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Exploring the Factors that Influence Students' Interest in Using Scratch to Learn Coordinate Geometry: An Integrated Model Based on the Technology Acceptance Model

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Abstract

Prior studies have shed important light on the considerations of students' decisions to accept and apply educational technologies to their learning. However, from the instruction perspective, the more crucial concern is how students decide on actions that may increase interest in and successful utilization of educational technologies. Research on using Scratch to help students acquire knowledge in coordinate geometry, which mathematics instructors have found difficult for students to understand, is scarce in the literature. To fill this gap in the literature, an integrated model based on the technology acceptance model was created to explore factors that influence students' interest in using Scratch to learn coordinate geometry. This study showed that students' situational interest in Scratch was predicted by their perceptions of usefulness, usability, and behavior intention irrespective of their gender, grade, accessibility to technology tools, and learning preferences. The results also suggested that the association between perceived usefulness and situational interest was positively mediated by perceived ease of use and behavior intention. These research findings have important implications for instructional decision-making on Scratch implementation in mathematics education.

Keywords: Scratch, coordinate geometry, interest, usefulness, usability.

INTRODUCTION

Coordinate geometry is essential in mathematics as it offers a potent instrument for analyzing and understanding geometric shapes and their attributes, as well as for resolving issues in other branches of science and mathematics. To this end, Oviawe et al. (2020) and Akaazua et al. (2017) ascribed the development of student's abilities in exploring, critiquing, creative thinking, and self-expression to studying geometry-related concepts. Conscious of the inherent gains for students studying coordinate geometry at school (Oviawe et al., 2020), the pre-tertiary curriculum for Ghana’s education is replete

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with contents related to coordinate geometry. At the Junior High School (JHS) level, coordinate geometry runs through two strands (Number, and Geometry and measurement) of the Common Core Curriculum (Ministry of Education [MoE], 2020). Consistent with established practices, the planners of the Common Core Curriculum have combined algebraic principles and techniques, and concepts of geometry in the study of coordinate geometry. Specifically, provisions in the common core curriculum (MoE, 2020) that deal with coordinate geometry include:

a) Use of proportional reasoning to find missing values in the tables, and the plot of pairs of values on the coordinate plane.
b) Determine shapes in real life that have reflectional (or fold) symmetries.
c) Plot points and shapes (i.e., plane figures) on a coordinate plane and draw their images under reflection in given lines; translation by a given vector; and rotation at angles.
d) Verify the concept of congruent and similar shapes in the coordinate plane using properties of both the object(s) and image(s); and in real-life situations (carpet designs, fabric pattern).
e) Recognize and represent proportional relationships between quantities by deciding whether two quantities are in a proportional relationship. (e.g. by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin).

By achieving these provisions in the curriculum, it is expected that JHS students would be equipped with the basic competencies to develop abstract, logical, and critical thinking, and the ability to reflect critically (MoE, 2020). Despite its prominence in the Ghanaian pre-tertiary curriculum, our analysis has uncovered persistent challenges encountered by Junior High School (JHS) students in comprehending and applying coordinate geometry concepts. Conventional teaching techniques that include graphs, equations, and formulas can often be overwhelming, making it difficult for students to interpret and analyze graphical representations (Plotz, 2015; Makar et al., 2018; Ghafar et al., 2023). Consequently, an in-depth study of the Basic Education Certificate Examination's (BECE) report of the West African Examination Council (WAEC), the body mandated to assess and grade JHS students confirms the difficulty of students in answering questions related to graphs.

