by the click of a button. Students can now go on field trips and experience different activities without having to leave the actual classroom. It can then be argued that instructional technology provides you with the tools to engage students in learning. Learning can be defined as the development of new knowledge, skills or attitudes as an individual interacts with information and the environment (Simonson, et al., 2012 p.9). This is not to say that technology can and should replace the teacher but rather, technology and media can help teachers become creative managers of the learning experience instead of merely dispensers of information. Today, many online resources are available to learners. This can be seen in the development of new applications and software tools to aid in this process.

The attitude of the teacher and the relationship between the teacher and the student can affect how well they perform. Clark (2012a) points out that there are other factors that should be considered when thinking about learning outcomes such as cost, time, distribution and availability. It is also important to help learners to understand the context of the learning experience because learners need to grasp the intent of the instructor when participating in various learning experiences (Simonson et al., 2012). The

teacher may not have properly engaged the students to stick to the game and properly supervised their use. This is a probable explanation for the variability in the results. Students may have participated because they had to and not because they wanted to. The amount of time spent on each lesson may affect how a student absorbs the formulas. This could be in the sense where the test questions were not challenging enough to prepare students to sit the district exam. The test questions in the software may have no influence on a student's reasoning ability and problem-solving skills.

Limitations of Study

The researcher encountered a few limitations in conducting the study. It is important to identify the limitations before conducting the study, as these may greatly affect how the results are interpreted.

1.To strengthen the validity of the study, one elementary school located in an inner-city community was used. One group was treated (experimental) while the other groups remain untreated (control).

2.The study used only sixth-grade math scores. This grade was deliberately chosen because, at this stage, students sit the Grade Six Achievement Test (GSAT) which determines which High School they will attend the following year.

3.Limited literature is available locally on the subject area with respect to gamification in the Jamaican educational system.

4. The current research gap was limited to the understanding of the potential nature of gamification as a learning tool to improve student math scores.

5. There were significant time constraints as the researcher had to keep a check on a weekly basis to ensure that the students were using the software and proper distribution

of questionnaires.

8.The researcher used the results from the sample to generalize to the population. Also, the researcher was the one who randomly placed the students in the classes to participate in the study based on the scores they received in the diagnostic pre-test using STATA. Hence, this study can only be generalized to a similar population using the same or similar instructional games.

10.There were limitations as it relates to resources that were used in the study. The researcher was required to pay subscription costs for the students who were participating in the study. This was done to get more valid and reliable results as all students in the experimental group must have access to the software.

Recommendations for Future Research

Based on the information garnered from the research, students are of the belief that they are motivated to learn math, but the test scores were not significant. From this result, several recommendations are suggested for future research;

A mixed method perspective could be considered where focus groups and interviews are included along with the traditional quantitative method of data collection. This strategy would allow researchers to get an opportunity to speak face to face with users and ask the "why" questions. As argued by (Marczeski, 2013), in order to find out the most effective use of a gamified setting, the researcher should conduct a viable experiment, test the findings and gather adequate feedback. This will include conducting research involving administrators, instructors, computer personnel, math teachers and everyone involved in the process including the maker/owner of the software.

This broader perspective will allow the researcher to gather feedback from stakeholders such as teachers, students and, parents who are involved in this process. The interpretivist/qualitative approach, on the other hand, would allow the researcher to delve deeper into the issue by conducting face to face interviews, focus groups, and observations. This will also allow instructional technology professionals to further understand the issues of delivery methods versus instructional technology and media in the classroom. In evaluating responses, the instructor can gain an understanding of how the learners perceived the class experience (p.134). Therefore, we should focus more on robust evaluation plans in order to identify the unique features of technological education programs (Clark, 2012a). Following from the previous recommendation, the Primary Exit Profile (PEP) as explained in Chapter One will be implemented officially in September 2018 to replace the GSAT. Therefore, additional studies should be done on this new testing standard to determine if it is effective.

Research should also focus more on how to improve student academic performance rather than what method is best to use. Gamification and its benefits should not be used only as a control mechanism however, it should serve the task of motivating and engaging the users (Marczewski, 2013). In further discussing what teaching strategies and media to be used, Simonson et.al. (2012, p.135) points out that "it is important to utilize students in this process as students can seek to provide insight into the design of the learning experience."

A longer time-period with different geo-political educational boundaries/districts could be implemented at different time periods. This would include implementing the software in at least one school in all seven districts focusing on low performing schools.

This would include a view to ensuring a more proportionate distribution of the island population rather than focusing on only one school. This would include tracking students' progress from the fourth or fifth grade using the technology for that length of time with the new PEP exam criteria.

A new study should be conducted examining one or several other variables including parent's educational background and social class. When studies that look at achievement outcomes are designed, there are other variables that could be included in the study. For example, we know that online students tend to spend more time studying than traditional students, so this extra time commitment can result in achievement gains (Simonson, et al., 2012).

The fundamentals inherent in the game require major improvements including the use of new questions to challenge students to solve the issue of repetitions. This improvement should also include the introduction of new activities and problem-solving challenges in a game-like format throughout that is more organized. One student wrote on the questionnaire that the program was more academic than game-like and not student-friendly. This means that it needs to be improved with more game-like features that allow the students to complete obstacle courses to solve problems rather than the traditional question format. The reward system in the game should be improved where students are rewarded at the completion of each level compared to a one-time award ceremony at the end of the year. This may serve as an incentive mechanism for students to use the game.

It was also recommended that when using interventions (i.e. computer games), that those interventions focus more on teaching math geared towards evidence-based instructional strategies. Other suggestions posed by Williams (1993) is that educators

should practice mathematical solutions and strategies which span several days focusing on specific skills/problems while solving different problems. Watson (2015) noted that administrators should assess which technologies are used on a daily basis at a higher rate than just purchase what is available to them.

A new study should also be conducted related to using technology to do math and its application to daily life as compared to other subjects. Bergmann and Sams (2012) speaks about the flipped classroom and the impact that gamification can have on flipped teaching environments. We will now move on to a summary of the findings and conclusion.

Summary and Conclusions

In summary, the study sought to answer the following research questions;

1. What are the effects of a gamified software intervention on mathematics achievement among sixth grade students in a small inner-city elementary school as measured by a school district-wide benchmark exam and final GSAT exam?

2.What effects do gamified applications have on students' motivation, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey?

3.What are the students' perceptions of math after working with a Gamification Software, as measured by a math motivation survey developed based on the amended Kaput center student attitude survey?

The researcher used standardized test scores to measure a student's achievement across three full terms of study. A survey was also used to collect data at two different periods to examine student attitudes towards math and student attitude towards using

technology to learn math. A pretest and post-test gain score analysis model was used to measure student progress throughout the three school terms. The data was analyzed using mean scores to determine if any significant difference exists between the percentage of student test scores as explained by their treatment status, diagnostic score and final GSAT scores. The results indicate that the intervention students scores were negatively affected and the estimated impact is not statistically significant as we fail to reject the null hypothesis at the .05 level. As such, the intervention did not statistically improve students performance in the short- or long-term. The self-determination theoretical framework was used to study the effects of gamified intervention on students test scores and by extension, effect of student motivation when using technology to learn math.

While many educators warn against viewing technology as the cure-all, it should not go unrecognized that media and technology play a very important role in teaching as students are no longer limited to the confines of the classroom. With computer networks and the internet, the world then becomes each student's classroom (Simonson, et al., 2012). Digital games possess the potential to create environments where students are engaged, eager to learn, enthused to engage in problem-solving activities, communication and a form of practice after a number of failures (Whitton, 2012).

Implications of Findings

This study will contribute to the present research on the topic of gamification and motivation especially those interested in the area of incorporating technology to learn mathematics. McGonigal (2011) suggests creating a game which augments our most essential human abilities in order to be happy, resilient and creative. This type of game it is suggested, will encourage humans to be more creative and empowers us to change the

world in more creative and meaningful ways. As Burke (2014) stated, the road to the success of gamification is full of many pitfalls as many companies do not appreciate the importance of gaming and motivation to the success of the players.

The study found that there remains a deficit gap in the literature that is available in the area of implementing a gamified classroom by way of an experiment that shows a high level of significant improvement in student scores. As this present study confirms, there exists a paucity of up to date research in the area of effectively using gamification to learn math, especially in the Caribbean. Therefore, future scholarship should focus on addressing the main areas that prevent students from performing poorly in math and how the inclusion of technology can fill this gap. Studies such as that done by Sailer, Hense, Mayr and Mandl (2017) showed that gamification in the classroom is not effective if the game design elements are not tied to specific learning outcomes. Understanding how each learner interacts with and use their unique talents and capabilities of each medium's format is essential to understanding the effect of media on learning (Kozma, 1994, p.4).

Based on the nature of the intervention adhered to in this present study, the approach can be adopted not only in the K-6 setting but also at High School and higher levels in the classroom. It is anticipated that the results included in this study will contribute to the limited knowledge available outlining the inclusion of gamification and other technology in the Jamaican classroom. It is also hoped that the research will become part of filling the deficit gap that exists in the Caribbean and is able to address some of the misunderstandings that exists regarding incorporating technology in the classroom curriculum and effectively adopt the flipped classroom model. The current research that exists on the topic has many gaps, but the topic of gamification has the

potential to overhaul the traditional classroom in the 21st century. Such research can also inform both local and regional policy-making initiatives in the long-term.

