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Exploring the Effect of STEM Teaching Methods on Grade 9 Mathematics Students' Conceptual Understanding and Performance Compared to Traditional Instruction at a Non-Traditional High School in Halfway Tree in St. Andrew

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Abstract

The ongoing dependence on conventional, lecture-centric mathematics teaching in Jamaican secondary schools has been linked to low levels of student engagement, restricted conceptual comprehension, and inadequate problem-solving results, especially in non-traditional high school environments. To address this issue, the present study sought to evaluate the efficacy of STEM-oriented teaching strategies in enhancing Grade 9 students' conceptual grasp and performance in mathematics, in contrast to traditional teaching methods. A mixed-methods research framework was utilized, involving 58 Grade 9 students from a non-traditional high school located in Half Way Tree, St. Andrew. During a five-day instructional timeframe, students participated in both STEM-integrated lessons—incorporating visual tools such as charts, graphs, and diagrams—and standard lecture-based instruction. Data collection was conducted through weekly mathematics evaluations and structured student surveys. Quantitative data were analyzed employing regression analysis and one-sample t-tests. The results indicated that STEM-based instruction had a statistically significant positive impact on student engagement, class participation, and understanding of mathematical concepts. Regression analysis revealed a moderate positive correlation between STEM variables and instructional effectiveness, while t-test outcomes confirmed significant differences favoring STEM instruction ($p < 0.05$). Despite facing challenges related to insufficient teacher training and resource limitations, the study concludes that STEM-focused teaching approaches are more effective than traditional methods in improving mathematical learning outcomes. The findings advocate for the incorporation of STEM pedagogy in mathematics education, particularly in under-resourced and non-traditional school settings.

Keywords: *Mathematical Comprehension, Non-traditional High School, STEM, Teaching.*

Introduction

Preface

This research was undertaken to investigate how the incorporation of STEM teaching methodologies could improve students' comprehension and performance in mathematics. It highlights the significance of connecting classroom theories to real-world applications through inquiry, problem-solving, and practical experiences. The preface outlines the justification for employing STEM strategies in Jamaican secondary schools and establishes the groundwork for evaluating their effectiveness in contrast to conventional instructional methods.

Background of the Study

The field of mathematics often appears complex to numerous students throughout their

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educational journey, leading to a decline in their enthusiasm for the subject.

Furthermore, the reliance on monotonous and repetitive instructional techniques, particularly through pre-prepared lectures, contributes to students' disinterest in mathematics [1].

Traditional teaching methods predominantly emphasize theoretical knowledge at the expense of practical comprehension. This imbalance creates confusion among students regarding the correct application of mathematical concepts. In such contexts, the implementation of STEM teaching methodologies can serve as an effective alternative, fostering students' excitement about studying mathematics. STEM provides a dynamic framework that encourages students to engage with mathematics in an enjoyable manner. It equips them with critical and logical thinking skills, facilitating easier problem-solving [2]. Students gain higher-order thinking abilities that prioritize practical strategies and enhance their problem-solving proficiency.

Statement of the Problem

The objective of this study is to investigate and evaluate the impact of the STEM teaching approach. Presently, few educational institutions have undertaken initiatives to determine whether the STEM methodology surpasses traditional teaching methods in effectiveness. This research aims to improve the conceptual understanding and performance of ninth-grade mathematics students.

Additionally, it will involve a comparison between traditional lecture-based methods and STEM teaching strategies to identify which approach is superior and more effective. For this analysis, a non-traditional high school, St. Andrew, situated in the Half-Way Tree area, has been selected.

Purpose and Justification of the Study

The purpose of this research is to empirically investigate the effects of STEM-oriented teaching strategies on the conceptual comprehension and mathematical performance of Grade 9 students, as opposed to conventional lecture-based instruction, within a non-traditional high school environment in St. Andrew, Jamaica.

This research is based on the ongoing dominance of traditional teaching methods in mathematics classrooms, which have been associated with low levels of student engagement, restricted conceptual understanding, and poor problem-solving results. Although STEM pedagogy has been extensively advocated as a learner-centered and inquiry-based approach that can tackle these issues, there is still a scarcity of empirical evidence demonstrating its effectiveness in Jamaican secondary schools, especially in non-traditional and resource-limited settings.

By methodically contrasting STEM-integrated instruction with traditional teaching techniques, this study aims to offer evidence-based insights into whether STEM pedagogy can act as a feasible instructional alternative for enhancing mathematical learning outcomes among Grade 9 students.

Significance of the Study

A substantial amount of research has underscored the practical benefits associated with the integration of STEM in mathematics education. Researchers have found that this instructional approach improves students' understanding of mathematical expressions and terminology. Additionally, the application of practical scenarios has bolstered their confidence in the subject and fostered an immediate and active interest [3].

In contrast to traditional teaching methods, where students often struggle to grasp mathematical concepts because materials are designed for the entire class, STEM instruction offers a more individualized learning experience. Given the advantages linked to STEM methodologies, it is crucial to

comprehend their practical implications when applied in real-world contexts.

