Journal of Education and Human Development
December 2023, Vol. 12, No. 2, pp. 32-45
ISSN: 2334-296X (Print), 2334-2978 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jehd.v12n2a4
URL: https://doi.org/10.15640/jehd.v12n2a4

Enhancing Mathematical Performance in Primary School Boys: The Role of the Mathific Learning Platform

Roland Birbal[1] (PhD), Nazreen Mohammed[2], Mala Ramdass[3] (PhD) & Gail Joseph-Alleyne[4]

Abstract

In Trinidad and Tobago, a study was conducted to explore the effects of the Mathific Mathematics Learning Platform on primary school boys' performance and attitudes in Mathematics. The research, carried out in an all-boys primary school, utilized a mixed methods approach. The experimental group engaged with Mathific daily, while the control group received traditional instruction over ten weeks. Pre- and post-quizzes assessed Math proficiency, and questionnaires and focus group interviews gauged attitude and motivation changes. The results indicated that Mathific did not significantly impact academic performance. However, it positively influenced boys' attitudes and motivation towards Mathematics. Teachers believed that the software had the potential to enhance academic performance by improving students' overall engagement with the subject. This study sheds light on the importance of educational technology in shaping students' attitudes and motivations in Mathematics, even though it did not lead to significant academic improvements.

Key words - Mathific, Academic performance, Student Attitudes, Motivation, Mathematical Proficiency

1. Background

The educational performance of boys in Trinidad and Tobago schools is a pressing concern. A recent report by the Ministry of Education of Trinidad and Tobago in 2020, titled "Male Academic Performance in Public Primary and Secondary Schools," (Office of the Parliament, 2020) found that:

- Males had a higher dropout rate in both public primary and secondary schools.
- From 2009 to 2016, females outperformed males in the National Test. Male performance in Mathematics, was around 7% lower than females for both Standards one and three.
- From 2009 to 2019, females outperformed males academically in the SEA examination. Moreover, males constituted about 70% of those scoring below 30% and only 41% of those scoring above 75%.
  Additional statistics from the Sixteenth Report of the Joint Select Committee published in 2020 also highlighted a significant performance difference between boys and girls in Standard three from 2009 to 2016. The report examined the percentage of male and female students scoring below the Lowest Benchmark-Standard Three National Test Mathematics (Office of the Parliament, 2020), with the exception of the year 2012. The report found that males were performing way below girls in the areas of Mathematics and English. Consequently, male underachievement and school dropout rates have become underlying issues (Office of the Parliament, 2020).

2. Purpose of the Study

The primary purpose of this study was to assess the impact of Mathific instructional software on enhancing mathematical abilities, attitudes, and motivations among male students. Combining quantitative and

[1] University of Trinidad and Tobago, Point Lisas Campus, 91-101 Esperanza Road, Brechin Castle, Couva, 540517
E-mail: roland.birbal@utt.edu.tt, Tel: 1-868-779-9475
[2] University of Trinidad and Tobago, Point Lisas Campus, 91-101 Esperanza Road, Brechin Castle, Couva, 540517E-mail: nazreen.mohammed047@we.utt.edu.tt, Tel: 1-416-258-8215
[3] University of Trinidad and Tobago, Point Lisas Campus, 91-101 Esperanza Road, Brechin Castle, Couva, 540517, E-mail: mala.ramdass@utt.edu.tt, Tel: 1-868- 712-8718
[4] University of Trinidad and Tobago, Point Lisas Campus, 91-101 Esperanza Road, Brechin Castle, Couva, 540517, Tel: 1-868-642-8888 Ext-29145

qualitative research methods, the study aimed to discern the effectiveness of Mathific in comparison to traditional teaching methods within two Standard 3 classes.

3. Significance of the Study

The significance of this study lies in its contribution to the expanding body of research surrounding the integration of teaching and learning software in educational settings. Understanding the potential of Mathematics educational software to transform students' attitudes, motivation, and performance in mathematics is paramount in the current educational setting. Positive outcomes from this research could manifest as heightened mathematical proficiency among male students, translating into improved exam scores and reduced underachievement rates. Bridging the gender gap in academic performance holds the promise of decreasing dropout rates among boys in primary and secondary schools, thereby mitigating gender disparities in education.

Moreover, this study has broader implications—it could act as a catalyst for the widespread adoption of educational technology across various subjects, reshaping the way students engage with learning materials. Ignoring the gender-based disparities in educational outcomes may lead to detrimental consequences for male students, affecting their future academic pursuits, higher education participation, and employment prospects. Furthermore, the link between poor academic performance and delinquency underscores the urgency of addressing these disparities, as research consistently demonstrates that students with low academic achievement are more susceptible to engaging in delinquent behavior. By delving into the effects of Mathematics educational software, this study not only addresses immediate educational concerns but also contributes to the broader social objective of fostering a more equitable and supportive learning environment for all students.

4. Research Questions

The research sought to address the following questions:

1. How does the use of a Mathematics educational software affect the academic performance of primary school boys in Mathematics?
2. What effect does a Mathematics educational software have on students' attitudes and motivation towards Mathematics?
3. What are the teacher's views of using educational software in the teaching and learning of Mathematics?

5. Literature Review

Students' attitudes towards Mathematics have attracted considerable attention. Jiawen et al. (2020) defined attitude as students' feelings and emotions towards math, their engagement in math tasks, confidence in their abilities, and the perceived value of Mathematics. Negative attitudes towards math can lead to anxiety, disengagement, and poor performance. Vankúš (2021) reviewed research on the effects of game-based learning software in Mathematics education, indicating that it positively influenced students' motivation, engagement, attitudes, enjoyment, and attention. Computer-based educational games have the potential to improve attitudes towards math, as they are perceived as enjoyable and provide immediate feedback (Jiawen et al., 2020; Vankúš, 2021). However, some studies highlight limitations in research instruments, game design, and study conditions that may affect outcomes (Vankúš, 2021).