From the study, it was discovered that no established theory exists that adequately explained gamification and game-based learning. The lack of an accepted theory in the field of Instructional Technology and Distance Education (ITDE) has contributed to its weakness as this has caused a lack of identity, lack of sense of belonging and lack of detailed procedures against where decisions on methods, media and financing can be made with some levels of confidence (Keegan, 1995, p. 41). Theories are important to research as it allows researchers to find out whether the study they intend to undertake will add or improve to the literature that already exists. While different models such as the game-based learning model and the theory of gamified learning exist to explain how learning can be achieved with the inclusion of games, the most appropriate theories exist in the field of Psychology. This explained the adoption of the Self Determination Theory to guide the research. Game designers and instructional technologists often rely on behaviorist, cognitivist and constructivist elements along with a combination of other established theories in designing games geared towards learning (Plass, Homer & Kinzer, 2015).

While many theories exist in the field, it is very difficult to agree on one central theory of how to practice and conduct research in the field of e-learning. The rapid changes in the field and such a diverse environment in which the field of ITDE is practiced have inhibited the development of a central theory i.e. the equivalency theory. However, because of these rapid changes in the field, and different approaches to learning distance education will always be contested (Simonson et al., 2012). Improved

results come from an integrated approach to learning that may or may not include additional technology.

Ross, Morrison and Lowther (2010) discussed several challenges to research that are plaguing the field of instructional technology. One of the most evident is the fact that we should capitalize more on models that fit better to real-world challenges that can be used by practitioners while maintaining independent approaches to conducting research. The issue essentially is that instructional researchers possess the theoretical understanding, but it is limited in practice and applying the findings to real-world work settings such as the workplace and the classroom. While the author gives credit to the Morrison, Ross and Kemp model and also the Dick and Carey model, there are still issues that plague the field when conducting scientific research.

The field of distance education has been plagued by trial and error approaches with little consideration being placed on the theoretical foundations for decision-making. Simonson et. al. (2012) explained that the field of ITDE has been mostly practical concentrating more on the logistics of the field as the theoretical underpinnings of distance education is very fragile. The rapid development of electronic communication in recent decades coupled with advances in technology, have had a great effect on the future of the field.

One of the ways that Ross et al. (2010) recommended to address this issue is being more comprehensive when conducting research by considering a more systematic view on seeking improvements in the field of education. Another solution that instructional technologists should adopt as purported by Ross et al. (2010) is that research should address different learning processes and outcomes from a variety of perspectives

including the addition of a wider range of more influential variables. We should bear in mind that technologies change very quickly over time and so, the issue arises whereby it is difficult to develop a body of work overtime on any given application. Without a theory that produces a proper hypothesis to conduct research, there will be no expanding of knowledge and techniques.

The field of instructional media will always be important because every day, researchers find new ways and means of incorporating different methods of learning into the curriculum. There will always be a need to find new and updated ways of improving student performance academically. This deficiency begs for future researchers focus on improving the models that currently exist rather than creating new theories to explain the field. Learning is a very dynamic process that involves many steps and the instructional designer plays a very important role in this equation. However, as time emerges, so does technology as it "does not sit still." I will end with the quote by Carl Berger, the highly respected Director of Advanced Academic Technologies at the University of Michigan who feels that the next killer application has yet to be invented (Barone, 2002).

References

Adimabua, A. O. (2015). 24/7 connection: Blessing or a curse? *In formation and Knowledge Management, 5*(5), p.2224-5758.

Al-Azawi, R., Al-Faliti, F., & Al-Blushi, M. (2016). Educational gamification vs. game-based learning: Comparative study. *International Journal of Innovation, Management and Technology, 7*(4), p.132-136. doi:10.18178/ijimt.2016.7.4.659

American Psychological Association. (2004). Increasing student success through instruction in self-determination. *American Psychologist, 59,* 236-260.

Association, A. P. (2010). *Publication manual of the American psychological association.* Washington DC: American Psychological Association.

Bell, K. (2016). *Experimental group defined.* Retrieved from Free Sociology Dictionary: http://sociologydictionary.org/experimental-group

Bergmann, J. & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International Society for Technology in Education. Library of Congress. New York, NY.

Bourne, P.D., Baxter, D., Pryce, C.S., Francus, C., Davis, A.H. & Solan, I. et.al. (2015). The psychology of the grade six achievement test (GSAT) in Jamaica. *J Psychiatry* 18:255,p.1-12. doi: 10.4172/Psychiatry.1000255

Bowman, N. K. (2015). Investigating the impact of a gamified unit of instruction on student motivation and learning. *20th annual technology, colleges, and community worldwide online conference.* Mānoa: University of Hawai'i.

Brahier, D. J. (2011). Motivation and disposition: The hidden curriculum. In D. J. Brahier, & W. R. Speer (Eds.), *Motivation and disposition: Pathways to learning*

mathematics (pp. 1-8). Reston, VA: NCTM.

Buckley, P., & Doyle, E. (2014). Gamification and student motivation. *Interactive learning Environments, 24*(6), p.116-117. doi:10.1080/10494820.2014.964263

Burke, B. (2014). *Gamify: How gamification motivates people to do extraordinary things.* Brookline, MA: Bibliomotion Inc.

Byun, J., & Joung, E. (2018). Digital game-based learning K-12 mathematics education: A meta-analysis. *School Science and Mathematics, 118*((3-4)), 113-126.

Carr, J. M. (2012). Does math achievement h'APPEN'en when ipad's and game-based learning are incorporated into fifth-grade mathematics instruction? *Journal of Information Technology Education, Research*(11), 269-286. Retrieved from https://doi.org/10.28945/1725

Chen, C. D., Yeh, T. K., & Chang, C. Y. (2016). The effects of game-based learning and anticipation of a test on the learning outcomes of the 10th grade geology students. *Eurasia Journal of Mathematics, Science & Technology Education, 12*(15), 1379-1388.

Chou, Y. (2016). *Actionable gamification. Beyond points, badges and leaderboards* (Kindle ed.). Octalysis Media.

Clark, R. E. (Ed.). (2012a). *Learning from media: Arguments, analysis, and evidence* (2nd ed.). Charlotte, NC: Information Age Publishers.

Clark, R. E. (1983b). Reconsidering research on learning from media. *Review of Educational Research, 53*, p.445–459.

Creswell, J. W. (2014). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Pearson Education.

Davis, N. (2016, April 5). Turning school exams into an online game in Jamaica, *BBC News Jamaica*, retrieved from http://www.bbc.com/news/business-35961107

de-Marcos, L., Dominguez, A., De-Navarrete, S., & Pages, C. (2014). An empirical study comparing gamification and social networking on e-learning, *Computers and Education Journal*, 75, (p.82-91).

DeVellis, R.F. (2012). *Scale development: Theory and applications*, 3rd edition, SAGE Publications, Los Angeles.

Dominguez, A., Saenz-Herraiz, J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, 63, p. 380-392

Elearnja. (2016). *Tablet in schools (TIS),* retrieved from http://www.elearnja.org/tabletsinschools/?page_id=705http://www.elearnja.org/tabletsinschools/?page_id=705

Facey-Shaw, L, Borner, D., Specht, M. & Bartley-Bryan, J. (2015). *A moodle-based badge system for evaluating the motivational levels of introductory programmers*, (Presentation). MATEL, Toledo, Spain.

Faghihi,U., Brautigam, A., Jorgenson, K., Martin, D., Brown, A., Measures, E., & Maldonado-Bouchard, S. (2014). How gamification applies for educational purpose specially with college algebra, *Procedia Computer Science*, (41), (pp.182-187) retrieved from https://doi.org/10.1016/j.procs.2014.11.102

Fathali, S. & Okada, S. (2017, October 10). A self-determination theory approach to

technology-enhanced out-of-class language learning intention: A case of Japanese EFL learners; *International Journal of Research Studies in Language Learning.* Vol. 4 (30*)*, DOI: 10.5861/ijrsll.2016.1607

Fenn, J. & Raskino, M. (2008). *Mastering the hype cycle: How to choose the right innovation at the right tim*e. Gartner Inc. Harvard Business Press.

Fien, H, Doabler, C.T., Nelson, N.J., Kosty, D.B., Clarke, B. & Baker, S.K. (2016). An examination of the promise of the numberShire level 1 gaming intervention for improving student mathematics outcomes. *Journal of Research on Educational Effectiveness*. Vol. 9(4). P.635-661. Retrieved from https://doi.org/10.1080/19345747.2015.1119229

Frost, R. D., Matta, V., & MacIvor, E. (2015). Assessing the efficacy of incorporating game dynamics in a learning management system. *Journal of Information Systems Education*, 26(1), p.59-70.