Generally, while the BECE reports in the last decade (2013 – 2022) showed that JHS students had little difficulty drawing graphs, they were constrained with the interpretation and analysis thereof. Specifically, scrutinizing 2013, 2014, 2015, 2017, and 2019 BECE reports for the years in which questions on coordinate geometry and graphing were posed, students preferred the use of formula rather than related graphs to determine values (WAEC, 2015); a section of students also found it difficult to translate and reflect objects in the x-y plane (WAEC, 2014); others were unable to accurately measure the angle between two given lines on a graph sheet (WAEC, 2017). Put together, the 2019 report indicted students for avoiding questions related to graphing (WAEC, 2019). These reports further admonished students for their inability to accurately read from graphs (WAEC, 2013; 2019). In some other instances, the report showed that most students avoided a question that related mapping to drawing and interpreting corresponding graphs. Students could not find the gradient from the graph nor were they able to use the graph to find the equation of lines (WAEC, 2019). The lack of comprehension is not limited to Ghana but resonates with global concerns, as demonstrated by Ubi et al.'s (2018) findings in Nigeria. As a consequence of conventional pedagogy in coordinate geometry, Kirschner et al. (2006) argued that young learners have limited working memory capacity and that providing too much open-ended instruction can overwhelm them and lead to ineffective learning. However, with explicit, step-by-step instruction and adequate practice and manipulation of learning resources, such as diagrams, simulations, and worked examples, students learn better and develop an interest in learning (Ahmad Shahrizal et al., 2022; Hasbullah et al., 2022; Budiastuti et al., 2023). Thus, more interactive and interesting teaching resources are required to teach coordinate geometry.

Deduced to Akinyemi et al. (2021), computer programming resources are the surest ways to learn geometry. Scratch, a visual programming language, created by MIT Media Lab, lets students use code blocks to make interactive animations and games. The Scratch interface has four areas: stage, sprite list, scripts area, and blocks palette. It is an easy-to-use interface that allows students to combine colored pieces of code to create interactive stories, games, and animations. Students can generate and manipulate geometric forms using coordinates in Scratch's user-friendly interface to grasp the mathematics principles and concepts. Accordingly, researchers, including Mo et al. (2021) and Ortiz-Colon and Romo (2016) have established that Scratch programming language improves students' achievement. In response to the persistent challenges faced by JHS students in coordinate geometry concepts, our study purposely explored the potential of Scratch, a visual programming language, to enhance students' situational interest in learning coordinate geometry. Subsequently, we explored potential factors that might account for the levels of situational interest of students in the use of Scratch to learn coordinate geometry.

We chose to investigate situational interest rather than interest in coordinate geometry because situational interest identifies with the immediate emotional response to a specific stimulus in the learning environment that focuses one's attention on the task in question, with uncertainty about how long the acquired interest endures over time (Rotgans & Schmidt, 2011). To that end, Frenzel et al. (2010) interpreted interest as context-dependent, implying that there is no such thing as individual interest, which tends to be consistent throughout time, but situational interest, which fluctuates with changing times. Rightly so, the interest of students in coordinate geometry may begin with their situational interest, which is usually triggered by a particular feature of the learning environment or the activity through to the individual interest, to developmental interest, and then to a well-developed interest inherent in the subject matter (Hidi & Renninger, 2006). Unlike conventional teaching methods, Scratch can be a great motivator for students who have a high situational interest in coordinate geometry since it can keep them on task and even foster a longer-lasting interest in mathematics. Earlier researchers have intimated that students' interest in the use of Scratch may to a large extent depend on how engaging the technology is to them (Campbell & Atagana, 2022; Iyamuremye & Nsabayezu, 2022; Dohn, 2019) vis-à-vis the usefulness and perceived ease of using

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Scratch (Liu & Jiao, 2020; Park, 2019). Scratch fosters computational thinking and problem-solving abilities and assures the examination of numerous mathematical concepts (Campbell & Atagana, 2022; Dohn, 2019; Park, 2019; Chang et al., 2012).

