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Do Instructional Strategies Impact Students' Situational Interests in Learning Mathematics? A Case Study of Secondary School Students in Guyana

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ABSTRACT: This experimental study investigates which instructional strategies are effective in promoting situational interest in learning mathematics among secondary school students. This research study builds on established theories of interest and mathematics education. Situational interest is an important facet of learning engagement, and it can potentially enhance students' interest and motivation in class. A total of 165 students were engaged in this study, selected from three diverse secondary schools in Georgetown, Guyana, encompassing different grade levels and varying motivating profiles. This study employed a quantitative research design, providing a comprehensive understanding of the relationship between instructional strategies and situational interest. Participants were given a carefully constructed questionnaire that entails questions about their level of situational interest and their perceptions of various instructional strategies used in their mathematics classroom. Results suggested visual aids, inquiry-based learning, and collaborative learning are most effective in promoting situational interest. These findings highlight the interplay between pedagogical approaches and students' motivation, and how closely connected they are. This emphasizes the importance of using teaching strategies that align with students' interests and needs.

KEYWORDS: Collaborative Learning, Inquiry-based Learning, Instructional Strategies, Learning of Mathematics, Motivation, Situational Interest, Visual Aids.

INTRODUCTION

Mathematics plays a leading role in scientific fields such as Physics, Engineering, and Statistics [1]. Mathematics, along with its applications, holds a significant relevance to various other subject areas, and is, therefore, considered a compulsory subject in schools across Guyana. It constitutes a central aspect of the school curriculum. Researchers mentioned that it is "commonly accepted" that mathematics is a complex and uninteresting subject for certain individuals [1]. Learning and interest are closely related; a student's willingness to learn increases with their level of interest. Learning and curiosity are mutually reinforcing; curiosity increases knowledge, which in turn increases interest [2].

Studies have shown that situational interest can be used as a powerful motivator for learning. According to researchers, situational interest is a state of heightened attention and engagement triggered by environmental elements that are surprising, notable, thought-provoking, or relevant [3]. An individual's interest can emerge through situational interest. Individual interest is defined as an individual's profound and long-lasting interest in a subject, demonstrated by their dispositional tendency to reengage with the topics over an extended period without external support [4].

The goal of this study is to explore how instructional strategies can be used to promote situational interest in learning mathematics among secondary school students and address additional objectives tailored to support this goal. Effective design of instructional materials encourages the right kind of thinking in learners, making it easier for them to succeed in their learning [5]. Instructional strategies, such as visual aids, real-world applications, technology, collaborative learning, and problem-based learning, can be used to trigger situational interest in mathematics.

This research will explore two hypotheses to identify which instructional strategies are effective in stimulating interest among secondary school students and capture students' engagement. Researchers suggest that students' poor performance in mathematics globally is more closely related to their perception of the subject than any other variable. Meaning that, whether students perceive mathematics positively or negatively, it does matter, since it will have a significant impact on their performance in the subject [1].

This study claims that instructional strategies have the potential to alter students' negative perceptions of mathematics and initiate a spark of interest.

Therefore, by implementing instructional strategies, teachers can work towards changing students' perceptions, from a negative one to a more positive one. Here, the concept of situational interest is crucial, since situational interest can be stimulated by employing instructional strategies that can make the subject more engaging, relatable, and relevant to students' lives. Hence by identifying which instructional strategies can capture the student's engagement, their situational interest, educators can help students increase their interest and motivation to learn, which in turn will influence their perception of mathematics.

This research also seeks to identify effective practices that can be implemented in secondary school mathematics classrooms. It will provide teachers with evidence-based recommendations for promoting situational interest in classrooms. The findings of this research can be used to inform the development of instructional learning materials and teaching practices that can better engage and support students with varying interests and motivations in their mathematics classrooms.

Interest is a semi-stable construct that reflects a person's dispositional tendencies to engage with a subject over a period of time [4]. Many students find it challenging to pay attention to subjects that don't catch their interest. Although teachers may perceive students as either lacking interest in a subject or having an interest in a subject, their interest is not fixed, it can be stimulated, nurtured, and developed through effective teaching [6]. It should be noted that a student's interest is one of the internal factors that affect their academic achievement. Both situational and individual interests play vital roles in students' academic performance [7].