Garris, R., Ahlers, R., & Driskell, J. E. (2002,). Games, motivation, and learning: A research and practice model, *Simulation and Gaming.* Vol. (33) 4. p. 441-467. SAGE Publications.

Gliem, J.A. & Gliem, R.R. (2003). Calculating, interpreting, and reporting cronbach's alpha reliability coefficient for likert-type scales. In *2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education. P. 82-88.*

Gopaladesikan, S. (2012). *Following gamification through gartner's hype cycle* retrieved from http://www.gamification.co/2012/12/11/following-gamification-through-gartners-hype-cycle/

Gressick, J. & Langston, J. B. (2017). The guilded classroom: Using gamification to engage and motivate undergraduates. *Journal of the Scholarship of Teaching and Learning. Vol. 17 (3). P.109-123.* doi: 10.14434/josotl.v17i3.22119

Hanus, M.D. & Cruz, C. (2016). Leveling up the classroom: A theoretical approach to education gamification; In H. Gangadharbatla, D.Z. Davis (Eds.), *Emerging Research Trends in Gamification*, (p. 440-455). Hershey, PA: IGI Global. doi:10.4018/978-1-4666-8651-9

Hanus, M.D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, 80, p.152-161. doi: 10.1016/j.compedu.2014.08.019

Hartmann, T., and Klimmt, C. (2006, July). Gender and computer games: Exploring females' dislikes. *Journal of Computer-Mediated Communication*, 11(4), p.910–931. doi:10.1111/j.1083-6101.2006. 00301.x

Hassan, A., Abiddin, N. Z. & Yew, S. K. (2014). The philosophy of learning and listening in traditional classroom and online learning approaches*: Higher Education Studies, Vol. 4 (2). p.19-28.* doi:10.5539/hes.v4n2p19

Heemskerk, I., Dam, G., Volman, M., & Admiraal, W. (2009). Gender inclusiveness in educational technology and learning experiences of girls and boys. *Journal of Research of Technology in Education*, 41, p.253-276.

Hibbert, K. (2016, June 29). *Exam to replace GSAT pushed back to 2018*, retrieved from

http://www.jamaicaobserver.com/news/Exam-to-replace-GSAT-pushed-back-to-2018_65354

Hieftje, K., Pendergrass, T., Kyriakides, T.C., Gilliam, W. & Fiellin, L. (2017, June 1). An evaluation of an educational video game on mathematics achievement in first grade students. *Journal of Technologies*, Vol. 5(30). doi:10.3390/technologies5020030

Higgins, K., Huscroft-D-Angelo, J. & Crawford, L. (2017, December 28). Effects of technology in mathematics achievement, motivation, and attitude: A meta-analysis. *SAGE Journals*. Doi- https://doi.org/10.1177/0735633117748416

Hill, K. (2015, August 14). Gamification for education, *Jamaica Gleaner*, retrieved from http://jamaica-gleaner.com/article/news/20150814/gamification-education

Hodges, G, A., Feng, G., and Pan, X. (2015, May 18). Tablet-based math assessment: What can we learn from math apps? *Journal of Educational Technology & Society*, Vol. 18, No.2, p.3-20

Hudson, S., Kadan, S., Lavin, K., Vasquez, T. (2010). *Improving basic math skills using technology*, Saint Xavier University, Chicago, Illinois.

International Mathematical Union. (2014). *Mathematics in Latin America and the Caribbean: Challenges and opportunities,* (IMU CDC LAC Report), Retrieved from http://www.mathunion.org/fileadmin/CDC/cdcuploads/CDC_MENAO/Mathematics_in_Latin_America_and_the_Caribbean.Report.pdf

Johnson, L., Becker, S., Estrada, V., & Freeman, A. (2014). Games and gamification: Time-to-adoption horizon: Two to three years, *NMC Horizon Report*: 2014

Higher Education Edition. Austin, Texas: The New Media Consortium.

Johnson, B. & Christensen, L. (2014). *Educational research: Quantitative, qualitative and mixed approaches*, (5th ed.) SAGE Publications.

Kachepa, A.& Jere, N. (2014). Implementation of mobile games for mathematics learning: A case of Namibian schools, *International Journal of Scientific Knowledge, Vol.5, No5*. p. 6- 16.

Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. New York: Pfieffer. https://doi.org/10.1145/2207270.2211316

Kappers, W. (2009). Educational video game effects upon mathematics achievement and motivation scores: An experimental study examining differences between sexes (*Doctoral Dissertation*), Identifier CFE0002586, retrieved from http://etd.fcla.edu/CF/CFE0002586/Kappers_Wendi_M_200905_PhD.pdf

Katmada, A., Mavridis, A.& Tsiatsos,T. (2014). Implementing a game for supporting learning in mathematics. *The Electronic Journal of e-Learning* Vol,12, issue 3 (p.230-242).

Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. *Handbook of Research on Effective Electronic Gaming in Education* (pp. 1–32). London: IGI Global. Retrieved from http://www.irma-international.org/viewtitle/49470/

Kebritchi, M. Hirumi, A. & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education*. Vol 55 (2). p. 427-443.

Keegan, D. (1995). *Distance education technology for the new millennium: Compressed video teachi*ng. ZIFF Papiere IO 1. ERIC, ED 3 89-93 1.

Kelly, K. McCain, T. & Jukes, I. (2012). Teaching the digital generation: No more cookie-cutter high schools. Thousand Oaks, CA: Corwin Press.

Kim, A. J. (2011, February 10). Gamification 101: Designing the player journey. *Slideshare*, Web. 23.

Kim, S. & Chang, M. (2010). Computer games for the math achievement of diverse Students. *Educational Technology & Society*, 13 (3), p.224-232, retrieved from http://www.ifets.info/journals/13_3/20.pdf

Kozma, R. B. (1994). *Will media influence learning? Reframing the debate. Educational Technology Research & Development*, 42(2), p.7-19. Retrieved February 15, 2006, from http://mmtserver.mmt.duq.edu/mm416-01/gedit704/articles/kozmaArticle.htm

Ku, O., Chen, S., Wu, D., Lao, A. & Chan, T. (2014). The effects of game-based learning on mathematical confidence and performance: High ability vs. low ability. *Educational Technology & Society*, 17 (3), p.65-78

Kumar, J. (2013*). Gamification at work: Designing engaging business software*. In: Marcus, A. (Eds.) Design, user experience, and usability: Health, learning, playing, cultural, and cross-cultural user-experience. HC12013 International. Springer Publications.

Lameras, P. & Moumoutzis, N. (2016). Towards the gamification of inquiry-

based flipped teaching of mathematics: A conceptual analysis and framework. *International Conference on Interactive Mobile Communication Technologies and Learning* (IMCL). p. 343-347.

DOI: 10.1109/IMCTL.2015.7359616

Landers, R.N., Armstrong, M.B. & Collmus, A.B. (2017). How to use game elements to enhance learning: Applications of the theory of gamified learning In Ma., M. & Oikonomou, A. (Eds.), *Serious Games and Edutainment Applications: Volume II,* Springer International Publishing.

DOI: 10.1007/978-3-319-51645-5_21

Lee, A. (2012). The effects of computer-based learning activities and school contextual factors on student math achievement. *Leadership and Policy Quarterly*, 1, p.58–72.

Leroy, C., & Symes, B. (2001). Teachers' perspectives on the family backgrounds of children at risk. *McGill Journal of Education*, 36(1).p. 45-60. Retrieved from WilsonWeb database.

Marczewski, A. (2013). *Gamification: A simple introduction and a bit more* (1st ed.). E-Book, ISBN; 978-1-4717-9866-5, Kindle edition.

Mayadas, F., Miller G. & Sener, J. (2015). *Updated e-Learning definitions*, blog, retrieved from http://onlinelearningconsortium.org/updated-e-learning-definitions-2/

Mayer, R. E. (2014*). Computer games for learning: An evidence-based approach*. Cambridge, MA: MIT Press.

McGonigal, J. (2011*). Reality is broken.* Why games make us better and how they can

change the world. The Penguin Press. New York.

Mckoy, M. & Anderson-Chung, S. (2016). Back in the game: Using gamification as an engagement tool with spanish language learners at UTech, Jamaica. *The Journal of Arts, Science and Technology*, Vol. 9, p. 124-130.

Mekler, E., Bruhlmann, F., Opwis, K., & Tuch, A. (2013). *Disassembling gamification: The effects of points and meaning on user motivation and performance.* Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI EA'13), 1137-1142. doi:10.1145/2468356.2468559

Miller, D.J., & Robertson, D.P. (2011, August 15). Educational benefits of using game consoles in a primary classroom: A randomized controlled trial: *British Journal of Educational Technology*, Vol. 42, No. 5, p. 850-864, doi:10.1111/j.1467-8535.2010.01114.x

Ministry of Education, Jamaica. (2016). *Grade six achievement test (GSAT).* 2015 Preliminary Report retrieved from http://www.japarliament.gov.jm/attachments/article/1504/1504_2015%20Ministry%20Paper%20102.pdf

NBER. (2017). Difference in difference estimation: What's new in econometrics? *Inbens/Woolridge, Lecture Notes*, 10, Summer 2017 retrieved from http://www.nber.org/WNE/lect_10_diffindiffs.pdf

Nicholson, S. (2014). A user-centered theoretical framework for meaningful gamification. Paper presented at Games+Learning+Society 8.0, Madison, WI.