Research Objectives

The main aim of this research is to evaluate the effect of STEM-based teaching techniques on students' conceptual understanding and mathematical performance. More specifically, the study seeks to ascertain how STEM instruction affects students' engagement, critical thinking, and problem-solving abilities, as well as to compare these results with those obtained through traditional teaching methods.

Research Questions

The study is guided by the following research questions:

1. In what ways does STEM-based instruction influence the mathematical comprehension of Grade 9 students attending non-traditional schools in St. Andrew, Jamaica?
2. What significant challenges do teachers and students face when implementing STEM-based mathematics instruction?
3. What notable advantages do teachers and students experience when utilizing STEM-based mathematics instruction?

Operational Definition and Terms

STEM: Science, Technology, Engineering, and Mathematics. STEM-Focused

Teaching: An instructional approach that integrates technology, engineering, and mathematics to improve mastery outcomes [4].

Mathematical Comprehension: The ability of students to understand, observe, and analyse mathematical concepts effectively

Non-Traditional High School: An educational institution that admits students who do not fulfil standard academic entry criteria and frequently operates with limited resources [5].

Citing this research. It identifies the research questions and the aim of the study. The section signifies understanding the importance of STEM methods and assessing their effectiveness in schools. It draws evidence from existing research to rationalise why using STEM can make students more logical and effective.

Research Hypothesis

Based on the survey, the following hypothesis was considered:

H0: STEM teaching method has no significant difference from traditional teaching methods, and does not help children understand mathematics concepts better.

H1: STEM teaching method is more effective than traditional teaching methods, and helps children understand mathematics concepts better.

Limitations of the Study

This research was confined to a single non-traditional high school located in St. Andrew, Jamaica, with a relatively small sample of Grade 9 students. Constraints related to time and limited access to technological resources also impacted the extent of classroom implementation. Furthermore, students' previous exposure to technology and their diverse learning capabilities may have affected the outcomes, complicating the ability to generalize the findings to all Jamaican secondary schools.

Organization of the Study

The study is structured into five distinct chapters. Chapter One outlines the background, objectives, hypotheses, and the scope of the research. Chapter Two offers a review of pertinent literature and theoretical frameworks related to STEM education. Chapter Three details the research design, sampling techniques, and data collection tools. Chapter Four emphasizes the presentation, analysis, and interpretation of the data, whereas Chapter Five addresses the findings, conclusions, and suggestions for enhancing STEM implementation in mathematics education.

Literature Review

Preface

The given section outlines the review of literature for the given study. It assesses and explains different research studies conducted on the subject of STEM education and its effectiveness. The section also identifies the theoretical frameworks that can justify STEM, followed by identifying the research gaps.

A comparison of Traditional Teaching Methods and STEM Teaching Approaches

Traditional teaching methods, which have been employed for many years, primarily involve lectures followed by memorization. The emphasis is on imparting textbook-based knowledge to students. The researcher notes a notable lack of practical application in these methods, with curricula designed to cater to the entire class. In traditional mathematics instruction, students are more likely to experience monotony, which can diminish their interest in the subject.

In traditional teaching practices, the emphasis tends to be on rankings and grades rather than fostering a genuine interest in the subject matter. The constant reliance on textbooks makes it challenging for children to connect with the material. The focus is predominantly on encouraging students to memorize facts instead of developing skills [6].

Conversely, STEM education methods offer educators the chance to empower students and motivate them to tackle complex problems. These methods primarily highlight hands-on learning experiences. They aim to inspire students to think innovatively and approach challenging math problems with enthusiasm rather than apprehension. [7] assert that the adoption of STEM teaching fosters active participation among students and encourages them to engage with real-life applications, as opposed to abstract knowledge. This creates a supportive environment for students to generate new ideas and absorb information more effortlessly.

The Significance of STEM in the Instruction of Mathematics

Mathematics plays a crucial role in STEM disciplines. It serves as a fundamental component of the STEM domain, facilitating a deeper comprehension of complex problems and concepts. As noted by [7]. One of the most advantageous aspects of teaching mathematics through STEM is the incorporation of practical experiments. This approach fosters curiosity among students regarding the subject.

It also enhances their engagement with the material. Furthermore, students are motivated to apply mathematical concepts and adopt a hands-on methodology. They are encouraged to utilize these concepts to tackle intricate numerical challenges in mathematics. By doing so, they embark on the journey of designing, analysing, and interpreting data based on their acquired knowledge. This process promotes independent thinking as students learn at their own pace [8].

One of the numerous advantages of employing STEM strategies in mathematics education is that it provides students with opportunities to engage with various interdisciplinary fields. According to [8], this approach fosters a research-oriented mindset, enabling students to appreciate the significance of mathematics and its connections to other disciplines. STEM facilitates the motivation for students to pursue mathematics in their future studies. It equips them with the skills necessary to address complex problems through logical reasoning and enhances their problem-solving abilities. In essence, it inspires students to embrace the subject and develop a mindset characterized by innovation and creativity.

Challenges of Utilizing STEM in Mathematics Education

Despite the benefits associated with STEM disciplines, numerous challenges arise during

their implementation. According to [9], a primary obstacle in the adoption of STEM teaching is the insufficient availability of essential resources.

Contemporary educational institutions often lack the necessary equipment, materials, and technology required to effectively engage students in mathematics instruction.