However, to achieve long-term academic success, situational interest needs to transition into individual interest. Numerous research has demonstrated that triggers may or may not be useful, implying that they may or may not maintain attention [8]. If teachers can recognize the different phases of interest development and understand the importance of it, then they can design instructional strategies that can effectively promote and nurture students' interest.

Mathematics is important in everyday life as well as for academic success. Students develop the perception that mathematics is abstract and as a result, the learning of mathematics would not be beneficial to them. Therefore, many students struggle with motivation and interest in mathematics because of this perception. This lack of interest from students can lead to students performing poorly academically and limiting future success [9].

To address this issue, this research project will explore how instructional strategies can be used to promote situational interest in learning mathematics among secondary school students examine how various instructional strategies affect situational interest, and identify effective approaches that can be used to promote interest in the subject.

RESEARCH QUESTIONS

This study was guided by the following research questions:

Research Question One: Do the instructional strategies have a significant impact on students' situational interests? Based on the research question one, the following research hypothesis was developed:

H_0*:* There is no significant impact between instructional strategies and situational interest.

Research Question Two: Do gender, age, and motivation have an impact on student interest?

Based on the research question one, the following research hypothesis was developed:

H_0: Gender, age, and motivation do not have a significant impact on student interest in learning mathematics.

CONCEPTUAL FRAMEWORK

The framework will investigate the relationship between two key components: situational interest and instructional strategies, as well as other factors such as grade level, gender, and motivation.

Situational interest is the dependent variable and is defined as a type of interest that can be aroused by interesting learning environments [10]. In this case, it will represent the temporary interest or engagement that students in the mathematics classroom experience through instructional activities. It is hypothesized to vary based on the different instructional strategies being employed by the teacher.

Instructional strategies are dependent variables. Instruction refers to the planned procedures and activities for teaching whereas strategies refer to the approach that a teacher may follow to achieve learning objectives [11]. Therefore together, instructional strategies would be approaches or plans that a teacher will use to teach and promote effective learning in a classroom.

Grade level and motivation are the mediating variables.

Mediating variables explain how, or why two variables are related [12]. It is hypothesized that with each grade level, the instructional strategies may have varying effects on situational interest. What works for Grade 8, might not work or be as effective for Grade 10 students. Whereas motivation plays an important role in influencing students' interest and engagement.
A student with a higher level of intrinsic motivation may be most likely to experience situational interest, as compared to those with lower motivation. These students may require specific strategies to spark their interest.
Gender is the moderating variable. Moderating variables examines the influence of an independent variable on a dependent variable, and if it changes at different levels of a third variable [12]. Research has shown that boys and girls will respond differently due to gender-related differences in interest and learning preferences. Females have shown higher academic achievement than males across various levels of education and are more prominently represented in universities [13]. The moderating variable gender in this study will be explored to determine if there are any differential impacts on situational interest based on gender. The impact of instructional strategies on situational interest is hypothesized to vary based on whether the students are male or female.

I. Promoting Situational Interest Through Visual Aids

Visual aids are instruments that can be employed or utilized to enhance learning outcomes, by providing a visual representation of data, concepts, or ideas to help students retain and understand the information [14]. They capture the student's attention and engage them in the learning process. Researchers mentioned that "visual aids arouse the interest of learners and help the teachers to explain the concepts easily" [15].
Visual aids help teach mathematics since they can help students visualize abstract concepts and make them more accessible. They involve a range of forms such as diagrams, charts, graphs, and images. Not only do visual aids help motivate students, they increase their interest and ultimately lead to better academic performance academically. Studies have shown that the use of visual aids has a significant impact on students' academic performance and the absence of visual aids affected their academic performance poorly. Therefore, the use of visual aids in educational classrooms is highly encouraged [16].