OECD. (2010). *Are new millennium learners making the grade*? Technology use and educational performance in PISA.

Papp, T. A. (2017). Gamification effects on motivation and learning: Application to primary and college students. *International Journal for Cross-Disciplinary Subjects in Education (IJCDSE).* Vol. 8(3)

Parker, J. (2012). Understanding youth and digital media from Lynn Schrum (Eds.) *Educational technology for school leaders* (pp.79-92); Corwin, A SAGE Company, Thousand Oaks, California

Perreaud, R. (2015). Solving the achievement gap in mathematics: It's not just a numbers game*: Education Masters,* Paper 300, St. John Fisher College Digital Publications.

Plass, J.L., Homer, B. D. & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist.* 50 (4). Pp.258-283. Routledge, Taylor & Francis. American Psychological Association. DOI: 10.1080/00461520.2015.1122533

Ross, S. M., Morrison, G. R., & Lowther, D. L. (2010). Educational technology research past and present: Balancing rigor and relevance to impact school learning. *Contemporary Educational Technology*, 1(1), 17-35.

Rossman, G.B. & Rallis, S.F. (2003). *Learning in the field: An introduction to qualitative research* (2nd edition). Thousand Oaks, CA: SAGE. Pp. 31-60

Rouse, K.E. (2013). Gamification in science education: The relationship of educational games to motivation and achievement. (*Doctoral Dissertations*). ProQuest Dissertations and Theses Database (AAT 3569748), Volume: 74-09(E).

Ryan, R. & Deci, L. E. (2017a). *Self-determination theory: Basic psychological needs in motivation, development and wellness*. Guilford Press.

Ryan, R. & Deci, L. E. (2000b). Self-determination theory and the facilitation of

intrinsic motivation, social development, and well-being. *American Psychologist,* 55, p.68-78 doi:10.1037//0003-066X.55.1.68

Şahin, M., & Namli, N. (2016). Gamification and effects on student's science lesson Achievement: *International Journal on New Trends in Education & Their Implications (IJONTE)*, 7(1), p. 41.

Sailer, M., Hense, Jan. U., Mayr, S.K. & Mandl, H. (2017, April 1). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior,* Vol. 69 p. 371-380

DOI- https://doi.org/10.1016/j.chb.2016.12.033

Sandusky, S. (2015). *Gamification in education*. University of Arizona, retrieved from http://arizona.openrepository.com/arizona/handle/10150/556222

Saunders, A. (2011, October 27). CSEC students get help in mathematics, JIS Jamaica, retrieved from http://jis.gov.jm/csec-students-get-help-in-mathematics/

Scepanovic, S., Zaric, N. & Matijevic, T. (2015, September 25*). Gamification in higher education learning-state of the art, challenges and opportunities.* Paper presented at the sixth international conference on e-Learning (e-Learning), p. 24-25, Belgrade, Serbia.

Schaaf, R. L. & Mohan, N. (2014). M*aking school a game worth playing: Digital games in the classroom.* Corwin Press.

Shin, N., Norris, C., & Soloway, E. (2006). Effects of handheld games on students

learning in mathematics, published in *International Society of the Learning Sciences, Proceedings of the 7th International Conference on Learning Sciences* (Vol. 2. pp. 702-708)

Simonson, M. R. Smaldino, S.E, Albright, M. & Zvacek, S. (2012). *Teaching and learning at a distance: Distance education foundations.* 5th. Pearson Publications

Smith-Edwards, A. (2016, June 15), Students shine in GSAT, *Jamaica Information Service*, Retrieved from http://jis.gov.jm/students-shine-gsat/

Stone, J., & Hamann, E. T., (2012). Improving elementary American Indian student math achievement with inquiry-based mathematics and games, *Journal of American Indian Education; 51 (1): p.45-66.*

Sung, Y., Chang, K., & Liu, T. (2015). The effects of integrating mobile devices with teaching and learning on students' learning performance. A meta-analysis and research synthesis. *Computers and Education Journal* Vol. 94, (p. 252-275), retrieved from http://www.sciencedirect.com/science/article/pii/S0360131515300804

Swaby, G. (2017, March 2). *Gamification: A tool for lifelong learning* (blog) posted to https://blog.edufocal.com/

Swaby, G. (2016, November 2). *Comparing learning in the 21st century: Edufocal vs traditional learning* (blog) posted to https://blog.edufocal.com/

Thompson, K. (2017, June 9). GSAT scores up. *Jamaica Observer, P. 6*

Tiedemann, J. (2000). Parents' gender stereotypes and teachers' beliefs as predictors of children's concept of their mathematical ability in elementary school. *Journal of Educational Psychology*, 92, 144-151.

Turgut, S. & Temur, O.D. (2017, October 20). The effect of game-assisted mathematics education on academic achievement in Turkey: A meta-analysis study. *International Electronic Journal of Elementary Education.* Vol. 10(2). DOI: 10.26822/iejee.2017236115

Vandercruysse, S., ter Vrugte, J., de Jong, T., Wouters, P. van Oostendorp, Verschaffel, L. & Elen, J. (2017, June 29). Content integration as a factor in math-game effectiveness. *Education Technology Research and Development* (2017). Vol 65 (5) p. 1345-1368. Doi- https://doi.org/10.1007/s11423-017-9530-5

Veltri, N.F., Krasnova, H., Baumann, A. & Kalayamthanam, N. (2014). Gender differences in online gaming: A literature review. *20th Americas Conference on Information Systems*, AMCIS 2014.

Viswanathan, P. (2016, November 02). *What is a mobile application*? (blog) Lifewire, Retrieved from https://www.lifewire.com/what-is-a-mobile-application-2373354

Wang, S. Y, Chang, S.C., Hwang, G.J. & Chen, P.Y. (2018). A microworld-based role-playing game development approach to engaging students in interactive, enjoyable, and effective mathematics learning. *Interactive Learning Environments*, Vol. 26 (3). p. 411-423.

Watson, C., L. (2015, May 8). The use of technology in secondary mathematics classrooms: The case of one school district: *Master's Theses*, Paper 111, University of Sothern Mississippi. Retrieved from http://aquila.usm.edu/masters_theses/111

Whitton, N. (2012). The place of game-based learning in an age of austerity.

Electronic Journal of e-Learning, 10(2), p.249-256.

Williams, M. (1993). A *study of the effects of a hypertext computer-assisted instruction in mathematics on the achievement levels of fifth-grade students (Doctoral* dissertation). Retrieved from NSUWorks, Center for Computer and Information Sciences. (921) .

Wilson, S. M. & Peterson, P. L. (2006). Theories of learning and leaching: What do they mean for educators? *National Education Association*. Washington, DC.

Appendix A
IRB Approval Letter

MEMORANDUM

To: **Janice Watson-Huggins**

From: **David B Ross, Ed.D,**
Center Representative, Institutional Review Board

Date: **September 9, 2017**

Re: **IRB #: 2017-535; Title, "An Experimental Study on the Effects of a Gamified Software Intervention in Mathematics Achievement Among Sixth Grade Students"**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt Category 1)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and David B Ross, Ed.D, respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: William Edmonds
Ashley Russom, Ed.D.

Appendix B
Survey-Experimental Group ONLY

TO PARTICIPANT:

- I am a student at the Nova Southeastern University reading for the Doctor of Education Degree in Instructional Technology and Distance Education.
- I am conducting a survey on using technology and games to improve student Math scores and motivation to learn Mathematics.
- This questionnaire, in part, will contribute to the completion of this degree.
- I kindly ask you to spend a few minutes to respond to the attached questions.
- All answers will be held in the strictest confidence, and you are not required to give your name.