This deficiency hinders hands-on learning opportunities and impedes students' ability to foster creativity and innovation [10].

Additionally, there exists a challenge regarding the preparedness of certain educators. For the successful cultivation and implementation of STEM teaching methodologies in the classroom, it is crucial for teachers to receive adequate training and possess sufficient experience to seamlessly integrate these methods into conventional teaching practices [11].

A critical aspect of STEM education involves the successful integration of its components and collaboration with everyday learning strategies within the classroom. [12]. Contend that achieving this integration can be challenging due to time constraints. A typical class spans 5-6 hours daily, making it difficult to incorporate a multitude of teaching methods within this limited timeframe.

Moreover, the presence of varying curriculum standards across different educational institutions may also present significant challenges. Each class adheres to its specific teaching curriculum, necessitating distinct strategies tailored to each group of students.

Time constraints represent one of the most crucial challenges, as STEM education demands specific applications that differ from traditional mathematics instruction. This divergence can be particularly challenging to implement within a standard mathematics curriculum in the classroom.

Theoretical Foundations

Numerous theories can be examined to comprehend the efficacy of STEM-oriented teaching methodologies in imparting mathematics to ninth-grade learners.

The constructivist learning theory, as proposed by Piaget and Vygotsky, serves as a pertinent framework that elucidates how STEM education can enhance students' awareness and their capacity to tackle intricate problems.

This theory underscores the knowledge that students construct through active participation and experiential learning [13]. Furthermore, it highlights the significance of hands-on learning activities and experiments, which encourage students to cultivate creativity and innovation.

To tackle the obstacles linked to STEM-based instruction, educators might consider employing the 5E instructional model (engage, explore, explain, elaborate, evaluate). This model can offer a sustainable framework for teachers, assisting them in the systematic design of STEM lessons

[14]. They could adopt a blend of various strategies that would afford students a well-rounded education, integrating both practical and theoretical components.

Kolb, through his experiential learning theory, has delineated the process of learning as a sequence of activities [15]. This cycle encompasses concrete experiences, reflection, conceptualization, and experimentation. To effectively implement STEM-based teaching, educators should proactively incorporate more laboratory experiments and expose students to STEM fairs, thereby broadening their perspectives on the subject [15]. In this manner, students will have the chance to develop a greater interest in the subject matter through practical engagement.

To summarize, there are several benefits associated with the implementation of STEM teaching methods in the classroom. However, the set of challenges, such as time constraints and different curricula, might pose a challenge

that makes traditional teaching methods more favourable for many schools.

Research Methodology

Preface

This chapter provides you with a brief understanding of the methods that will be implemented for the given research study. The first part of the section will outline the research design that will be finalized so that a better understanding of the effectiveness of STEM teaching methods can be assessed. This has been followed by identifying the population and selecting the sampling method.

The section also outlines a brief understanding of the data collection process that has been selected, along with its justification. It also provides an outline of the research analysis methods that will be implemented, along with identifying the ethical considerations.

Research Design

The research will make use of a mixed research design. In mixed methods, there is the use of both quantitative and qualitative methods [16]. The use of this method will help enhance the validity of the findings, because the understanding of the effectiveness of STEM teaching methods is still not very comprehensive and detailed

[16]. In order to provide a more comprehensive understanding of the concept, a positivist philosophy will be used. This will help to better explain the findings using existing theories and hard facts [16]. A deductive approach will also be used to help identify the causal relationship between the selected variables and gain more perspective about the research questions. Lastly, an exploratory design will be considered, which will contribute towards gaining more insight into the facets of STEM teaching and gaining a detailed comparison of the same with traditional teaching methods.

Research Population and Sampling

The research population will consist of students in grade 9 studying mathematics. The objective is to gain an understanding of what methods of teaching, STEM or traditional, help make math easier for students to understand. A total of 58 students will be considered for grade 9, and to make the research manageable, the sample comprises students studying in grade 9 at a non-traditional high school in Half Way Tree in St. Andrew.

A random sampling method will be implemented to provide each student with an equal probability of being selected. [17]. Stated that it is a simple and flexible process that will make selecting the participants easier.

Data Collection Methods

Data will be collected through the help of a questionnaire that consists of a total of 15 closed-ended questions. The 58 students will be given added instructions using STEM methods of visual aids, along with their regular classes. The visual aids will be used on their current syllabus, which is probability. The STEM method used in this case will be visual aids that will include graphs, charts, and diagrams, while the traditional methods will include the use of books.

A total of 5 classes will be given in an entire week, followed by which the students will be asked to take part in a weekly test that is organized by the school as part of their curriculum. The classes will each be of 1 hour, with each student being required to attend at least a minimum of 30 minutes of the class.

The students will have the choice to leave the class after 30 minutes. This will be followed by asking the students to fill out the common questionnaire at the end of the 5th day, after the test. The teachers who teach math will be provided with visual aids and resources, such as cue cards and visual charts that they will use to teach the same concepts of math to the students. The data that will be analysed will be based on the data from the questionnaire.