II. Promoting Situational Interest Through Real-World Applications

Real-world application refers to problems that relate to real-life situations, contexts, or problems. Incorporating this into classrooms will enhance students' engagement and promote critical thinking skills. This strategy is often referred to as context personalization where context personalization is defined as a strategy that incorporates interest from students' daily life activities into fun learning activities [17].
Students will also understand the relevance and importance of the concepts being taught. Researchers mentioned that teaching practices that take part with real-life content "is an approach aiming to create interest and excitement related to the living environment and a teaching environment which contribute to its continuity" [18]. A 2018 study done by researchers found that if they personalized four units of algebra problems to the interest of students' school life activities would have a sufficient increase in their situational interest [17].

III. Promoting Situational Interest Through Technology

The use of technology in education is as important as any other teaching aid as revealed in studies [19] and billions of dollars have been spent to increase technology tools in classrooms [20]. Technology offers teachers innovative ways to engage students and facilitate learning while enabling students to learn at their own pace. Technology places information right at your fingertips [19].
Additionally, technology provides teachers with data to monitor students' progress and performance. The incorporation of technology in classrooms has been shown to increase students' engagement and promote access to vast amounts of information available online, thereby facilitating a more dynamic and interactive learning environment. Technology that can be used in classrooms include digital media and educational apps [19] [20].

IV. Promoting Situational Interest Through Collaborative Learning

Collaborative learning (CL) in education refers to two or more students participating together to achieve a common educational objective [21][22]. This method will allow students to actively engage with their peers, and share their ideas and knowledge, while also taking responsibility for their learning. It promotes constructive student engagement [23]. There are many forms of collaborative learning, such as group projects, peer tutoring, group discussions, and cooperative learning activities. Researchers observed that cooperative learning can lead to improved academic outcomes, relational skills, and mindset among students when they work collaboratively in a group [24]. Teachers' supervision is favorably connected with student collaboration because, without it, there may be less chance of beneficial contact between the students [22]. Researchers conclude that "a collaborative learning environment could promote accelerated (and maintained) conceptual changes" [25].

V. Promoting Situational Interest Through Inquiry-Based Learning

Inquiry-based learning is a teaching and learning strategy where students imitate how scientists act and think to build their scientific understanding [26]. In other words, teachers allow students to ask questions freely. This approach encourages students to explore a given topic while doing so, it will help students develop their understanding of the concepts. As a result, there may be an increase in motivation and a deeper comprehension of the material by the students in the classroom. It is considered a student-centered approach, this approach helps students develop creative skills, critical thinking skills, and problem-solving skills. Research studies have revealed that inquiry-based learning can result in students achieving better grades in mathematics, and as a result, educators now agree that this approach should form the cornerstone of mathematics instruction in classrooms [27]. There are numerous variations of inquiry-based learning, including case, problem, and projectbased learning [26].

MATERIALS AND METHOD

In this research study, the positivist research philosophy has been chosen as the guiding framework. Positivism relies on the hypothetico-deductive method to empirically evaluate pre-existing hypotheses, often expressed quantitatively genderinclusive. This approach aims to establish functional relationships between independent variables, which represent the causes or explanatory factors, and dependent variables, which are the outcomes of interest [28].

This study is a quantitative research study. This method involves measuring and quantifying the relationship between two variables, independent and dependent variables. In this study, the instructional strategies would be the independent variable. The researchers would ask students to verify the different instructional strategies being used in their classroom, and students will also be asked to rate their level of situational interest upon entering their mathematics classroom. The situational interest would then be the dependent variable, as it is the different instructional strategies influencing the outcome. By manipulating the independent variable and assessing the dependent variable, the researchers can examine the association and determine the effectiveness of the instructional strategies in promoting situational interest.

The numerical data was collected through a survey questionnaire from a sample of secondary school students in Georgetown, Guyana. This study involved students from Grades 9, 10, and 11, from three different secondary schools in the same district, Georgetown, Guyana. These three schools are St. Joseph High School, North Georgetown Secondary School, and Christ Church Secondary School selected by a random sampling method. The questionnaire was divided into two parts, the first part gathered students' demographic information such as age, gender, and ethnicity. The second part was divided into Section one and Section two as situational interest and instructional strategies, respectively.