PLEASE TICK OR HIGHLIGHT THE APPROPRIATE ANSWER

Demographic Questions

1. What is your Gender?
   Male (1) Female (2)

2. Do you enjoy playing games on edufocal?
   Yes, No

3. Which parts of the game did you enjoy most?

   ……

4. What part of the game did you dislike the most?

a) Design
b) Feedback
c) Rules
d) Dynamics
e) Other……

5. The scale below is asking your views about Mathematics. Please tick the appropriate response below based on the key provided
   0-strongly disagree
   1-disagree
   2-neutral/undecided
   3-Agree
   4. Strongly agree

	Math Motivation scale	**Strongly disagree**	**disagree**	**neutral**	**agree**	**Strongly agree**
a	Knowing Math will help me later in my career					
b	I get bored in Math's class					
c	I am not afraid to answer questions in Math class					
d	I get annoyed in Math's class					
e	Math is an easy subject for me					
f	Taking Math is a waste of my time					
g	I study Math because I have to					
h	I am motivated to learn Math					
i	I like to share my answers to Math problems with my peers					
j	Mathematics interests me					
k	When I see a Math problem, I get nervous					
l	I am eager to participate in discussions that involve Mathematics					
m	Math's tests are usually difficult to me					
n	I feel confident in my ability to solve math problems					
o	I am sure I can learn Math					
p	I practice topics I learn in Math class at home					
q	When I am not sure, I ask for help when doing math					
r	I do not perform well in Math					
S	I am motivated when I solve a Math problem on my own					
t	The Math teacher encourages me to learn					
u	I want to perform well in math					
v	Math is my worst subject					
w	I can get good grades in Math					
x	I like being able to explore Math					

	problems rather than just sit and listen about how to do math problems					
y	Math is the hardest subject to take					
z	I am not good at Math					
aa	I love Math					

6. **The scale below is to be used with the experimental group ONLY to ask about your opinion on using technology to learn Math after the experiment.**
   0-strongly disagree
   1-disagree
   2-neutral/undecided
   3-Agree
   4. Strongly agree
   Please tick the appropriate response below based on the key provided

	Technology attitude scale	**Strongly disagree**	**disagree**	**neutral**	**agree**	**Strongly agree**
a	In the past, I have not enjoyed Math class until using edufocal					
b	I receive good grades on Math test and quizzes in edufocal					
c	I am not comfortable using technology to learn Math					
d	I prefer the traditional method of learning Math					
e	Using games has encouraged me to do Math					
f	Maths tests are usually difficult to me					
g	I am eager to participate in discussions that involve Mathematics after using Edufocal					
h	I feel confident in my ability to solve Math problems					
i	I practice topics I learn in Math class at home					
j	I am motivated when I solve a Math problem on my own					
k	Games has helped me to perform better in Math					
l	Math is my worst subject					
m	I think my focus has improved					

	through learning with technology					
n	I enjoy using the computer when learning Math					
o	I enjoy using Edufocal software to learn Math					
p	Using Edufocal has increased my motivation in learning Math					
q	Using Edufocal software allowed me to perform better in Math					
r	I love Math					
s	When using technology for learning Mathematics, I feel like I am in my own private world					
t	Since using Edufocal gaming, my Math scores has increased tremendously					
u	Technology has made Math easier to understand					
v	I am motivated to learn Math					
w	I am more comfortable using technology to improve my Math grades					

Appendix C
Survey-Control Group

TO PARTICIPANT:

- I am a student at the Nova Southeastern University reading for the Doctor of Education Degree in Instructional Technology and Distance Education.
- I am conducting a survey on using technology and games to improve student Math scores and motivation to learn Mathematics.
- This questionnaire, in part, will contribute to the completion of this degree.
- I kindly ask you to spend a few minutes to respond to the attached questions.
- All answers will be held in the strictest confidence, and you are not required to give your name.

PLEASE TICK OR HIGHLIGHT THE APPROPRIATE ANSWER

Demographic questions

1. What is your Gender?
   Male (1) Female (2)

2. The scale below is asking your views about Mathematics. Please tick the appropriate response below based on the key provided
   0-strongly disagree
   1-disagree
   2-neutral/undecided
   3-Agree
   4. Strongly agree

	Math Motivation scale	**Strongly disagree**	**disagree**	**neutral**	**agree**	**Strongly agree**
	Knowing math will help me later in my career					
	I get bored in Math's class					
	I am not afraid to answer questions in Math class					
	I get annoyed in Math's class					
	Math is an easy subject for me					

	Taking math is a waste of my time					
	I study math because I have to					
	I am motivated to learn math					
	I like to share my answers to math problems with my peers					
	Mathematics interests me					
	When I see a math problem, I get nervous					
	I am eager to participate in discussions that involve mathematics					
	Math's tests are usually difficult to me					
	I feel confident in my ability to solve math problems					
	I am sure I can learn math					
	I practice topics I learn in Math class at home					
	When I am not sure, I ask for help when doing math					
	I do not perform well in math					
	I am motivated when I solve a Math problem on my own					
	The math teacher encourages me to learn					
	I want to perform well in math					
	Math is my worst subject					
	I can get good grades in math					
	I like being able to explore math problems rather than just sit and listen about how to do math problems					
	Math is the hardest subject to take					
	I am not good at math					
	I love Math					

Appendix D
Child Assent Form

Assent Form for Participation in the Research Study Entitled; *The Effects of a Gamified Software Intervention in Mathematics Achievement*

Funding Source: None.

IRB approval # (Generated by IRB)

Principal investigator(s):
Janice Watson-Huggins
XXXXXXXXXXXXXX
XXXXXXXXXXX
XXXXXXXXXX
XXXXXXXXX

Co-investigator(s):
Dr. William Edmonds
c/o Ashley Russom, EdD
Fischler College of Education
3301 College Avenue
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Institutional Review Board
Nova Southeastern University
Office of Grants and Contracts
(954) 262-5369/Toll Free: 866-499-0790
IRB@nsu.nova.edu

What is a research study?
A research study is when someone collects information on a topic that they are interested in.

Why is this study being done?
This study is being done to find out if using edufocal and other gaming systems can improve the math scores for grade six students and also to improve your motivation towards learning mathematics.

What will happen to me?
You will be asked to complete a brief 10-minute questionnaire, one at the beginning of the term and one at the end of the term when you have completed the Grade Six Achievement (GSAT)exam. You will be given a login and access to go to the computer lab and sign in to edufocal and talk to your peers while playing games and watching videos.

What are the good things about being in the study?
There are no direct benefits to you for participating in this study. The good thing about this study is that if it shows that your attitude towards math changes, we can consider using edufocal game again next year and including it as part of the

school syllabus.

Will being in the study hurt me?

There is no harm for you participating in this study because no name or other identification will be shared with anyone. You will not be asked any personal questions.
Also, you will not benefit from being in this study. We don't think you will be hurt by helping with this study.

How long will I be in the study?

This study will take two terms. You do not need to do anything specific other than attend regular math classes and use edufocal software in the lab during lab time and at home. The surveys take no more than 10 minutes to complete each.

Do I have other choices?

You have the right to withdraw from participation at any time during the study. If you experience any uncomfortable feeling while in the study, please let us know.

Will people know that I am in the study?

We will take great care to eliminate and reduce any one knowing that you are a part of the study. Only the researcher, your parents and teachers should be aware. Anything you tell us or do for us might be found out by someone else, but we will do everything we can to keep it secret.

Whom should I ask if I have questions?

If you have any questions about this research and your rights to participate, please feel free to contact me via email at **jw1096@mynsu.nova.edu** or by cellphone at XXXXXXXXXX. You can also contact your parents/guardian or your teacher if you have any questions.

Is it OK if I say "No, I don't want to be in the study"?

You do not have to be a part of this study if you don't want to. No one will be mad or upset. If you change your mind, you can decide during the study to stop being in the study.

Do you understand and do you want to be in the study?

I understand. All my questions were answered.

- ❑ I want to be in the study.
- ❑ I don't want to be in the study.

_____

Your name

_____ _____

Your signature Date

_____ _____

Signature of person explaining the study Date

Appendix E
Permission Letter

Consent Form for Participation in the Research Study Entitled
The Effects of a Gamified Software Intervention in Mathematics Achievement among sixth grade students

Funding Source: None.

IRB protocol #

Principal investigator

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For questions/concerns about your research rights, contact:
Human Research Oversight Board (Institutional Review Board or IRB)
Nova Southeastern University
(954) 262-5369/Toll Free: 866-499-0790
IRB@nova.edu

Site Information
Nova Southeastern University
Fischler College of Education
3301 College Avenue
Fort Lauderdale, FL 33314

What is the study about?
My name is Janice Watson-Huggins, a Doctoral student at Nova Southeastern University. I am conducting my field research to find out the effects of a gamified software intervention in mathematics achievement among sixth grade students in an inner-city elementary/ secondary school. The selected site is the **Lane Mout Primary School. This study is a partial fulfilment for my Doctor of Education in Instructional Technology and Distance Education degree. I will deeply appreciate your willingness to allow me to conduct this study at your institution. The final project should be completed by August 2018.

Why are you asking me?
I will deeply appreciate your willingness to allow me to use your institution to conduct this study. Math scores from two grade 6 classes will be collected to form the basis of this study. There will be between 20 to 25 participants in each class.
The focus of the survey will be on student's perceptions on using technology and games to teach mathematics.

What will I be doing if I agree to be in the study?

The student's will be involved in a brief 10-minute survey conducted by the researcher Miss Janice Watson. The final project should be completed by August 2018. The student's will not be asked any personal questions and all information received will remain anonymous and stored in a secure place. Each child/ward has the right to withdraw from participation at any time. You also have a right to confidentiality. No child's name or any personal identifying information will be shared. The survey should take no more than 15 minutes to complete. However, the collection of four separate math scores will be an ongoing process until the end of the study in August 2018.

Is there any audio or video recording?

No audio or video recording will be involved in this study.