Data Analysis Techniques

In the quantitative analysis, the statistical method of SPSS will be implemented. This will help analyse the causal relationship between the selected variable set. This will also help gain insight into the effectiveness of STEM teaching tactics compared to traditional teaching methods. A regression analysis will be run, followed by a t-test to test the feasibility of the hypothesis

[19]. The qualitative method will include justifying the findings using data from secondary sources. The use of secondary data will be to strengthen the validity of the findings and prove the effectiveness of STEM teaching methods.

Ethical Considerations

The research will follow all ethical principles to ensure its reliability and validity. [18]. Talk about the importance of a consent form. This is why a consent form will be provided to all the participants, as well as the school administrator. It will outline information about the scope of the research, objectives, and proposed outcomes. Complete transparency in information will be maintained through the consent form with the students as well as school administrators, to ensure research authenticity during the data collection process.

Data Presentation

Preface

The given chapter outlines the analysis based on the collected data to assess the impact of STEM teaching methods on students. The data has been collected based on the classes given to the students, followed by a self-assessment. The self-assessment of the students has been to understand their preferences, in terms of which method has made it easier for them to understand mathematical concepts better. The section has implemented a regression analysis to identify the relationship between the causal variables, if any. This has been followed by a t-test to assess the validity of the hypothesis.

Role of Testing

In order to better understand the effectiveness of STEM teaching methods in the classroom, the first step that was implemented was conducting a short class on mathematics for 5 days, each for an hour, using STEM methods. It is essential to note that the effectiveness was being measured by conducting weekly mathematics tests in the classroom. This was coupled with feedback received from the teacher to the students in terms of how they can improve.

The only new addition, because of this research, was the survey that was conducted. Hence, both quantitative and qualitative methods were used in this case to measure effectiveness. The selected school was already using traditional teaching methods, like books, to teach the students mathematics. The traditional method that was being considered included chalk and board work, the use of lectures, maintaining textbook-driven learning, memorization, and rote learning. There was not sufficient use of technology or applications being made.

Hence, the STEM method of visual aid was only being used for an hour each day, for the same class. There were no changes in the syllabus; rather, the class was taught using visual aids.

From the same existing syllabus. The class was learning about probability that week, so visual aids were prepared on the same topic. The objective of conducting this class was to expose the students to STEM teaching methods.

The school was already in the process of conducting weekly tests at the end of each week, as mentioned above. The tests provided the teachers with a comprehensive understanding of the progress made by the students. Using the method of weekly tests helped the students memorize the subject better. It was only after the students had given their weekly math test that the survey was given to the students to be completed for this research.

The test results were considered for this test, along with short verbal feedback from teachers.

The dependent variable for this study has been considered as the effectiveness of the Teaching Approach, while the independent variable considered was the effectiveness of STEM teaching and traditional teaching. Based on these variables, the research was conducted. The reason for choosing only two variables was to keep the research more focused and concise.

Data Presentation and Analysis

In this section, the researcher will showcase the data gathered during the investigation through the use of tables to enhance clarity and facilitate understanding. In addition, the researcher will analyse the results to uncover patterns, trends, and insights regarding the topic. This analysis will assist in drawing significant conclusions based on the evidence.

Presentation of Demographic Data

The section below briefly outlines the demographic distributions for the given study.

Gender

Table 1. Gender of the Class

Gender					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Female	26	44.8	44.8	44.8
	Male	32	55.2	55.2	100.0
	Total	58	100.0	100.0	

Table 1 above shows that a total of 55.2% of the participants were male students and 44.8% were female students.

It can be stated that the class did not comprise an equal representation of females. Each of the participants in the class was provided with equal treatment in terms of teaching mathematics through both STEM methods and traditional methods.

Length of Math Class

Table 2. Length of Math Class

Length of math class					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	0-30 minutes	2	3.4	3.4	3.4
	30-45 minutes	7	12.1	12.1	15.5
	45 min-1 hour	49	84.5	84.5	100.0
	Total	58	100.0	100.0	

As shown in Table 2, the majority of students (84.5%) reported attending mathematics classes for 45 minutes to one hour, while a smaller proportion attended for shorter durations. This suggests that most participants were exposed to extended instructional time, which is critical for effective engagement with both STEM-based and traditional teaching approaches.

The table above provides a general representation of the duration of math classes in the school. As can be seen, that 84.5% of the participants attend the classes for a minimum period of 1 hour, while only a significant set of other participants have stated that they attend classes for a minimum period of 30 minutes. The discrepancy is mostly related to the choice

provided to students, who can leave the class after attending for at least 30 minutes.

Based on the findings, it can be stated from the above table that the maximum participants attend math classes for a minimum period of an hour. This proves that students found a level of interest in the classroom when the STEM method was used to teach them math.

Presentation of Specific Data

The above section provided a basic understanding of the distribution of the demographic population in the chosen sample. The idea remained to understand whether gender or the length of mathematics classes had any impact on students' learning math better. It was assessed from the section that the length of math classes created a divide in terms of grasping concepts of mathematics. Longer classes allowed students to be able to take time to better learn mathematics, as compared to shorter durations.