Section one measured students' situational interest in learning mathematics. This section used four-point Likert scale questions, asking participants to rate their level of interest in mathematics as well as to give reasons as to why they are motivated in their class. Section two measured students' perceptions of instructional strategies that have been used in their mathematics classroom. This section asked questions about instructional strategies that they were exposed to before the study and how frequently are different instructional strategies being used in their classroom, as well as using five-point Likert scale questions, asking participants to rate the effectiveness of the instructional strategies being used in their classroom.

A statistical analysis will be performed on the gathered data using the Statistical Package for Social Sciences (SPSS) to detect patterns, correlations, and statistically significant outcomes. Determining statistical significance aids the researchers in reaching trustworthy conclusions based on the data and provides evidence to either accept or reject the null hypotheses.

By using inferential statistical techniques such as ordinal logistic regression analysis the researchers aim to conclude the relationship between instructional strategies and situational interest. The findings provided insight into understanding which instructional strategies are most likely to promote situational interest among secondary school students. Ordinal regression is designed for situations where the response variables have an order or ranking, and it deals with the overall trend across these order or rank values by using cumulative distribution and fitting parameters for each association [29].

A pilot test was conducted to evaluate the viability and effectiveness of the research instrument and procedure before the main study. A sample of thirty students was selected. The research instrument used in the pilot test was a survey questionnaire. This questionnaire included Likert-scale questions designed to assess students' perceptions of instructional strategies and their situational interest in learning mathematics.

DATA ANALYSIS AND RESULTS

Research Question 1: *Do the instructional strategies have a significant impact on students' situational interests?*

The researchers used Ordinal Regression Analysis to compute the data for this research question. Ordinal Regression Analysis was used to examine how changes in the predictor variables relate to impact the likelihood of moving up the ordinal scale. The data set looked at instructional strategies, the researcher assumes that higher levels of each instructional strategies correspond to higher levels of situational interest. Secondary school students were asked if they have very low, low, high, or very high interest in mathematics. Hence, the outcome variable has four categories. Data on each instructional strategy was collected.

Output:

Model Fitting Information

Model	-2Log Likelihood	Chi-Square	df	Sig.
Intercept Only	340.167			
Final	309.012	31.156	19	.039

Table I - Showing the model-fitted information

If $p < 0.05$ then the model is a good fit for the data. The $p - value$ of 0.039 shows that the model is a good finding on how well the model fits the data.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	375.726	362	.299
Deviance	300.694	362	.992

Table II - Showing the goodness-of-fit

If $p > 0.05$ then the model is a good fit for the data.

Both tests (Pearson and Deviance) have $p - values > 0.05$, therefore, they both reject the null hypothesis, H_0: There is no significant impact between instructional strategies and situational interest. Thus, it can be concluded that there is a significant impact between instructional strategies and situational interest.