Constructivist learning approaches, including game-based learning, are encouraged in Scottish schools (Abdul Razak& Connolly, 2013). Game-based learning can increase motivation, engagement, strategic thinking, and content understanding. Abdul Razakand Connolly (2013) found that while computer games slightly improved learning outcomes, the teacher's pedagogical style significantly influenced students' preferences and enjoyment. Similar findings were observed by Simsek (2016), who demonstrated the positive effects of game-based apps on Mathematics skills for students with learning disabilities.

Game-based learning is considered effective for enhancing students' learning motivation (Chen, 2017). Digital game-based instruction can improve problem-solving abilities and positively affect motivation (Chen, 2017; Divjak&Tomic, 2011). However, there were mixed results regarding the impact of mathematical computer games on motivation (Divjak&Tomic, 2011). A study by Kebritchi et al. (2010) observed no significant improvement in Mathematics motivation. According to Tokac et al. (2019) educational games have the potential to enhance Mathematics achievement and problem-solving skills.TurgutandTemur (2017) found that using games in Mathematics teaching positively affected academic achievement. Yeh et al. (2019) demonstrated that a gamified educational software improved low-achieving students' Mathematics abilities. However, challenges exist in designing effective educational games, and not all studies show significant effects on performance (Tokac et al., 2019; Aljojo, 2018).

Pinder (2016) investigated the effectiveness of game-based learning in primary school instruction, specifically in Trinidad and Tobago where limited research had been conducted. The findings indicated that game-based learning positively impacted teaching and learning processes, leading to skills development, critical thinking, and problem-solving abilities among students. Teachers believed that game-based learning was effective for assessing primary students' skills and could be beneficial for students with disabilities.

Dowker et al. (2019) showed significant relationships between students' attitudes towards Mathematics and arithmetical performance in one group, while the correlation was less pronounced but still present in another group. Studies on attitudes and performance in younger primary school children have produced mixed results regarding the extent to which attitudes predict performance.

5.1 Evaluation of Matific - Mathematics Learning Platform

Matific is an instructional application designed to teach math using interactive activities and games. It uses real world scenarios that make math relatable and easy to understand and is mapped to common textbooks (SEG Measurement, 2017). Progressing from fundamental math objectives to increasingly challenging activities, the Matific learning system encourages child self-discovery and internalization of mathematical insights and rules. According to some teachers, the unique aspects of Matific were mainly the enjoyable nature of the exercises and studying with the program (Manny-Ikan et al., 2016). The Matific program contributes to students' understanding of the material, it is attractive and user-friendly, allows opportunities for experiential learning and is very interactive in nature. The Matific Learning Platform has a set of programs, that each focuses on a specific mathematical concept. Each concept is linked to the Mathematics curriculum and presents a series of five questions that provide a gradual increase in challenge (Attard, 2016).

Findings from quantitative and qualitative studies have reported improved performance in mathematics and engagement with mathematics.During the 2016-2017 school year, SEG Measurement (2017) conducted a year-long study to evaluate the effectiveness of Matific with 1477 grade two and three students. Using a quasi-experimental design, the study compared the growth in Mathematics skills for students in classes using the Matific program (treatment group) and those in comparable classes following traditional instructional practice without using Matific (control group). Students in both the treatment and control group were administered a pre-test and post-test of Mathematics skills. ANCOVA was used to statistically compare both groups of students by examining their test scores (SEG Measurement, 2017). It was determined that students using the Matific Mathematics Learning Platform improved their math skills significantly more than students receiving instruction without Matific. Overall, students in the treatment group showed about 4 points more growth in Mathematics skills than students in the control group. The results therefore supported the effectiveness of Matific use in improving grade two and three students' math skills. According to the evaluation research of Matific by Manny-Ikan et al. (2016), students had more positive perceptions of learning with the program to a great extent in terms ofunderstanding the material, ease of learning, level of enjoyment, and level of interest. These differences were found to be statistically significant, with the exception of the difference regarding the importance of studying math. Furthermore, the attitudes of teachers and students toward Matific were generally positive and contributed to students' enjoyment of their studies, their comprehension of the material, and their level of interest, as well as variety, enjoyment, and interest in teaching, and the relevance of the instruction for students (Manny-Ikan et al., 2016). In another study carried out by Attard (2016), it was examined whether and how the use of Matific resources could improve student engagement with Mathematics and assist students in learning and understanding mathematical concepts. This research utilized case study methodology of eight case studies. This included 16 participating teachers that used the Matific resources. It was concluded that Matific helped students learn and resulted in a 34% overall improvement index (Attard, 2016). When teachers did differentiate the learning, students appeared to be more engaged because the episodes contained an appropriate level of challenge. Additionally, the teachers who did set Matific as homework found it to be successful and highly engaging for their students. It was evident from the aforementioned studies which looked at data from students and teachers that engagement with Mathematics improved as a result of using the Matific Mathematics Learning Platform.

6. Theoretical Framework

The study is grounded in social cognitivism and constructivism, focusing on how these theories relate to educational software design and its impact on student learning. Social cognitivism views learners as information processors, engaging them through animations, instructional explanations, and demonstrations. It emphasizes knowledge acquisition by organizing and simplifying information, focusing on learner involvement and analyzing prerequisite relationships. Constructivism emphasizes knowledge construction from personal experiences, considering social and cultural contexts. It involves investigation and problem-solving, enabling students to find

solutions using technology. Key principles include contextualized learning, diverse presentation formats, and learner-centered instruction.