While at it, some studies have shown that students' predisposition factors such as gender, prior experience in computing or programming, and learning styles have some levels of relationships with the learning of computer-assisted programming language and mathematics. Markedly, Byrne et al. (2001) could not establish a statistical relationship between gender, learning styles, and prior programming experience with success in programming. Similarly, Thangavelu et al. (2019) opinionated that gender differences have no significant effect on performance with Scratch. Nevertheless, Zdawczyk and Varma (2022) provided empirical data to show that even girls with low self-efficacy in mathematics had their interest improved, courtesy of the use of Scratch in teaching mathematics. Other studies (Graßl et al., 2021; Hsu, 2014) have shown that male and female students have different interests and levels of engagement with the Scratch technology. Besides, Chang et al. (2012) experiment revealed a significant relationship between learning styles and learners' engagement with Scratch. Based on their findings, Chang et al. (2012) proclaimed that learners with V-style (visual learners) have higher engagement on Scratch. Although success in programming requires considerable prior programming language (Lokkila et al., 2022; Thangavelu et al., 2019; Lee et al., 2011), prior knowledge in computing and programming may not be a requirement for using Scratch (SantClair et al., 2021; Thangavelu et al., 2019). It is of interest to note that the use of Scratch in mathematics learning ranges from elementary school (Mo et al., 2021; Calder, 2010), through high school (Dohn, 2019), to the university levels (Papadakis & Kalogiannakis, 2019).

Based on the purpose of this study, we answered three research questions as follows:

a) What is the extent of students' situational interest in using Scratch to learn coordinate geometry?
b) To what extent do the usefulness, ease of use, and behavior intention predict the situational interest of students in using Scratch to learn coordinate geometry?
c) To what extent do the usefulness, ease of use, and behavior intention relate to predicting the situational interest of students in using Scratch to learn coordinate geometry?

Our conviction towards these research questions is that combining students' perceived usefulness, ease of use, and behavior intention with other predisposition factors might help explain the situational interest of JHS students (hereafter referred to as students) in the learning of coordinate geometry. Consequently, explaining situational interest in technology-enhanced learning, the study advances the theoretical framework, enhances hypotheses, and guides future study. In an age of digital literacy, understanding how Scratch affects students' mathematics interests is important for education. Based on the claims of Sun et al. (2022) that the use of computer programming software alone is not a sufficient predictor of students' interest in their use, further research has shown that predisposition factors such as gender (Akudo, 2021; Zhang, 2021), learning styles (Taley & Ndamenenu, 2022; Akudo, 2021), and prior experience (Fasinu et al., 2023; Phan & Ngu, 2021), affect students' achievement in mathematics and coordinate geometry. In an era where digital literacy, integrating these factors provides a complete picture of influencers of students' interest in coordinate geometry through Scratch.

CONCEPTUAL FRAMEWORK

The Technology Acceptance Model (TAM), according to Venkatesh and Bala (2008) was developed to predict individual adoption and use of new technologies. TAM framework identified two beliefs that influence people's decision to use technology (behavioral intention) – the degree to which a person thinks using the technology will improve their performance (perceived usefulness), and the degree to which a person thinks using technology will be effortless (perceived ease of use). Without prejudice to any editions of the TAM model, this study did not attempt to validate but only adapted the basic TAM framework of Lederer et al. (2000) to examine students' situational interest in coordinate geometry facilitated using Scratch. In this regard, we focused on the psychometric aspects of TAM constructs.

We, in this study, conceptualized that besides the perceived usefulness and the perceived ease of use, the behavioral intent could influence the situational interest of students in the learning of coordinate geometry using Scratch technology. This is because the behavioral intention, which is seen as a more futuristic desire to use Scratch can affect the immediate behavior (situational interest) towards the use of Scratch. The theory of planned behavior (Ajzen, 2020), which has been widely applied to predict behavioral changes in the use of technology postulates that people are more inclined to adopt a favorable attitude about behavior if they believe that it will lead to beneficial outcomes in the future. This positive attitude then influences their intention to engage in the behavior, which, in turn, shapes their immediate actions.