It allowed students to better be able to formulate the answers based on the questions presented. This outlines one of the primary requirements for students when learning mathematics, is having longer duration classes, irrespective of using STEM-based or traditional teaching methods. Thus, here the hypothesis testing based on demographic data was *H0*, which outlined that there is no significant difference in student understanding in terms of what teaching methods are used, unless there is sufficient time for classes to be present for students.

Regression Analysis

A regression analysis was conducted on the data collected from the findings with the sole objective of identifying if there was any causal relationship present between the selected variables [19]. The analysis has also helped identify what aspects of these variables are causing the effectiveness of teaching methods to vary for this study. The independent variables selected for this study include the effectiveness of STEM teaching and traditional teaching methods.

The method that will be more effective for students to understand math concepts will be considered to have a higher degree of variation on the dependent variable. A higher degree of tradition will be signified through a higher value, which will help establish the effectiveness of the causal relationships.

The regression analysis for this study has been discussed in three stages: Model Summary, ANOVA, and Table of Coefficients.

Model Summary

Table 3. Model Summary

					Change Statistics					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**	**Durbin-Watson**
1	.574	.330	.220	.83220	.330	3.012	8	49	.008	1.702

a. Predictors: (Constant), Teaching methods experience, Confidence STEM, Visual aid retains concept better, STEM Engagement, Class participation in math, Traditional methods performance, Effectiveness of traditional teaching, Confidence traditional
b. Dependent Variable: More effective approach

The regression model summary presented in Table 3 indicates a moderate positive relationship between the independent variables and the dependent variable ($R = 0.574$), with approximately 33% of the variance in teaching effectiveness explained by the model ($R^2 = 0.330$).

The table above shows the values of R and R-squared. The value of R-squared measures

the goodness of fit, where any value that is above 0.95 is stated to be statistically significant for that given research study. This makes the data suitable for conducting further research. [20]. As can be seen from the above table, in this table the percentage of variation in the dependent value has been estimated to be 0.330.

This shows that 33% of the selected variables can be effectively explained from the data collected. simultaneously, the value of R has been identified to be at 0.574. This value explains that there is a moderate degree of correlation present between the selected Independent and

dependent variables in this research. This means that the selected variables can adequately define the validity of the research hypothesis [20].

It is important to note that the model summary table provides an assessment of the degree of change. This is identified by the value of Sig. F Change. Any value that is less than 0.05 is considered to be significant [21]. As can be seen from the table, the degree of variation has been estimated to be 0.008.

This shows that there is a strong and significant variation present in the selected variables, and that there is indeed a causal relationship present. The 0.008 value highlights that the causal relationship is present in terms of the teaching methods affecting the ability of the students to understand math concepts better.

ANOVA

Table 4. ANOVA Table

ANOVA						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	16.686	8	2.086	3.012	.008
	Residual	33.935	49	.693		
	Total	50.621	57			

a. Dependent Variable: More effective approach
b. Predictors: (Constant), Teaching methods experience, Confidence STEM, Visual aid retains concept better, STEM Engagement, Class participation in math, Traditional methods performance, Effectiveness of traditional teaching, Confidence traditional

The ANOVA results displayed in Table 4 confirm the overall statistical significance of the regression model ($F = 3.012$, $p = 0.008$).

The second step in the regression analysis is to analyse the ANOVA table. The objective of this table is to provide a better estimation of the regression equation. This is mostly to justify whether the data set selected for the analysis can be efficiently fitted in the regression equation to

test its validity [22]. Through this table, it becomes easier to assess whether the selected dependent variable is valid or not. The above table highlights the mean square value of 2.086. This shows that there is a positive relationship present between the predictor variables outlined with the dependent variable.

The high value of the mean square also stresses the significance of the relationship present between the variables. Similarly, this is also supported by the degree of significance that is at 0.008. The value of P is only considered to be significant when $p < 0.05$. In this case, the value of significance is significantly lower than 0.05, proving that there is a strong causal relationship present between the variables. This makes the model valid and effective, with the dependent variable being easily represented by the independent variables selected.

Table of Coefficients

Table 5. Table of Coefficients

Coefficients						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	**Std.**	**Beta**		
1	(Constant)		Error			
		.845	.530		1.593	.118
	STEM Engagement	-.298	.146	-.326	-2.041	.047
	Confidence STEM	-.124	.119	-.163	-1.036	.305
	Effectiveness of traditional teaching	-.036	.149	-.042	-.244	.808
	Confidence traditional	.014	.141	.018	.100	.921
	Visual aids retain concept better	.106	.156	.088	.681	.499
	Traditional methods performance	.272	.189	.243	1.440	.156
	Class participation in math	.144	.139	.144	1.034	.306
	Teaching methods experience	.340	.113	.391	3.009	.004

a. Dependent Variable: More effective approach

As illustrated in Table 5, STEM-related variables demonstrated a stronger predictive influence on instructional effectiveness than traditional teaching variables.

The next step in the regression analysis is the table of coefficients, which helps predict the changes in responses and justify the validity of the proposed hypothesis. The regression equation is identified as: ***DV: (Constant Value) + (IV1) + (IV2) + … + (IVn).***

The higher the value in the table of coefficients, the more they contribute towards the variation in the responses collected [23]. This highlights the impact each of these variables has on changing the performance of students in conceptualizing and solving math problems.