Educational software design and development should consider 12 factors (Spyropoulou et al., 2013)related to student performance and learning material based on these theories, encompassing feedback, multimedia, learner control, design, scaffolding, authenticity, and variety of activities. According to Roblyer and Doering (2019), early software aligned with behaviorism and cognitivism, while later software aimed for constructivist learning through exploration and knowledge generation. Some software functions, like simulations and games, can serve both directed and constructivist purposes based on their design.

7. Methodology

This study adopted a mixed methods approach using a convergent parallel design. Mixed methods research combines quantitative and qualitative methods to gain a comprehensive understanding of a research problem. In this study, both quantitative and qualitative data were collected simultaneously, merged, and compared to enhance the overall understanding of the research problem.

The study was conducted in one primary school in the Port-of-Spain Educational District. For the quantitative aspect of the study, two classes were selected using a nonprobability convenience sampling method. One class was the experimental group which was taught using the Mathific software and the second class was the control group which was taught using a directed (traditional) approach. Each class consisted of 30 students. The teachers of the two classes possess a Bachelor of Education degree with over ten years teaching experience. The teacher of the both classes indicated that they were proficient with the integration of technology in their teaching.

The study includes participants from one primary school in the Port-of-Spain Educational District.The school had one experimental group and one control group. The experimental group was taught using theMathific software, while the control group was taught using a directed approach.

7.1 Instrument

Student performance was assessed by comparing quiz results at the beginning using a pre-test and at the end of a 10- week period using a post-test. This consisted of 10 multiple-choice questions to be completed within one hour. The pre-test covered four topics, and the post-test covered an additional topic. A pre-and-post questionnaire using a 5- point Likert scale was used to examine the boys' attitudes and motivations toward Mathematics. The questionnaire consisted of 30 questions categorized into 10 sub-scales. These sub-scales comprised of Family Connection, School Connection, Community Connection, Participation in Home and School Life, Participation in Community Life, Self-esteem, Empathy, Problem Solving, Goals and Aspirations and Peer Support.

Focus group interviews with the students and a semi structured interview with the teacher were conducted to explore attitudes, motivation, and perceptions. Microsoft Teams was utilized for interviews, allowing for recording and transcription. Google Forms were used to administer the online questionnaires, while online quizzes were employed for the pre-and-post tests.

7.2 Data analysis

The quantitative data obtained from questionnaires and quizzes were analyzed using JASP statistics software. Paired Sample t-tests were applied to assess changes in performance, attitudes, and motivations before and after the experiment in both the experimental and control groups. Independent Samples t-tests were conducted to compare post-test scores between the experimental and control groups within the school, focusing on performance, attitudes, and motivation. The qualitative interview data were analyzed using NVIVO software. The results from both quantitative and qualitative analyses were juxtaposed to determine whether the two data sources produced similar or disparate outcomes, as is the process for mixed methods research with a convergent parallel design.

7.2.1 Research Question 1: Impact of Mathematics Educational Software on Academic Performance of Primary School Boys in Mathematics

The math performance of the 30 students in the experimental group (Class AX) was compared to 30 students in the control group (Class AY). Paired Sample T-Tests were conducted for the experimental and control groups separately (Table 1).

Table 1 Paired Samples T-Tests

Group (n=30)	Pretest Mean	Pretest SD	Post-test Mean	Post-test SD	Mean Change Score	t value	p value
Experimental	54.333	23.479	60.333	18.048	6.000	1.671	0.106
Control	53.667	13.322	56.333	15.916	2.667	1.577	0.126

p≤0.05

The experimental group (M=54.3: SD =23.4) and control group (M=53.6; SD= 13.3) had similar mean pretest scores.However, the results of the paired samples t-test showed there was no statistically significant difference in the mean scores between the experimental and control groups which indicated that there was no significant change in students' math performance for both groups) the difference was not statistically significant, indicating that there was no significant change in students' math performance for both groups (Table 1).

Independent Samples T-Test was also conducted to compare the post-test scores between the experimental and control groups (Table 2).

Table 2 Independent Samples T-Test

Factor (n=60)	Mean Difference	t	df	p
Post-test	3.333	0.910	58	0.366

p≤0.05

Table 2 shows that there was no significant difference (t (58) = 0.91, p= 0.36) in the post-test scores between the experimental and control groups.The results showed no statistically significant improvement in the mathematical performance of the experimental group compared to the control group, suggesting that Mathific's immediate academic impact was limited.

7.2.2 Research Question 2: Impact of Mathematics Educational Software on Students' Attitudes and Motivation towards Mathematics

Pre-and-post questionnaires were used to assess the attitudes and motivation of students towards mathematics.The attitudes and motivation of 30 students in the experimental group (Class AX) were compared to 30 students in the control group (Class AY). Paired Sample T-Tests and Independent Samples T-Tests were conducted.