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		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[SInterest = 1.00]	22.891	3.500	42.773	1	.000	16.031	29.750
	[SInterest = 2.00]	24.653	3.518	49.100	1	.000	17.757	31.549
	[SInterest = 3.00]	26.791	3.544	57.133	1	.000	19.844	33.738
Location	Age	.351	.176	3.964	1	.046	.005	.696
	[Gender=1.00]	.058	.354	.027	1	.871	-.636	.751
	[Gender=2.00]	0^a	.	.	0	.	.	.
	[Visual_Aids=1.00]	1.588	1.445	1.207	1	.272	-1.245	4.421
	[Visual_Aids=2.00]	1.323	1.445	.838	1	.360	-1.510	4.156
	[Visual_Aids=3.00]	1.637	1.470	1.240	1	.265	-1.244	4.518
	[Visual_Aids=4.00]	0^a	.	.	0	.	.	.
	[RealWorldApp=1.00]	-1.500	.916	2.679	1	.102	-3.296	.296
	[RealWorldApp=2.00]	-1.425	.860	2.747	1	.097	-3.111	.260
	[RealWorldApp=3.00]	-1.399	.859	2.653	1	.103	-3.082	.284
	[RealWorldApp=4.00]	0^a	.	.	0	.	.	.
	[Technology=1.00]	-1.352	2.141	.399	1	.528	-5.549	2.844
	[Technology=2.00]	-2.123	2.116	1.007	1	.316	-6.270	2.024
	[Technology=3.00]	-1.944	2.114	.846	1	.358	-6.087	2.200
	[Technology=4.00]	-4.316	2.293	3.543	1	.060	-8.809	.178
	[Technology=5.00]	0^a	.	.	0	.	.	.
	[CollabLearning=1.00]	1.856	.779	5.675	1	.017	.329	3.382
	[CollabLearning=2.00]	1.806	.704	6.590	1	.010	.427	3.185
	[CollabLearning=3.00]	1.665	.706	5.557	1	.018	.281	3.049
	[CollabLearning=4.00]	0^a	.	.	0	.	.	.
	[IBL=1.00]	20.167	.745	733.148	1	.000	18.707	21.626
	[IBL=2.00]	20.451	.679	907.561	1	.000	19.121	21.782
	[IBL=3.00]	20.192	.702	827.419	1	.000	18.816	21.567
	[IBL=4.00]	19.089	.000	.	1	.	19.089	19.089
	[IBL=5.00]	0^a	.	.	0	.	.	.

Table III - Showing the Parameter Estimates

We are most interested in the location aspect of the parameter estimates in Table III above. The estimate tells the likelihood of how probable it is for instructional strategies to be more advanced or better on situational interest. There are positive values for visual aids, collaborative learning, and inquiry-based learning. Therefore, it means that if there is an increase in visual aids (i.e., sometimes to always) there would be an increase in their situational interest. Similarly for collaborative learning and inquiry-based learning. Both real-world applications and technology have negative values, which means the opposite, if there is an increase in variables, there will be a decrease in their situational interest.

Test of Parallel Lines

Model	-2Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	309.012			
General	264.410	44.601	38	.214

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories

Table IV - Test of Parallel lines

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If $p - value > 0.05$ indicates non-significance. This tests the assumption of proportional odds. The $p - value = 0.214$ so we reject the null hypothesis.

Conclusion: The null hypothesis (H_0: the independent variables do not have a significant impact on the dependent variable) was rejected, since the $p - value > 0.05$. There is evidence of a significant impact of the independent variables on the dependent variable.

Research Question 2: Do gender, age, and motivation have an impact on student interest?

The data set looks at independent variables, gender, age, and motivation. The researchers assume that these factors collectively will contribute to students' varying levels of situational interest. Secondary school students were asked if they have very low, low, high, or very high interest in mathematics. Hence, the outcome variable has four categories. Data on each independent variable was collected.

Model Fitting Information

Model	-2Log Likelihood	Chi-Square	df	Sig.
Intercept Only	176.787			
Final	139.103	37.685	5	.000

Table V - Showing the model-fitted information.

If $p < 0.05$ then the model is a good fit for the data. The $p - value$ of 0.000 shows that the model is significantly a good fit for the data.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	82.999	67	.090
Deviance	73.520	67	.273

Table VI - Showing the goodness-of-fit

If $p > 0.05$ then the model is a good fit for the data. Both tests (Pearson and Deviance) have $p - values > 0.05$, therefore, they both reject the null hypothesis, H_0**:** Gender, age, and motivation do not have a significant impact on student interest in learning mathematics. Thus, gender, age, and motivation have a significant impact on student interest in learning mathematics.