What are the dangers to me?
Risks to each child is minimal. This means that we will take great care to eliminate and reduce any risk of harm that may arise from this study. If the student experiences any harm during the duration of the study, they are free to end participation, or they can make a formal complaint. No identifying information will be included on the instrument that can point to a specific student. The questionnaires will be numbered starting from the number one to keep track of all instruments that have been distributed and returned. These procedures will be followed to prevent unintended harm to others that can result in a loss of the data. Throughout the process, they will have the right to receive referrals and resources for dealing with any discomfort that may arise from the material being recorded. You may also contact the IRB at the numbers indicated above with questions about your research rights.

If you have any questions about this research or your child's rights to participate, please feel free to contact me via email at jw1096@mynsu.edu or by cellphone at XXXXXXXXX. You may also contact the IRB if you need further assistance.

Are there any benefits to me for taking part in this research study?
There are no direct benefits to each child for participating in this study. The information obtained from the research can be used to guide policymakers on how to improve math's scores in the future.
The area of gamification is under-researched in Jamaica and by extension the Caribbean. Therefore, this research promises insightful lessons for decision-making in the Jamaican education system. These lessons can also shed light on other cases of similar nature in other Caribbean education systems. The study can also be of benefit in providing recommendations in improving the ways that decisions are made as it relates to technology in the classroom.

Will I get paid for being in the study? Will it cost me anything?
There are no costs to you or payments made for participating in this study. You will also not be asked to pay any fees for your child to participate in the study.

How will you keep my information private?

The researcher will collect the math scores and store it in an encrypted Microsoft excel data file. The names of the students will not be used to store the scores. Each student will however be assigned a special number starting from one that only the researcher can identify. All information obtained in the study will be kept strictly confidential.

What if I do not want to participate or I want to leave the study?
Each child/ward have the right to leave this study at any time or refuse to participate. If any child decides to leave or decide not to participate, he/she will not experience any penalty. If a child withdraws, any information collected about your child **before** the date you decide to leave the study will be kept in the research records until the conclusion of the study and may be used as a part of the research.

Other Considerations:
If the researchers learn anything which might change your mind about being involved, you will be told of this information.

Voluntary Consent by Participant:
By signing below, you indicate that

- this study has been explained to you
- you have read this document, or it has been read to you
- your questions about this research study have been answered
- you have been told that you may ask the researchers any study related questions in the future or contact them in the event of a research-related injury
- you have been told that you may ask Institutional Review Board (IRB) personnel questions about your study rights
- you are entitled to a copy of this form after you have read and signed it

you voluntarily agree to participate in the study entitled; *The Effects of a Gamified Software Intervention in Mathematics Achievement among sixth grade students*

Participant's Signature: _____ Date: _____

Participant's Name: _____ Date: _____

Signature of Person Obtaining Consent: _____

Date: _____

Appendix F
GSAT Math Test

1. Which represents the expanded form of 5 439?
   - **A.** 9 000 + 300 + 40 + 5
   - **B.** 5 000 + 400 + 30 + 9
   - **C.** 500 + 400 + 30 + 9
   - **D.** 5 + 4 + 3 + 9

2. What is $\frac{83}{100}$ expressed as a decimal?
   - **A.** 8.3
   - **B.** 0.83
   - **C.** 0.083
   - **D.** 0.0083

3. What is the value of the digit **3** in the number 6 030 478?
   - **A.** three
   - **B.** thirty
   - **C.** three thousand
   - **D.** thirty thousand

Use the two sets listed below to answer items 4 and 5.

X = {2, 3, 5, 7}

Y = {1, 3, 5, 7, 9}

4. Which list of members represents the intersection of set **X** and set **Y**?
   - **A.** {1, 2, 3, 5, 7, 9}
   - **B.** {3, 5, 7}
   - **C.** {1, 2, 9}
   - **D.** { }

5. Which **best** describes the members of set **Y**?
   - **A.** Composite numbers less than 10
   - **B.** Even numbers less than 10
   - **C.** Odd numbers less than 10
   - **D.** Prime numbers less than 10

6. What is 12.78 rounded to the **nearest** whole number?
   - **A.** 10
   - **B.** 11
   - **C.** 12
   - **D.** 13

7. What is the total cost of the following items?

   1 loaf of bread — $306
   1 pack of sugar — $190.89
   1 dozen eggs — $298.13

   - **A.** $795.02
   - **B.** $684.92
   - **C.** $492.08
   - **D.** $489.02

8. What is the **lowest** common multiple of 4 and 5?
   - **A.** 10
   - **B.** 20
   - **C.** 30
   - **D.** 40

9. Which are the prime factors of 36?
   - **A.** 1, 2, 3, 4, 6, 9, 12, 18, 36
   - **B.** 2, 3, 6
   - **C.** 4, 9
   - **D.** 2, 3

10. Which number is **exactly** divisible by 4?
    - **A.** 134
    - **B.** 234
    - **C.** 344
    - **D.** 454

11. What fraction of the circle is shaded?

A. $\frac{3}{8}$
B. $\frac{3}{5}$
C. $\frac{1}{3}$
D. $\frac{5}{8}$

12. Which ratio is equivalent to 7 : 8?

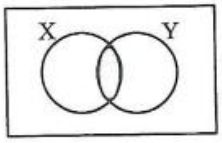
A. 14 : 24
B. 17 : 18
C. 21 : 24
D. 40 : 35

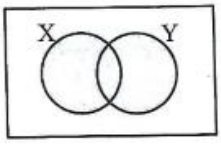
13. Calculate

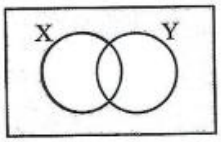
$$8\frac{3}{4} \div \frac{7}{8}$$

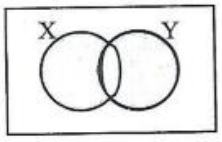
A. $\frac{32}{245}$
B. $\frac{1}{10}$
C. $\frac{245}{32}$
D. $\frac{10}{1}$

14. Which shaded area shows the **intersection** of sets X and Y only?

A. 

B. 

C. 

D. 

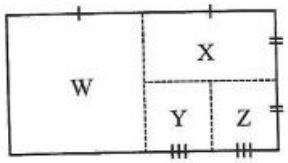
15. Three friends share $6 000 in the ratio 3 : 4 : 5. How much is the **largest** share?

A. $1 200
B. $1 500
C. $2 000
D. $2 500

16. John bought 5 cases of juice. There were 24 bottles of juice in each case. How many bottles of juice in all did John buy?

A. 19
B. 24
C. 29
D. 120

The diagram below represents the top view of a rectangular room. The room is divided into 4 sections. Use the diagram to answer item 17.



17. What fraction of the rectangular room is section Y?

A. $\frac{1}{8}$

B. $\frac{1}{4}$

C. $\frac{1}{3}$

D. $\frac{1}{2}$

18. Which value of $\square$ makes the following equation **true**?

$\square \div 3 = \square - 18$

A. 6
B. 15
C. 21
D. 27

The table below shows the distance four students travel to school daily. Use this table to answer item 19.

Name	Distance (km)
Nadine	$\frac{5}{6}$
Brad	$\frac{3}{4}$
Marlon	$\frac{7}{8}$
Ana	$\frac{2}{3}$

19. Who travels the farthest distance to school?

A. Ana
B. Brad
C. Marlon
D. Nadine

20. A drink is mixed using 120 ml syrup with 600 ml water. How much syrup is needed if 3 000 ml water will be used to mix the drink?

A. 480 ml
B. 600 ml
C. 720 ml
D. 2 520 ml

21. Pencils cost \$70 each. What is the **greatest** number of pencils Paul can buy from \$500?

A. 6
B. 7
C. 8
D. 9

22. One-quarter of a cake is shared equally among 6 persons. What fraction of the whole cake did each person receive?

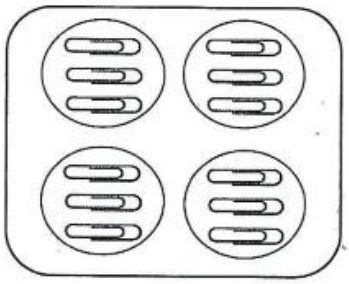
A. $\frac{1}{24}$

B. $\frac{1}{8}$

C. $\frac{1}{6}$

D. $\frac{1}{4}$

The diagram below shows sets of paper clips. Use it to answer item 23.



23. Which number sentence **best** represents the diagram shown?

A. $4 \times 3 = 12$

B. $4 + 4 + 4 = 12$

C. $12 \div 3 = 4$

D. $3 \times 3 \times 3 \times 3 = 12$

24. There are 200 children at a camp. 70% of them are boys. How many of the children are girls?

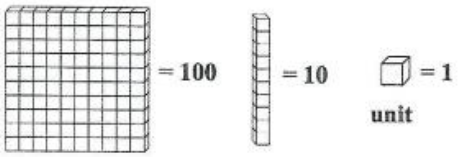
A. 140

B. 130

C. 60

D. 30

Use the models of some blocks shown below to answer item 25.



25. What number is represented by a set of blocks with **6 flats, 12 rods and 8 units?**

A. 6 128

B. 728

C. 708

D. 608

During a drought two towns received water from a water truck. Town P received water once every two days while Town S received water once every three days. Use the roster below to answer item 26.