Table 3: Paired Samples T-Test (Experimental Group)

Means and Standard Deviations for Pretest and Post-test Scores on Various Factors (n=30)

Factor (n=30)	Pretest Mean	Pretest SD	Post-test Mean	Post-test SD	Mean Change Score	t value	p value
Academic Motivation	11.841	0.699	12.296	0.533	0.455	2.550	0.016*
Attitude towards learning Mathematics		11.808	0.694	12.587	0.719	0.779	4.524	0.001*
Desire to learn Mathematics		11.817	0.654	12.192	0.828	0.375	1.900	0.067
Interest in Mathematics	11.931	0.691	12.264	0.674	0.333	2.592	0.015*	
Mathematics Confidence		12.018	0.636	12.271	0.734	0.253	1.672	0.105
Class Evaluation		11.628	0.607	12.673	0.930	1.045	4.783	0.001*
Motivational Intensity		12.020	0.645	12.283	0.688	0.263	1.513	0.141
Parental Encouragement		12.017	0.740	12.310	0.750	0.293	1.449	0.158
Software Evaluation	11.912	0.675	12.603	0.648	0.691	4.101	0.001*	
Value/ Usefulness	12.022	0.631	12.347	0.519	0.325	2.685	0.120	
All factors		11.901	0.229	12.383	0.193	0.4811	0.229	0.001*

p≤0.05

The Paired Samples T-Test as shown in Table 3, indicated that there were significant differences in Academic Motivation, Attitude towards learning Mathematics, Interest in Mathematics, Class Evaluation, Software Evaluation and All factors. The mean increase in attitudes and motivation when looking at all the factors overall was found to be 0.481 with a significant p value of 0.001. This suggests that the experimental group generally had a better attitude and motivation towards Mathematics after using the educational software.

Table 4 Paired Samples T-Test (Control Group)

Factor (n=30)	Pretest Mean	Pretest SD	Post-test Mean	Post-test SD	Mean Change Score	t value	p value
Academic Motivation		12.065	0.355	11.997	0.432	-0.067	0.590	0.060
Attitude towards learning Mathematics		11.946	0.350	12.125	0.365	0.180	2.241	0.033*
Desire to learn Mathematics		11.990	0.348	12.071	0.351	0.082	0.907	0.372
Interest in Mathematics	11.944	0.255	11.997	0.299	0.054	0.944	0.353	
Mathematics Confidence		11.905	0.335	11.950	0.333	0.045	0.515	0.611
Class Evaluation	11.981	0.279	12.125	0.295	0.144	2.155	0.040*	
Motivational Intensity		11.904	0.327	11.933	0.261	0.029	0.367	0.716
Parental Encouragement		12.048	0.320	12.028	0.363	- 0.020	0.308	0.760
Software Evaluation	11.981	0.407	12.055	0.308	0.074	0.969	0.341	
Value/ Usefulness	11.970	0.397	11.956	0.452	0.014	0.154	0.878	
All Factors		11.973	0.105	12.024	0.112	0.051	2.001	0.055

In the control group there were significant differences on two sub-scales namely students' attitude towards mathematics (p= 0.03) and class evaluation (p=0.04) (Table 4).

Table 5 Independent Samples T-Test (Experimental and Control Group)

Factor (n=60)	Mean Difference	t	df	p
Academic Motivation Post-test	0.299	2.384	58	0.020
Attitude towards learning	0.462	3.136	58	0.003
Mathematics Post-test				
Desire to learn Mathematics	0.120	0.733	58	0.467
Post-test				
Interest in Mathematics Post-test	0.266	1.977	58	0.053
Mathematics Confidence Post-test	0.322	2.184	58	0.033
Class Evaluation Post-test	0.549	3.079	58	0.003
Motivational Intensity Post-test	0.350	2.602	58	0.012
Parental Encouragement Post-test	0.282	1.854	58	0.069
Software Evaluation Post-test	0.548	4.182	58	0.001
Value/ Usefulness Post-test	0.391	3.114	58	0.003
All Factors Post-test	0.359	8.811	58	0.001

$p \leq 0.05$

The Independent Samples T-test showed that there was a significant difference in the post-test results between the experimental and control group on seven of the ten factors. The experimental group had more positive attitudes and motivation towards Mathematics than the control group with regards to academic motivation, attitude towards mathematics, interest in mathematics, mathematics confidence, class evaluation, motivational intensity, software evaluation and usefulness (Table 5).

Focus group interviewon students' perceptions of Mathematics software

Inductive Coding

The attitudes and motivation of 30 students (Class AX) assigned to the experimental group were examined through a pre-and-post focus group interview. The results of the two focus group interviews were combined and presented under the following themes using inductive coding.

Academic Motivation

In the pre-interview, some students (33%) felt unmotivated to do Mathematics, especially as homework or to study for a test. All students (100%) affirmed that using the Math Educational Software motivated them to learn so that they can perform well academically. In addition, they stated that Mathematics is important because most other subjects and jobs depend on being good at Mathematics. Some of the comments were:
"I liked using the Mathematics software because you can learn a few fun things like adding fractions and it could help you with other subjects like science, like comprehension questions in a graphic when you have to add something."

"I want to get good grades in Maths because most topics depend on Maths and most jobs depend on Maths too. It's my goal that I do well in Maths."

"I think it is important to get good grades in Maths because I want to be great in every subject to make my family proud and the career I want to do requires Maths. Using the Maths software can help me get better."

Attitude towards learning Mathematics

The majority of students (87%) stated that they liked Mathematics at the end of the experiment as compared to a slightly lower percentage (76%) at the start of the experiment. Therefore, there was some improvement in students' attitude towards learning Mathematics as there were more students expressing that they enjoyed doing Mathematics. Some of the students stated:

"I like Maths because you could learn new things and sometimes if you do not know your timetables, you could learn it from Maths."

"I do love Maths because you could have a fun way in learning new things, like multiplying fractions."

When questioned on how the teacher could improve in making them enjoy the subject, students (22%) in the post-interview wished that Maths could be made more fun with games, by doing competitions and by using a Maths educational software:
"Using the Matific software, make it fun by getting some prizes, I find using the Maths software is better and real fun."
"I think it can be more fun by letting us do competitions."
"Make it a little more fun, instead of just sitting down and doing the Maths, make it a little more fun for us to do. After every session of a big/long topic or a hard topic, have a competition or game and depending on the results, then go on to a different topic."