Output:

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[SInterest = 1.00]	4.369	4.808	.826	1	.363	-5.054	13.793
	[SInterest = 2.00]	6.331	4.823	1.723	1	.189	-3.122	15.785
	[SInterest = 3.00]	8.524	4.847	3.093	1	.079	-.976	18.024
Location	Age	.321	.311	1.067	1	.302	-.288	.930
	[Gender=1.00]	-.123	.330	.139	1	.710	-.770	.524
	[Gender=2.00]	0^a	.	.	0	.	.	.
	[Grade=1.00]	.347	.749	.215	1	.643	-1.121	1.815
	[Grade=2.00]	-.104	.502	.043	1	.836	-1.087	.879
	[Grade=3.00]	0^a	.	.	0	.	.	.
	[Motivation_Math=1.00]	2.472	.465	28.295	1	.000	1.561	3.382
	[Motivation_Math=2.00]	0^a	.	.	0	.	.	.

Table VII - Showing the Parameter Estimates

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The estimate tells the likelihood of how probable it is for each independent variable to be more advanced or better on situational interest when increased by one variable. The estimate for the age variable is 0.321, which means that when the age of the respondent increases, the chances of him or her having higher interest also increase. As for gender, female students had a higher interest in mathematics in comparison to male students. As for the impact of grade levels, those students in grade 8 have a lower interest as compared to students who are in grades 7 and 9. As for motivation, students who are already motivated have a higher chance to increase their motivation, and students who are motivated also have a chance to increase their motivation since the $p - value$ = 0.000 and is considered to be statistically significant.

Test for Parallel Lines

Model	-2Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	139.103			
General	126.011	13.091	10	.219

Table VIII - Showing the test of parallel lines

If $p - value > 0.05$ indicates non-significance. This tests the assumption of proportional odds. The $p - value = 0.219$ so we reject the null hypothesis.

Conclusion: The null hypothesis (H_0: gender, age, and motivation do not have a significant impact on student interest in learning mathematics) was rejected, since the $p - value > 0.05$. There is evidence of a significant impact of these independent variables on the student's situational interest.

DISCUSSION

The results obtained from the statistical analysis reveal important insights. The null hypothesis for research question one posited that the independent variables (visual aids, real-world applications, collaborative learning, technology, and inquirybased learning) do not have a significant influence on the dependent variable (situational interest). The null hypothesis was rejected since the $p - value > 0.005$. This suggests that the dependent factors significantly influence the dependent variable is supported by some degree of evidence. Similarly, the null hypothesis for the second research question was also rejected due to the same foreseeable results. Since both research questions reject the null hypothesis, then the independent variables play a role in influencing students' interest in mathematics learning.

The current study delved into the realm of situational interest in mathematics and the instructional strategies that can effectively enhance it. The findings underscore the significance of well-designed teaching methods in capturing students' attention and fostering engagement. Through ordinal logistic regression analysis, it was evident that certain instructional strategies correlate positively with heightened situational interest. Moreover, gender, age, and motivation were identified as factors influencing students' responses to these strategies.

As we seek to cultivate a deeper appreciation for mathematics and encourage its pursuit, teachers must recognize the pivotal role of situational interest. By tailoring their teaching methods to not only convey mathematical concepts but also evoke curiosity and captivation, educators can pave the way for more enriched learning experiences. This study provides a stepping stone for pedagogical practices that acknowledge diversity in students' backgrounds, needs, and motivations.

Pedagogical Recommendations

Based on the impact of gender, age, and motivation on students' situational interest, particularly in subjects like mathematics, teachers should consider the following pedagogical recommendations to enhance learning outcomes:

Promote gender-inclusive learning environments. That is to create a classroom environment that promotes gender equity. The first step to promote gender-inclusive learning environments should be gender-inclusivity training. They should tailor instruction to each grade level. They should recognize the varying ages and adjust instructional strategies accordingly. To promote intrinsic motivation, they should provide opportunities for autonomy, competence, and relatedness in the learning process. By implementing these, teachers can cultivate an inclusive and motivating learning environment [30].

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CONCLUSION

In conclusion, the journey to promote situational interest in mathematics is a multidimensional one, influenced by an interplay of strategies, demographics, and individual propensities. As educational landscapes continue to evolve, this research calls for a dynamic approach to teaching, one that transcends conventional methodologies and embraces innovation, inclusivity, and the ever-evolving tapestry of student diversity.

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