	Town P	Town S
Day 1	✓	✓
Day 2	×	×
Day 3	✓	×
Day 4	×	✓
Day 5	✓	×
Day 6	×	×
Day 7	✓	✓
⋮		

Key: ✓ received water

X received **NO** water

26. When next will both communities receive water on the same day?

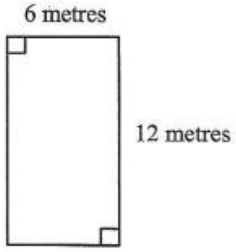
A. Day 11

B. Day 12

C. Day 13

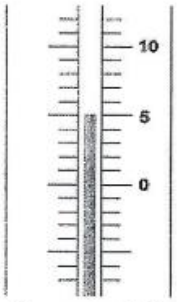
D. Day 14

27. What is the perimeter of the rectangle below?



A. 18 metres
B. 30 metres
C. 36 metres
D. 72 metres

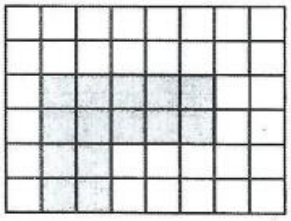
The diagram below shows part of a thermometer. Use it to answer item 28.



28. Which **best** represents the temperature reading shown on the thermometer?

A. 10 degrees above zero
B. 5 degrees above zero
C. zero degrees Celsius
D. 5 degrees below zero

The diagram below represents a grid divided into equal squares. The area of each square ☐ is 1 square metre. Use the diagram to answer item 29.



29. What is the area of the shaded area?

A. 14 square metres
B. 18 square metres
C. 20 square metres
D. 48 square metres

30. Which unit is used when measuring length?

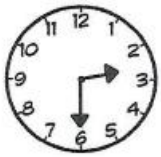
A. degrees
B. gram
C. litre
D. metre

31. Mike bought a watermelon weighing 3.5 kg. How many grams of watermelon does this represent?

A. 35
B. 350
C. 3 500
D. 35 000

32. Franco Primary School ends at 2:35 p.m. Which clock is showing the time Franco Primary School ends?

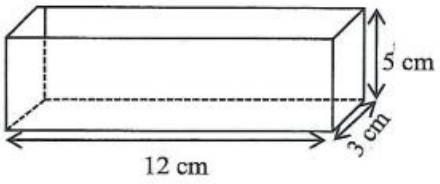
A. 

B. 

C. 

D. 

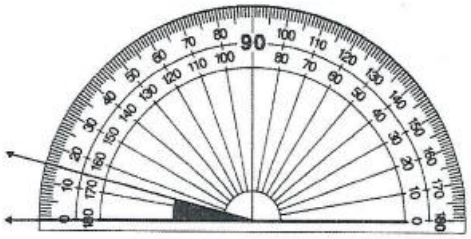
The diagram below (*not drawn to scale*) represents a rectangular box. Use it to answer item 33.



33. What is the volume of the rectangular box?

A. 20 cm^3
B. 36 cm^3
C. 60 cm^3
D. 180 cm^3

34. What is the size of the angle shown?



A. 175°
B. 165°
C. 25°
D. 15°

35. The perimeter of a square is 32 cm. What is the area of the same square?

A. 16 cm^2
B. 64 cm^2
C. 256 cm^2
D. 1 024 cm^2

36. A concert began at 6:30 p.m. and ended at 10:10 p.m. How long did the concert last?

A. 3 hours 20 minutes
B. 3 hours 40 minutes
C. 4 hours 20 minutes
D. 4 hours 40 minutes

37. On a map 1 cm represents 1 m. What is the relationship between the distance on the map and the actual distance?

The distance on the map is _____.

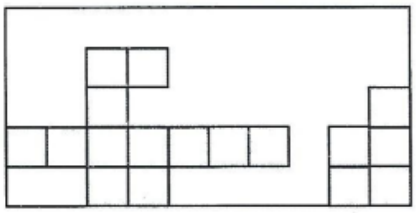
A. 1000 times the actual distance.

B. 100 times the actual distance.

C. $\frac{1}{100}$ of the actual distance.

D. $\frac{1}{1000}$ of the actual distance.

Square tiles of the same size are used to cover a rectangular floor area. The diagram below (*not drawn to scale*) represents the rectangular floor area and the tiles already used. Use this information to answer item 38.



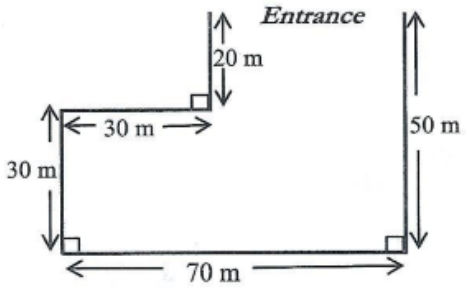
38. How many **more** tiles are needed to cover the entire rectangular floor area outlined?

A. 17
B. 33
C. 39
D. 50

39. Brenda drinks 4 200 millilitres of water every day. How much more would she have to drink to increase the amount to 6 litres?

A. 1 800 millilitres
B. 180 millilitres
C. 18 millilitres
D. 0.018 millilitres

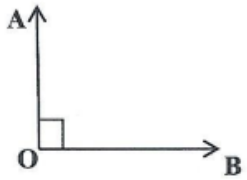
The diagram below (*not drawn to scale*) represents the layout of a playground. The boundary of the playground is shown. Use the diagram to answer item 40.



40. How wide is the entrance of the playground?

A. 200 m
B. 100 m
C. 70 m
D. 40 m

41. Which **best** describes OB?

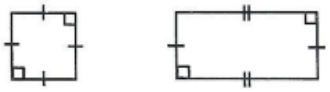


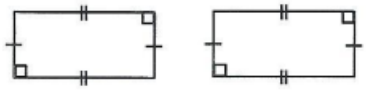
A. angle
B. line segment
C. point
D. ray

42. Which two shapes are congruent?

A. 

B. 

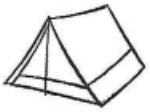
C. 

D. 

43. Which **best** represents a cylindrical object?

I

II



III

IV

A. I
B. II
C. III
D. IV

44. In which diagram is the shaded angle a reflex angle?

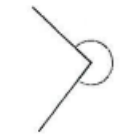


Diagram 1

Diagram 2

Diagram 3

Diagram 4

A. Diagram 1
B. Diagram 2
C. Diagram 3
D. Diagram 4

45. Which diagram shows the diameter of a circle with centre O?

A. 

B. 

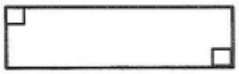
C. 

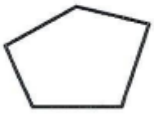
D. 

46. Which shape has two lines of symmetry?

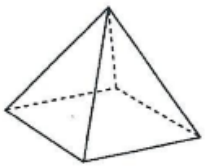
A. 

B. 

C. 

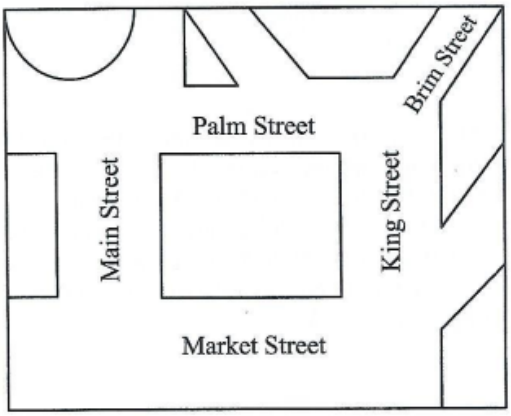
D. 

47. How many vertices does a square based pyramid have?



A. 1
B. 4
C. 5
D. 8

The diagram below represents the map of a small town. Use it to answer item 48.



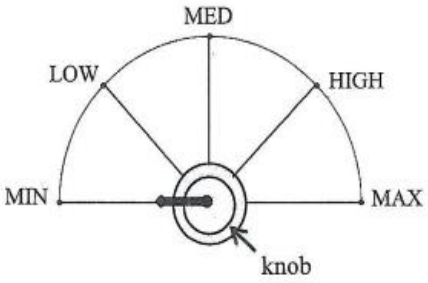
48. Which street is parallel to Main Street?
A. Brim Street
B. King Street
C. Market Street
D. Palm Street

49. Which geometric solid has **both** rectangular and triangular faces?
A. cube
B. cuboid
C. triangular pyramid
D. triangular prism

50. Which quadrilateral has all its sides equal in length, opposite sides parallel and two obtuse angles?
A. kite
B. rhombus
C. square
D. trapezium

51. Which would be the **most suitable** to use in making a circular wheel for a toy car?
A. cube
B. cylinder
C. square-based pyramid
D. triangular prism

The diagram below represents the volume control knob on a radio. The knob turns between the MIN and MAX positions, within the semicircle shown. The volume settings are equal distances apart on the semicircle. Use the diagram to answer items 52 and 53.