A closer look at the above table shows that all the variables significantly impact student outcomes. It can be assessed from the table that while the students have positive responses towards STEM teaching methods, their confidence and the system have not been strong. However, most students have responded that traditional teaching is not effective when compared to the STEM method.

In this case, the one-sample T-test was implemented to test the effectiveness of the research variables and justify the validity of the proposed hypothesis. Through the implementation of this test, it became easier to prove the reliability of the findings.

Table 6. One-Sample Statistics

One-Sample Statistics				
	N	**Mean**	**Std. Deviation**	**Std. Error Mean**
Teaching methods experience	58	2.0172	1.08404	.14234
STEM Engagement	58	2.3103	1.02951	.13518
Effectiveness of traditional teaching	58	2.2586	1.08515	.14249
Confidence traditional	58	2.6897	1.21694	.15979
Visual aid effectiveness	58	2.0172	.76069	.09988

More effective approach	58	1.7586	.94238	.12374
Confidence STEM	58	2.7069	1.24264	.16317
Visual aids retain concepts better	58	1.8103	.78264	.10277

Descriptive statistics presented in Table 6 show mean values above the test value across all constructs.

The above table highlights the one-sample T-test statistics where each of the values has been assessed and simultaneously compared to the main score of the discounted data to test its validity [24]. The data samples in this table have been based on both the dependent and independent variables.

A closer look at the table shows that the mean depression score of the variables is higher than the test value given, which proves the significance of the finding. higher values of the variables refer to higher significance and thereby make the data reliable.

One-Sample Test

Table 7: One-Sample Test

Test Value = 0						
	T	**Df**	**Sig 2 tailed**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Teaching methods experience	14.172	57	.000	2.01724	1.7322	2.3023
STEM Engagement	17.091	57	.000	2.31034	2.0396	2.5810
Effectiveness of traditional	15.851	57	.000	2.25862	1.9733	2.5439
Teaching						
Confidence traditional	16.832	57	.000	2.68966	2.3697	3.0096
Visual aid effectiveness	20.196	57	.000	2.01724	1.8172	2.2173
More effective approach	14.212	57	.000	1.75862	1.5108	2.0064
Confidence STEM	16.590	57	.000	2.70690	2.3802	3.0336
Visual aids retain concepts better	17.616	57	.000	1.81034	1.6046	2.0161

The one-sample t-test results in Table 7 indicate statistically significant differences ($p < 0.05$), supporting the effectiveness of STEM-based instruction.

The t-test makes it easy to demonstrate the presence of causal relationships between the selected variables. It helps check the strength of the relationship and its significance to justify the acceptability of the proposed hypothesis [25]. Each of the findings in the one-sample T-test is our contribution of the variables on the normal population, where the research was conducted. Each of the values of T-Statistic (***t),*** Significance or P-Value ***(Sig),*** and Degrees of Freedom ***(df)*** helps provide a better understanding of the reliability of the assumptions proposed.

The T-statistic was used to measure the number of standard error units in the sample mean that is away from the hypothesized population mean. A larger absolute t-value refers to a greater difference between the sample mean and population mean. Similarly, the p-value indicates the probability of observing the sample data. Any value that is less than 0.05 is considered statistically significant. Lastly, the degrees of freedom highlight the number of independent values

present, with n being the number of observations considered in the study. As can be seen from the table that each of the values of the independent variables shows a degree of significance *(Sig)* estimated to be at 0.000 (where p = 0.05).

As per the assumptions of the research, when the value of significance is less than 0.05, they are considered to be significant and effective. The values of the mean difference of the selected variables are all positive, which highlights a strong dependency between them and the dependent variable. Therefore, based on these results, the null hypothesis is rejected and the alternative hypothesis is accepted. This means that STEM teaching methods are indeed effective in helping students understand math better when taught regularly to students in the class.

Table 8. Hypothesis Testing

Hypothesis	Accepted/Rejected
H1: The STEM teaching method is more effective than traditional teaching methods, and helps children understand mathematics concepts better.	**Accepted**
H0: STEM teaching method has no significant difference from traditional teaching methods, and does not help the children understand mathematic.	**Rejected**

Interpretation, Implications for Teaching, Summary, and Conclusion

Role of STEM-based instruction on the Mathematical Understanding of Grade 9 Students

Research analysis has identified that providing STEM-based learning to students indeed improves their ability to understand and conceptualize mathematical problems. The regression analysis reveals a strong causal relationship between visual aid effectiveness and class participation in math. In this case, it has been found that students were far more receptive towards solving complex math problems and participating actively in class when STEM methods were used. [26].

Existing literature has pointed out that STEM methods contribute towards enhancing conceptual understanding [26]. This makes it easier for students to understand mathematical problems and increases their interest in the classroom. The same has also been proven from the regression analysis, where students have shown to preference for STEM methods more than traditional methods.

Challenges encountered by Students and Teachers when using STEM-based instruction

There have been certain challenges that have been identified from the analysis. As can be seen from the regression table of coefficients that students found it difficult to grasp the concepts of STEM methods completely, and thereby showed lower levels of confidence. This has been indicated by the negative value of -0.163. This can be mostly because of being exposed to the process for the first time and not having any prior experience.