Desire to learn Mathematics

Some students (52%) confirmed in the pre-interview that they strongly wanted to learn Mathematics due to the fact that practice makes them understand Maths better. This increased in the post-interview as more students (74%) had a desire to learn Mathematics after using the educational software. Some of the statements from the students were:
"I like to do Maths problems using the software."
"I like to do Maths problems every day, I do Maths lessons from 4 to 6 every day, a lot of Maths problems."
"I do Maths every day so that I can understand it."

In the pre-interview, a few students (17%) didn't like doing Mathematics because they didn't like the subject and thought it was too difficult for them. There comments included:
"I don't really do Maths problems."
"I don't like to do them because I don't like Maths."
"I don't like Maths because it's hard. I do Maths maybe 2 to 4 times a week."
"I don't like to do it every day as some of the sums are hard and easy."

Interest in Mathematics

Before the experiment, most students (75%) affirmed that they were interested in Mathematics. After using the software, the majority (87%) of the students showed a greater interest in mathematics. Some of the comments were:
"I love this Maths software, it was so fun, I learnt so much. Now I can proudly say that Maths is my strong suit and I have grown attached to it."
"I like Maths because you could learn new things and if you do not know your timetables, you could learn it from using the Maths software."
"I like the software and I am sad that it's ending right now."
"I loved using the Matific Learning Software as it helps me learn Mathematics better."

Mathematics Confidence

The pre-interview suggested that there was a general lack of confidence in doing mathematics among a large number (67%) of students. This remained the same in the post-interview. Some of the comments were:
"Well, sometimes it's hard, and sometimes it's easy. Like if it's just adding then it won't be hard but if it's like adding fractions or converting it to mixed numbers, it's kind of nervous."
"I get nervous doing questions but when I play Math games, I get less nervous."

From the post-interview conducted, Mathematics anxiety continued to be a problem for a large number of students (62%). Their comments included:
"I'm nervous of doing Maths because I'm worried that I might get it wrong."
"If I get a hard question and I know how to do it but forget, I get kind of nervous like why I get it wrong, I know these things."

Class Evaluation

When questioned on how they felt about Math class before and after the experiment, the majority of students (80%) stated in the pre-interview that they liked Maths class and all students (100%) said they enjoyed the class after using the Math software. Students enjoyed Math class for many reasons, such as:

"I like Maths class because it helps you with multiplication, addition, subtraction, it helps with everything."

"Yes, I would like to use the software in class. I enjoyed Miss class when using the software. I think most of these games I am aceing and it's a lot more fun. It's fun to be class and doing games that help you learn and it's my favourite type of school of the whole part of the day."

Many students (49%) emphasized in the post-interview that they needed help from the teacher even while using the educational software and that they prefer a mix of both having the teacher use traditional methods and the Math software. Some of their responses were:

"Yes, I need help from the teacher. Sometimes the questions from the Maths software could be hard but some easy."
"I think it will be easier when the teacher helping you because some things you might not understand like a difficult Maths problem."
"Yeah, sometimes I need help like when it's hard. Sometimes I need help from the teacher when using the learning software because sometimes things don't be working and I have to show the teacher to get help."
"I prefer for the teacher to teach and explain and you can write it down. When you use the software, it's just right and wrong."
"I find it was good but I still prefer physical teaching, I think I would learn better so I prefer a mix of teacher teaching and using the software."

Motivational Intensity

Some students (39%) were motivated to do Mathematics in the pre-interview, however, more students (57%) were increasingly motivated to do Maths in the form of digital games in the post-interview. Some of the comments were:
"When it's in a game, my mind is in the game. So yeah, I like when it's in a game."
"Yes from my experience in Miss class, it was fun when it's a game. I'm very competitive in games and I'm good at Maths."
"I like spending more time doing Maths games because it makes Maths easier and fun." "Yes, I find the Maths game is better than regular Maths so I like doing more of it when it's a game."

Parental Encouragement

All students (100%) indicated that their parent helped them both before and after the experiment:
My mom has me use software to learn Mathematics after school and over the summer break.
"My parents help but not all the time because some of the time they are working. When I don't understand something, I ask them for help."
"My parents help me only if I find it very hard, like the homework, I'll ask for help or they explain it to me."
"My parents help me with learning Maths every time I get homework. My dad is really great with Maths, the adding and subtracting, I am able to do it on my own, but the harder for challenging ones, he helps me with those."

Software Evaluation

In the pre-interview, many students (85%) were not familiar with educational software:
"I don't think I ever used software to learn."
"I don't know what educational software is."

In the post-interview, all students (100%) liked the Math Educational Software at the end of the experiment because of the game elements and because it was fun:
"Yes, I would like to use the software everyday so that I could learn my Maths better.
Every day because it's fun."
"The Maths learning software is a fun educational thing that will make me learn better, want it every day because it will make me smarter."
"Yes I like it and I like the games on it. The games are fun and hard at the same time. I like to play for points and top the leaderboard."
"I think the Maths software was very fun and I like competing."
"The software is good, why I like it is because of the games. It'sMaths games and it's fun. I like playing against the other students. I love the games. I like the software to play games while learning."

Some students (11%) did not like when the game was ended:
"I didn't like when Miss ended the game. I didn't like some of the food games because it makes me hungry."
"I didn't like the speed in some of the games, it was too slow. I didn't like some of the slow games, some were not exciting."