RESEARCH DESIGN

A one-shot case study quasi-experimental design (Creswell, 2014) in which learners were taught coordinate geometry using Scratch guided the conduct of this study. The design permitted students' perception of usefulness, ease of use, intention, and situational interest to be explored after going through a single demonstration lesson without recourse to any previous entry behavior. In this case, only a post-test learning behavior was assessed. The demonstration lesson on using Scratch in teaching coordinate geometry was opened to all JHS students within the Mampong Educational Directorate. However, 103 students showed up for the demonstration lesson. The memo sent to the schools (through the Mampong Education Directorate) requested the presence of five students from each of the 19 JHSs in the Directorate. Although we did not influence the selection of the learners, we requested that the learners be selected across the three grade levels (Basic 7, 8, and 9).

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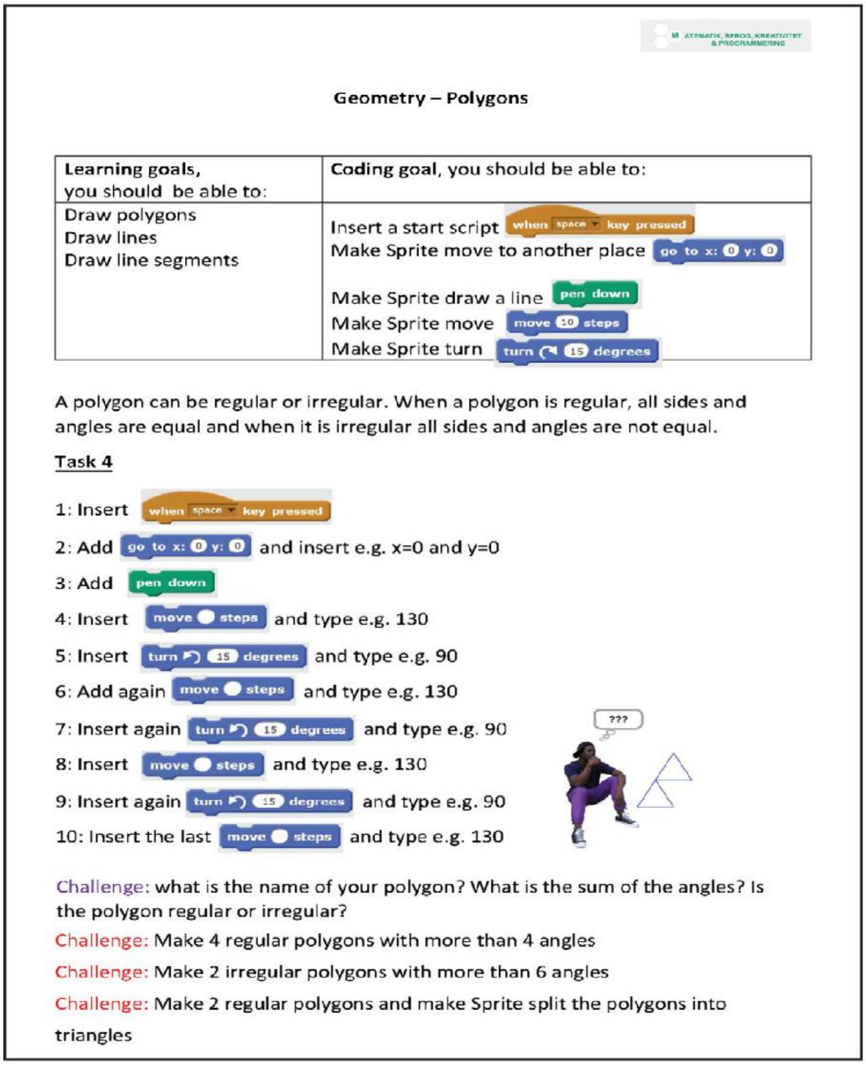
Based on the capacity of the ICT lab of the center for the study, the research sample was put into three groups of 34 students. Each group received 90 minutes of mathematics instruction. The three-part lesson planning (Meier, 2015) was adapted to provide meaningful instruction. Part 1 (Minds-on, introduction to coordinate geometry and Basic Scratch programming skills; 20 mins) – engaged, reactivated prior knowledge, assessed students' conceptual understanding and provided them with any skills they might need moving forward. Part 2 (Action, making a coordinate grid, plotting points and shapes, exploring transformations, and Interactive activities and games; 50mins) – students used the information from the first part of the lesson in this section to explore, enquire about, and test their knowledge and skills concerning using the Scratch programming language. Students interacted with their computers while the facilitators provided adaptive individual student support. Part 3 (Reflection; 20 mins) – utilized various techniques, including the gallery walk and math congress, to consolidate and reflect on the lesson. This way, every student could view other students' work because it was displayed.