52. How many degrees does the knob turn as it moves from the **MIN** position to the **HIGH** position on the radio?
A. 45°
B. 90°
C. 135°
D. 180°

53. If the control knob is set at LOW and then turned approximately 90°, what position will it move to?
A. MIN
B. MED
C. HIGH
D. MAX

54. A triangle has one obtuse angle. The other two angles in the triangle must be _____ angles.
A. right
B. reflex
C. obtuse
D. acute

55. What is the value of $3 \times (4 + 8) \div 2$?
A. 10
B. 14
C. 18
D. 24

56. What value of x makes the number sentence below **true**?

$$6 + x = 72$$

A. 12
B. 66
C. 74
D. 78

57. Which symbol should be placed in the box to make the expression below **true**?

$$17 \times 3 \square 150 \div 3$$

A. $\leq$
B. $=$
C. $<$
D. $>$

58. For every girl in a grade six class there are 2 boys. How many boys are in the class if there is a total of 14 girls?
A. 7
B. 21
C. 28
D. 42

59. What is the value of the expression $3t + 2s$ when $t = 4$ and $s = 5$?
A. 59
B. 23
C. 22
D. 14

60. Which expression **best** represents the phrase below?

"5 less than the product of 2 and a number, n"

A. $5 - 2n$
B. $2n - 5$
C. $(2 + n) - 5$
D. $5 - (2 + n)$

A student entered a Math Marathon. The table below shows the number of math problems the student solved each hour. Use the table to answer items 61 and 62.

Hour (h)	Number of math problems solved each hour ($3h + 2$)
1st	5
2nd	8
3rd	11
4th	14
5th	
⋮	⋮
	26

61. How many math problems did the student solve in the 5th hour of the marathon?
A. 37
B. 19
C. 17
D. 15

62. During which hour would the student solve 26 problems?
A. 6th
B. 7th
C. 8th
D. 9th

A number pattern is shown below. Use it to answer item 63.

1st number	2nd number	3rd number	4th number	5th number
x	$x + 2$	$x + 4$	$x + 6$	?

63. What is the 5th number in the pattern if $x = 3$?
A. 8
B. 10
C. 11
D. 15

Use the set of numbers below to answer items 64 and 65.

40, 32, 70, 68, 55, 32, 50

64. What is the mode of the set of numbers?
A. 70
B. 68
C. 50
D. 32

65. What is the median of the set of numbers?
A. 70
B. 68
C. 50
D. 32

The pictograph below shows the number of trees recorded in various towns in 2010. Use it to answer items 66 and 67.

Name of Town	Number of Trees
Newton	🌲🌲🌲🌲🌲
Orange Town	🌲🌲🌲
Farmville	🌲
Silton	🌲🌲🌲🌲🌲🌲
Eastport	🌲🌲🌲

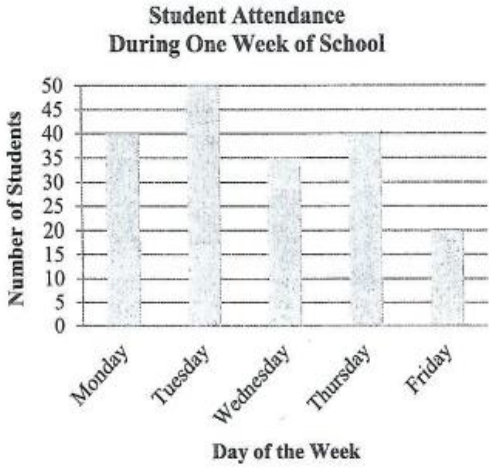
🌲 represents 10 000 trees

🌲 represents 5 000 trees

66. How many trees were recorded in Newton in 2010?
   A. 4.5
   B. 45
   C. 4 500
   D. 45 000

67. Scientists say that the more trees a town has, the more rainfall it experiences. Which town was expected to experience the **most** rainfall in 2010?
   A. Farmville
   B. Orange Town
   C. Silton
   D. Eastport

There are 50 students in a class. The bar graph below shows the number of students who attended school daily during one week. Use it to answer items 68 – 70.



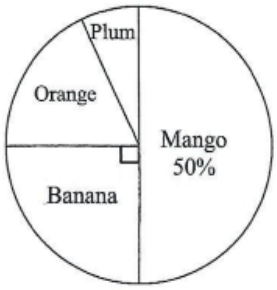
68. How many students attended school on Tuesday?
   A. 20
   B. 35
   C. 40
   D. 50

69. How many days during the week did less than 40 students attend school?
   A. 1
   B. 2
   C. 3
   D. 4

70. The class teacher took 10 electronic tablets to class. Students were placed in groups of 5. After giving each group a tablet, she was left with 3. On which day was this activity done?
   A. Monday
   B. Tuesday
   C. Wednesday
   D. Friday

A teacher recorded the favourite fruit of each student in his class. Each student chose one fruit. The pie chart below shows the results. Use it to answer items 71 – 73.

Students' Favourite Fruits

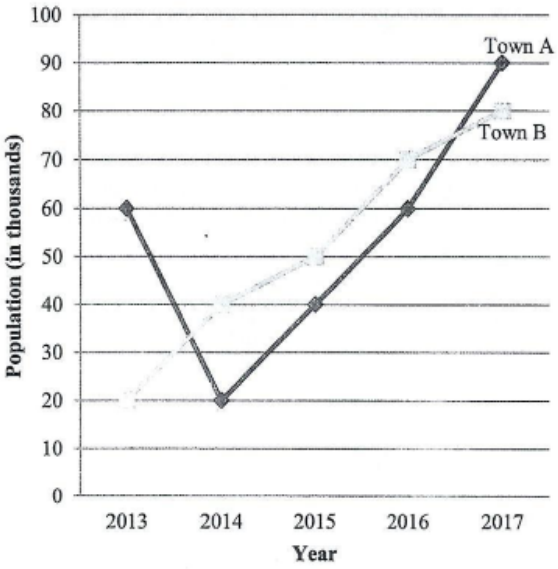


71. Which fruit is **least** preferred by the students in the class?
   A. Banana
   B. Orange
   C. Mango
   D. Plum

72. What percentage of students prefer bananas?
   A. 25%
   B. 50%
   C. 75%
   D. 90%

73. What is the total number of students in the class if 20 of them chose mango as their favourite fruit?
   A. 10
   B. 40
   C. 100
   D. 180

The line graph below shows the population of two towns over a five year period. Use it to answer items 74 and 75.



74. In which year was the population in Town B the **lowest**?
   A. 2013
   B. 2014
   C. 2016
   D. 2017

75. Which town and period of time **best** associates with the statement below?

   "Large groups of people left the town due to hurricane damage."

   A. Town A between 2013 and 2014.
   B. Town A between 2016 and 2017.
   C. Town B between 2014 and 2015.
   D. Town B between 2015 and 2016.

76. Which set of tally marks represents the number 16?

A. 𝍸 |

B. | 𝍸 |

C. 𝍸 𝍸 |

D. 𝍸 𝍸 𝍸 |

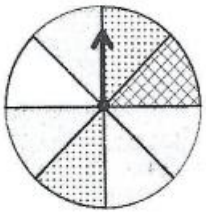
77. How many possible outcomes are there when a regular die is rolled once?

A. 1
B. 2
C. 4
D. 6

78. Which of the following values **CANNOT** be the probability of an event?

A. $\frac{3}{5}$
B. 0.2
C. $\frac{24}{25}$
D. 1.04

The diagram below shows a spinner divided into eight equal sectors. Use it to answer items 79 and 80.



79. What is the probability that when the pointer is randomly turned it will land on the sector shaded ?

A. $\frac{1}{8}$
B. $\frac{1}{4}$
C. $\frac{1}{2}$
D. 1

80. What is the likelihood that when the pointer is randomly turned it will land on ☒ ?

A. Certain
B. Very likely
C. Not likely
D. Impossible

Appendix G
Screenshot From Software Dashboard

LANGUAGE ARTS : GSAT

SCORE ACHIEVED		
AVERAGE	HIGHEST	LOWEST
55%	96%	0%

TESTS TAKEN
60 tests

TIME PER TEST		
AVERAGE	FASTEST	SLOWEST
3 mins	1 mins	72 mins

Show Details

MATHEMATICS : GSAT

SCORE ACHIEVED		
AVERAGE	HIGHEST	LOWEST
53%	90%	0%

TESTS TAKEN
42 tests

TIME PER TEST		
AVERAGE	FASTEST	SLOWEST
6 mins	1 mins	720 mins

Hide Details

TOPICS	SCORES			TIME TAKEN			TESTS
	AVERAGE	HIGHEST	LOWEST	AVERAGE	FASTEST	SLOWEST	
Numbers	55%	90%	0%	8 mins	1 mins	13 mins	8
Measurement	55%	80%	30%	8 mins	5 mins	15 mins	17
Geometry	54%	80%	25%	6 mins	4 mins	720 mins	7
Algebra	47%	70%	0%	6 mins	2 mins	12 mins	7
Probability	47%	50%	45%	8 mins	5 mins	8 mins	2
Statistics	38%	38%	38%	5 mins	5 mins	5 mins	1