Value/Usefulness

Both before and after the experiment, most students (90%) found learning Mathematics to be important and useful because of benefits to other subjects and future careers:

"Yes it is important, because if you're going for a career like engineering, you would need to know your Maths."

"I think it's actually very important to get good grades in Maths because most topics depend on Maths and most jobs depend on Maths too. It's my goal that I do well in Maths."

"I like Mathematics because you can learn a few fun things like adding fractions and actually it helps you with other subjects like science, like comprehension questions in a graphic when you have to add something."

Significant positive shifts in attitudes and motivation toward Mathematics were observed in the experimental group. These findings align with previous research underscoring the benefits of educational software in enhancing students' engagement and motivation.

7.2.3 RESEARCH QUESTION 3: What is the teacher's perceptions of using educational software in the teaching and learning of Mathematics?

The perceptions of the teacher of Class AX (experimental group) were examined through a semi-structured interview.

Educational software (Teachers' perceptions of Mathematics software)

The teacher had a good understanding of what is educational software and affirmed in the post-interview that shewould consider using it in herclassroom:

"Educational software is software that can be used to help teachers teach and help students learn a subject."

"Yes I would consider using educational software that is free, probably use it about once for the week."

"In my own studies I discovered that a person needs to do something 24 times repeatedly to just gain 80% efficiency… so if I had such software available to me, I would recommend it to students who needs the extra practice."

Benefits to Implementing

The teacher subscribed to the view that the benefits of using educational software included the ability to provide personalized learning to each student and it can develop children's technology skills:

"Yes there are benefits which include providing a personalized learning to each student, they can do at their own pace and the teacher can monitor their progress. In this digital age, it's a benefit for students to become familiar with using a variety of technology."

"It offers so much more than just the teacher led class and gives students a chance to learn on their own. I think they would appreciate what they're learning even more when it's presented in a fun way."

Teachers indicated that there were beneficial changes in terms of student's attitude and motivation towards Mathematics after using the software:

"There were changes in those students that used the software. Self-esteem, as I said, kicks in and they become more confident. They would volunteer more in class."

"Yes I did, the ones that used the software, they were readily going towards the class. Their attitude and motivation towards Mathematics class improved."

The two teachers noted that the experimental group of students were more willing to attend and participate in class than the control group of students.

"It was a positive thing for the students who used the software and it reflected in terms of their willingness to go into the class."

"I did notice that the ones who were in the software group were more willing to offer answers to questions than the ones who were not part of the software group."

Drawbacks to Implementing

The teacher stated in the post-interview that there would be drawbacks in implementing educational software use in teaching and learning such as not being able to afford the cost of the software and not having the required equipment/resources at the school:

"The biggest problem would be scheduling the use of devices, as our school has limited devices so it has to be shared with multiple classes."

"The only negative thing that I can think of, to using it, is the issues of cost of software, and school and parents may not be able to afford to purchase the software."

"We don't have easily connectable laptops that could connect to the projector. So that connectivity, internet, the primitive cost in terms of the software are drawbacks."

Furthermore, the teacher of Class AX suggested that the use of educational software may encourage too much screen time for children:

"I would say maybe encouraging too much screen time for children."

The teacher also pointed to the fact that some educational software are not custom-tailored to the Mathematics curriculum for Trinidad and Tobago, such as the use of pounds instead of dollars for currency and the different coins that vary across countries. In addition, the methods used to solve certain Mathematics problems in the software applications are different to how the teacher would normally solve them and how they would teach students to do so. Some of the comments which reflect this were:

"I don't think it would cover the scope. Sometimes the method they use, it's different than what we do in Trinidad and Tobago. For example, with money, it's either in pounds or in pennies that kind of limits the applicability of the software."

"I would implement it but the quality of the software, the applicability of it, in terms of our scheme of work in Trinidad and Tobago would limit my usage of it."

"In terms of students, sometimes the way the solution is done. Sometimes the way they do it may conflict with the way I taught it in class."

Students' Attitude

The teachers expressed in the post-interview that the students that used the Math Software had a better attitude towards Mathematics, a greater desire and interest in Mathematics and enjoyed the class more that those who didn't use the software:

"Students had a better attitude towards Mathematics after using educational software. I think it promotes students' self-esteem, causing them to have a greater desire and interest to learn and enjoy the class more."

"Yes, because as I said, most times it offers an intermediate reward system and it gives them that sense of accomplishment. It also gives them the opportunity to practice at their pace so that when they come back to class, they would be able to say, yes I can do that."

Moreover, one of the teachers indicated in the post-interview that the use of educational software can also help with anxiety of students, since in building their self-esteem, they would become more confident in doing Mathematics problems:

"I believe it would also help with anxiety of students because it allows them to become familiar with the topic and in building their self-esteem, it would lower their anxiety and they would become more confident in doing Mathematics."

Students' Motivation

Additionally, the teacher emphasized that students were more motivated to do Mathematics with the game-based approach used in the educational software:

"Students became motivated to do Mathematics with the game-based approach after using the software, it offers an alternative to just the teacher led, teacher centric class. It would motivate them to want to do Mathematics."

"Students were motivated to do Mathematics and started to ask me to incorporate more game-based software activities in my teaching."

Students' Engagement

The teacher also felt that interactive games would keep students engaged while completing Math problems:

"I would use educational gaming software also because it would keep students engaged and interested in learning."

"Students would be more engaged if doing Mathematics through an App, if on their phones, even better as it offers mobility with one of our mostly held devices, the mobile phone."