Also, with students only being exposed to the use of visual aids for an hour at most per class left them with little time to understand how to implement them in their exams. In the case of the teachers, the major challenge was a lack of training in teaching students using STEM methods [27]. The teachers could only teach the students based on the visual aids that were provided to them. There were no resources related to STEM methods available in the classroom. The lack of proper resources left the

teachers unprepared to manage STEM teaching [28].

Benefits encountered by Students and Teachers when using STEM-based instruction

One of the major benefits witnessed from the students through this research was increased interest in math as a subject. Students were more proactive when visual aids were used to teach them concepts of probability [29]. This was proven by the positive values in the coefficients table for class participation. The weekly test results also showed a slight improvement in the performance of the students. For the teachers, it was found that they were more eager to learn about STEM methods, as they felt the confidence of the students was slightly improved when using STEM [30].

It can be justified that STEM methods are indeed more effective as compared to traditional methods, as they help students better understand complex mathematical concepts.

Limitations

There have been several limitations that have presented themselves when researching this topic. The research limitations mostly arose due to time constraints and permission issues.

1. The research did not consider interviewing the teachers regarding their experience of using STEM methods in class to teach math to the students. This creates a significant gap in the research in terms of assessing whether the method was useful or not. Also, it was not assessed whether the teachers could effectively use the visual aids to teach in class. This left a significant area for bias.
2. The research conducted a common survey, where there was no control variable or independent variable. This leaves chances for the reliability and validity of the findings to be affected negatively.
3. The weekly test that was considered failed to effectively measure whether there were any improvements in student outcomes. This is because there was no comparison made with the previous week's test results. The lack of comparison makes it very difficult to measure and imply confidently that the use of STEM methods led to helping students understand math concepts better.

Summary

It can be summarized from the above section that there is indeed a positive impact of STEM-based learning on a better understanding of mathematical concepts for grade 9 students in question. It has been assessed that the students found it easier to understand and solve complex math problems when visual aids were used as opposed to traditional teaching methods.

However, there was also a significant lack of confidence for students in both STEM and traditional teaching methods. The lack of confidence in STEM was mostly because of having no prior exposure. In the case of traditional methods, the lack of confidence mostly arose from the monotony in how math was being taught.

Conclusion

It can be concluded from the given study that the use of traditional methods in teaching mathematics is useful but not very effective. The lack of practical demonstration often creates challenges for students and, as a result, causes difficulty in solving complex math problems. However, this problem can be easily mitigated with the implementation of STEM-based techniques. In this given research, the use of visual aids to teach math to grade 9 students proved to be effective in enhancing the ability of the students to comprehend complex math problems better. It made them more proactive in class in terms of participation in solving math.

At the same time, the research highlighted that the students found the use of visual aids to be interesting. It was also easier to manage.

Also, it was found that despite the effectiveness of STEM methods, the students were still not confident about their implementation. This is mostly as a result of a lack of exposure to these methods before the experimentation.

The research analysis highlighted that the students found it easier to retain mathematical concepts better when they were taught using visual aids. The students also found that STEM methods were more effective for them as they provided them with a positive class experience. However, it is important to note that there were significant challenges that were established, especially in the form of a lack of training in part for the teachers.

The school was also not prepared in terms of resources, as it implemented STEM-based learning in the classroom. There are several limitations that have been identified in this research, especially in terms of how the teachers were not considered for evaluation to understand their perception about using STEM teaching in the classroom.

Also, another limitation was not having a separate control and independent variable, which could have provided proper justification regarding what factors made STEM teaching more effective.

However, aside from these aspects, it can be concluded based on the research findings that STEM-based methods are indeed effective in helping students become actively interested in the Math subject. The use of visual aids indeed helps students to understand math better and solve complex problems easily.

Scope for Future Research

There is significant scope for future research on the topic, as there have been several gaps identified in this case. Firstly, to better understand and prove the effectiveness of STEM teaching, it is essential to look into the literature for the perception of teachers and their experience with this method. Secondly, as opined by Yilmaz and Yanarates, there is also scope for research in understanding in what ways STEM-based teaching can help improve the logical thinking capabilities of the students and make math subjects more interesting for students.

Conflict of Interest

The author declares no conflict of interest.

Ethical Approval

This research was carried out in alignment with the ethical guidelines governing educational studies. The administration of the participating non-traditional high school in St. Andrew granted permission to conduct the research. Additionally, consent was secured from the Grade 9 Mathematics Department. All student participants, along with their guardians, were provided with comprehensive information regarding the study's objectives, methodologies, and anticipated outcomes. Participation was entirely voluntary, and no personal identifying information was gathered. Throughout all phases of data collection, analysis, and reporting, confidentiality and anonymity were strictly maintained.

Data Availability

The data that underpin the conclusions of this research can be obtained from the corresponding author upon a reasonable request. In order to safeguard student confidentiality, the raw responses from questionnaires and test scores cannot be disclosed publicly. Nevertheless, aggregated data tables and the statistical outputs utilized for analysis can be made available upon request.