Students' Performance

When questioned about how sheviewed educational software as a way of increasing student's academic performance, the teacher perceived that if students are engaged and motivated and if their attitudes improved, then they will willingly practice Math problems more, get better and therefore would eventually improve in their Math tests:

"Motivation is key at times to students being successful. If they are engaged and like what they are doing, their attitude improves and then by willingly practicing more, they get better and therefore would eventually perform better."

Both teachers identified that the data analytics that can be retrieved from most of the educational software packages today can be used to determine students' progress, their strengths and weaknesses. These can then be used to tailor classes which in turn would have a positive impact on student's Math skills:

"Provided I have that data, I could see where students are having difficulty in a particular topic. I would then try to review, give more concept lessons, more reinforcement lessons and more expansion lessons for them."

"On an individual basis, if I see if a student is struggling, I could target that student and provide that necessary support as needed."

Game-based Learning

In response to questions about game-based learning,the teacher suggested that game-based learning would gain the interest of students, get them excited and motivated and give them a sense of accomplishment:

"With games, we compete, we win rewards that gives us a sense of accomplishment. So DGBL is using those positives of gaming and applying it to learning."

"Game based learning software works in terms of the students not even knowing that they are learning something, they get that sense of accomplishment and self-esteem, in that they can beat the game. They are learning and it would motivate them to do more."

Classroom Observations

The teacher experienced a generally positive change in the students that used the Math educational software in their classrooms:

"I observed some students became more comfortable with using technology in general as they required less guidance from me when I asked them to do tech-related task."

"Students that used the software were excited to tell the students that didn't use the software what they were doing in the class, telling their peers which activities were easy, which were hard, how fast they could complete the game and what topics they covered."

The teacher recognized the potential benefits of Mathific in improving student engagement and academic performance. She cited advantages such as personalized learning and technological skill development, alongside challenges related to resources and alignment with local curricula.

8. DISCUSSION

The findings, derived from a combination of qualitative and quantitative data, provided valuable insights into the effects of educational software on teaching and learning in the classroom.

Inferential statistics were employed to determine whether the use of educational software had a significant impact on students' Math performance. The Paired Samples T-Test and Independent Samples T-Test conducted on the experimental and control groups indicated that there was no significant improvement in students' performance.The findings suggest that the use of Mathematics educational software does not significantly affect the academic performance of primary school boys in Mathematics, based on the quantitative results obtained from the experimental group.These results may be attributed to the short duration of the study (10 weeks) and the small sample sizes. These findings differ from previous studies, such as those by Tokac et al. (2019), which suggested that game-based learning promotes Mathematics achievement. Other studies, including those by Turgut&Temur (2017), Yeh et al. (2019), and Aljojo (2018), have also found positive effects of educational software on academic achievement.

These findings are consistent with Hamiyet (2015), where no significant difference in mathematical skills was observed with or without the use of math computer games. However, they contradict Ferguson's (2014) findings, which indicated that the control group outperformed the experimental group in achievement tests.

Furthermore, research on the Mathific Mathematics educational software by SEG Measurement (2017) found significant improvements in math skills compared to the control group, suggesting its effectiveness. Attard (2016) also reported successful implementation of the Mathific software, resulting in a 34% overall improvement index.

The Paired Samples T-Test and Independent Samples T-Test conducted indicated a significant positive change in attitudes and motivation for the experimental group but not for the control group. The inductive coding for the experimental group also yielded positive changes in attitudes and motivation. The findings suggest that the use of Mathematics educational software has some positive effects on the attitudes and motivation of primary school boys towards Mathematics, based on the quantitative and qualitative results obtained.

These findings align with previous research such as Simsek (2016) and Vankus (2021) who reported improvements in students' attitudes towards mathematical content. Kayan&Aydun (2020) found higher post-test scores in attitudes for the experimental group compared to the control group. Studies by Chen (2017) and Divjak &Tomic (2011) supported the enhancement of students' motivation through digital game-based instruction. Ghoorchaei&Rahmani (2018) observed statistically significant differences in motivation tests. Howard & Crotty (2017) indicated that educational software enhanced the motivation of male students. Manny-Ikan et al. (2016) demonstrated positive attitudes toward the Mathific Mathematics software, contributing to student enjoyment, comprehension, and interest in learning.

The analysis of qualitative data from the experimental group revealed that the teacher believed educational software could positively impact students' attitudes, motivation, and academic performance in Mathematics. She expressed intentions to use it in her teaching and learning due to its benefits, such as personalized learning, building self-esteem, game-based learning, student engagement, data analytics, and increased excitement for learning. However, the teacher also highlighted challenges related to cost, software limitations, and equipment availability.The findings suggest that the teacher perceived the use of Mathematics educational software as a means to improve students' attitudes, motivation, and academic performance in Mathematics. These findings are consistent with Pinder's (2016) study, which emphasized the positive impact of game-based learning on teaching and learning in primary schools. Dagnew (2017) also supported the notion that positive attitudes and valuing education contribute to academic performance, which can be achieved through educational software. Cannon (2017) indicated teachers' perspectives aligned with computer-assisted instructional software meeting individual student needs, monitoring progress, implementing small group instruction, increasing engagement, and supplementing teacher-led instruction.

While Mathific did not significantly enhance immediate academic performance, it positively influenced attitudes and motivation. This underscores the potential of educational technology in reshaping students' engagement with Mathematics, aligning with previous studies that highlight the benefits of game-based learning and digital instruction in motivating students.

9. Recommendations for Future Research

Based on the findings, several recommendations for future research can be made. Firstly, it is recommended that future studies should consider longer durations, larger and more diverse samples, and the development of curriculum-aligned educational software. Involving multiple schools and various class levels throughout Trinidad and Tobago would provide a broader understanding of the impact of instructional software on boys and students in general. Additionally, comparing high-performance and low-performance students could also offer valuable insights. Finally, comparisons between different software tools could provide further insights into the most effective strategies for integrating technology in Mathematics education.