Author Contributions

Dr. Mark A. Lewis is the sole author of this manuscript. He was responsible for conceptualizing the study, designing the methodology, executing the data collection and analysis, preparing all tables and figures, interpreting the results, and drafting and revising the complete manuscript.

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References

[1]. Eshaq, H. A., 2024, The effect of using STEM education on students' mathematics achievement. Every, E., Ball, L., & van Driel, J.

[2]. Ortiz-Revilla, J., Greca, I. M., & Arriassecq, I., 2022, A theoretical framework for integrated STEM education. *Science & Education*, *31*(2), 383-404.

[3]. Felder, R. M., & Brent, R., 2024, Teaching and learning STEM: A practical guide. *John Wiley & Sons.*

[4]. Sevimli, E., & Ünal, E., 2022, Is the STEM Approach Useful in Teaching Mathematics?

[5]. Foust, C., 2017, Traditional versus Non-Traditional School Management: an Exploratory Analysis of the Impact on High School Students' Academic Achievement.

[6]. Sirajudin, N., & Suratno, J., 2021, Developing creativity through *STEM education.*

[7]. Jawad, L. F., Majeed, B. H., & AL Rikabi, H. T. S., 2021, The Impact of Teaching by Using STEM Approach in The Development of Creative Thinking and Mathematical Achievement Among the *Students of The Fourth Scientific Class.*

[8]. Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F., 2021, Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated *STEM education.*

[9]. Rahman, N. A., Rosli, R., Rambely, A. S., & Halim, L., 2021, Mathematics Teachers' Practices of *STEM Education.*

[10]. Holmes, K., Mackenzie, E., Berger, N., & Walker, M., 2021, Linking K-12 STEM pedagogy to *local contexts*

[11]. Nagaraj, B. K., Kalaivani, A., Begum, S., Akila, S., & Sachdev, H. K., 2023, The emerging role of artificial intelligence in *STEM higher education.*

[12]. Kandaga, T., Dahlan, T., Gardenia, N., & Saputra, J., 2021, A Lesson Study to Foster Prospective Teachers' Disposition in *STEM Education.*

[13]. Huang, Y. C., 2021, Comparison and contrast of *Piaget and Vygotsky's Theories.*

[14]. Polanin, J. R., Austin, M., Taylor, J. A., Steingut, R. R., Rodgers, M. A., & Williams, R., 2024, Effects of the 5E Instructional Model: *A Systematic Review and Meta-Analysis.*

[15]. Mayombe, C., 2024, Promoting youths' skills acquisition through experiential learning theory in vocational education and training in South Africa

[16]. Taherdoost, H., 2022, What are the different research approaches? Comprehensive review of qualitative, quantitative, and mixed-method research, their applications, types, and limitations.

[17]. Noor, S., Tajik, O., and Golzar, J., 2022, Simple random sampling. *International Journal of Education & Language Studies*, *1*(2), pp.78-82

[18]. Hasan, N., Rana, R. U., Chowdhury, S., Dola, A. J., and Rony, M. K. K., 2021, Ethical considerations in research.

[19]. Liu, X., 2022, December. Multivariate Linear Regression Method Based on SPSS Analysis of the Influencing Factors of Urban Residents' *Exhibition Support.*

[20]. Ali, P., and Younas, A., 2021, Understanding and interpreting regression analysis.

[21]. Introduction to Linear Regression Analysis, Fifth Edition. Douglas C. Montgomery, Elizabeth A., Peck, G. Geoffrey Vining, John Wiley & Sons, Inc. Published 2012 by *John Wiley & Sons, Inc.*

[22]. Skiera, B., Reiner, J., and Albers, S., 2021, *Regression analysis.*

[23]. Chicco, D., Warrens, M. J., and Jurman, G., 2021, *The coefficient of determination, R-squared is more informative than SMAPE, MAE, MAPE, MSE, and RMSE in regression analysis evaluation.*

[24]. Afifah, S., Mudzakir, A., and Nandiyanto, A. B. D., 2022, *How to calculate a paired sample t-test using SPSS software: From step-by-step processing for users to the practical examples in the analysis of the effect of the application of anti-fire bamboo teaching materials on student learning outcomes.*

[25]. Elsayed, A. M. A., 2022, *SPSS.*

[26]. Bakirci, H., Kirici, M. G., and Kara, Y., 2022, The Effectiveness of STEM-Supported Inquiry-Based Learning Approach on Conceptual Understanding of 7th *Graders: Force and Energy Unit.*

[27]. Diana, N., 2021, March. *Analysis of teachers' difficulties in implementing the STEM approach in learning: A literature review.*

[28]. Syafril, S., Rahayu, T., Al-Munawwarah, S. F., Satar, I., Halim, L. B., Yaumas, N. E., and Pahrudin, A., 2021, February. *Mini review: Improving teachers' quality in STEM-based science teaching-learning in secondary school.*

[29]. Hamad, S., Tairab, H., Wardat, Y., Rabbani, L., AlArabi, K., Yousif, M., Abu-Al-Aish, A., and Stoica, G., 2022, *Understanding science teachers' implementations of integrated STEM*

[30]. Bal, A. P., and Bedir S. G., 2021, *Examining teachers' views on STEM education.*