References

Abdul Razak, A., & Connolly, T. (2013). Using Games-based Learning: How it Influences the Learning Experience and Outcomes of Primary School Children. *International Journal Of Emerging Technologies In Learning (Ijet)*, *8*(S2), 47. https://doi.org/10.3991/ijet.v8is2.2782

Aljojo, N. (2018). The Design and Implementation of a Mathematics Game-Base Learning Application for Primary Students. *International Journal Of Interactive Mobile Technologies (Ijim)*, *12*(3), 142. https://doi.org/10.3991/ijim.v12i3.8739

Attard, C. (2016). *RESEARCH EVALUATION OF MATHIFIC MATHEMATICS LEARNING RESOURCES*.

Cannon, C. (2017). *Teacher and Student Perceptions of Computer- Assisted Instructional Software to Differentiate Instruction.* Walden University.

Chen, Y. (2017). Empirical Study on the Effect of Digital Game-Based Instruction on Students' Learning Motivation and Achievement. *EURASIA Journal Of Mathematics, Science And Technology Education*, *13*(7). https://doi.org/10.12973/eurasia.2017.00711a

Cohen, L., Manion, L., & Morrison, K. (2000). Research Methods in Education 5th Ed. RoutledgeFlamer: New York.

Dagnew, A. (2017). The relationship between students' attitudes towards school, values of education, achievement motivation and academic achievement in Gondar secondary schools, Ethiopia. *Research in Pedagogy*, *7*(2), 30-42. https://doi.org/10.17810/2015.46

Divjak, B., &Tomic, D. (2011). The Impact of Game-Based Learning on the Achievement of Learning Goals and Motivation for Learning Mathematics - Literature Review. *JIOS*, *35*(1), 15-30.

Dowker, A., Cheriton, O., Horton, R., & Mark, W. (2019). Relationships between attitudes and performance in young children's Mathematics. *Educational Studies in Mathematics*, *100*(3), 211-230. https://doi.org/10.1007/s10649-019-9880-5

Ferguson, T. (2014). *Mathematics Achievement with Digital Game-based Learning in high school Algebra 1 classes*. Liberty University.

Ghoorchaei, B., &Rahmani, M. (2018). The Effect of using GET on Iranian Intermediate EFL Learners' Pronunciation and Motivation.

Hamiyet, S. (2015). The effects of computer games on the achievement of basic mathematical skills. *Educational Research And Reviews*, *10*(22), 2846-2853. https://doi.org/10.5897/err2015.2172

Howard, S., & Crotty, Y. (2017). The potential of an interactive game-based software to motivate high-achieving Mathematics students at primary school level. *The Electronic Journal of Mathematics and Technology*, *11*(2).

Jiawen, J., Zelem, N., Prieur, J., &Kilanowski, L. (2020). *Importance of Students' Attitude Towards Mathematics in Learning and How Game-Based Learning Can Promote Positive Attitude*.

Kayan, A., & Aydın, İ. (2020). The Effect of Computer-Assisted educational Games on Teaching Grammar. *World Journal Of Education*, *10*(1), 117. https://doi.org/10.5430/wje.v10n1p117

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern Mathematics computer games on Mathematics achievement and class motivation. *Computers & Education*, *55*(2), 427-443. https://doi.org/10.1016/j.compedu.2010.02.007

Manny-Ikan, E., Berger-Tikochinski, T., &Marmor, A. (2016). *Research Evaluation of "Mathific "*. Henrietta Szold Institute.

Office of the Parliament. (2020). *Male Academic Performance in Public Primary and Secondary Schools*. Retrieved 21 December 2021, from http://www.ttparliament.org/reports/p11-s5-J-20200612-HRED-R16.pdf.

Pinder, P. (2016). *Exploring the Effects of Game Based Learning in Trinidad and Tobago's Primary Schools: An Examination of In-Service Teachers' Perspectives*.

Roblyer, M., &Doering, A. (2019). *Integrating educational technology into teaching* (8th Ed.). Allyn and Bacon.

SEG Measurement. (2017). *AN EVALUATION OF MATHIFIC USE IN GRADES TWO AND THREE*.

Simsek, O. (2016). *Use of a Game-Based App as a Learning Tool for Students with Mathematics Learning Disabilities to Increase Fraction Knowledge/Skill*. University of South Florida.

Spyropoulou, M., Ntourou, D., Simaki, V., Malagkoniari, D., Koumpouri, A., &Sorra, M. (2013). *Evaluating the correspondence of educational software to learning theories*.

Tokac, U., Novak, E., & Thompson, C. (2019). Effects of game- based learning on students' Mathematics achievement: A meta- analysis. *Journal Of Computer Assisted Learning*, *35*(3), 407-420. https://doi.org/10.1111/jcal.12347

Turgut, S., &Temur, Ö. (2017). The Effect of Game-Assisted Mathematics Education on Academic Achievement in Turkey: A Meta-Analysis Study. *International Electronic Journal Of Elementary Education*, *10*(2), 195-206. https://doi.org/10.26822/iejee.2017236115

Vankúš, P. (2021). Influence of Game-Based Learning in Mathematics Education on Students' Affective Domain: A Systematic Review. *Mathematics*, *9*(9), 986. https://doi.org/10.3390/math9090986

Yeh, C., Cheng, H., Chen, Z., Liao, C., & Chan, T. (2019). Enhancing achievement and interest in Mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, *14*(1). https://doi.org/10.1186/s41039-019-0100-9