Intervention

The session started with an overview of the Cartesian coordinate system, including an explanation of the x-axis, and y-axis and the idea of ordered pairs. Consequently, we provided actual examples to assist students in comprehending the everyday applications of coordinates. Scratch was introduced to the class in a brief session. Students learned how to use the different coding blocks to build sprites, animate objects, and respond to user input. We also helped students understand fundamental programming ideas like algorithms, operators, loops, and variables. Students learned to use Scratch to make a coordinate grid as illustrated in Figure 1. The x- and y-axes were represented by xy-grid backdrops and sprites that were moved on the lines. To customize the grid's appearance, we encouraged experimentation and imagination.

Students gained knowledge of how to plot points on the coordinate grid using Scratch's programming building blocks. To represent points and shapes, students created sprites, which they then programmed to move to specific coordinates (Figure 1). Students were able to see how algebraic coordinates related to their geometric representation. Subsequently, we explored rotations, translations, and reflections, and students used these ideas to program sprites to move and reflect across the coordinate plane (Figure 1). Students had the opportunity to reinforce their grasp of transformations in coordinate geometry as they observed the modifications of the location and orientation of the shapes. We incorporated engaging exercises and games into the lesson to enhance learning. For instance, students designed games to determine the coordinates of objects on a screen (Figure 1). These activities promoted active participation from the students and offered us the chance for formative evaluation.



Geometry – Polygons

Learning goals, you should be able to:	Coding goal, you should be able to:
Draw polygons Draw lines Draw line segments	Insert a start script [when space key pressed] Make Sprite move to another place [go to x: 0 y: 0] Make Sprite draw a line [pen down] Make Sprite move [move 10 steps] Make Sprite turn [turn 15 degrees]

A polygon can be regular or irregular. When a polygon is regular, all sides and angles are equal and when it is irregular all sides and angles are not equal.

Task 4

1: Insert [when space key pressed]

2: Add [go to x: 0 y: 0] and insert e.g. x=0 and y=0

3: Add [pen down]

4: Insert [move steps] and type e.g. 130

5: Insert [turn 15 degrees] and type e.g. 90

6: Add again [move steps] and type e.g. 130

7: Insert again [turn 15 degrees] and type e.g. 90

8: Insert [move steps] and type e.g. 130

9: Insert again [turn 15 degrees] and type e.g. 90

10: Insert the last [move steps] and type e.g. 130

Challenge: what is the name of your polygon? What is the sum of the angles? Is the polygon regular or irregular?

Challenge: Make 4 regular polygons with more than 4 angles

Challenge: Make 2 irregular polygons with more than 6 angles

Challenge: Make 2 regular polygons and make Sprite split the polygons into triangles

Figure 1: Task example – to plot transformation in Scratch

Before the enactment of the demonstration lesson, a survey of the student's learning preferences was conducted. Post the demonstration lesson too, a survey of students' perceived usefulness (PU), perceived ease of use (PEU), behavior intention (BI), and situational interest (SI) in using Scratch to learn coordinate geometry was conducted. The survey instruments were designed in a single booklet. Fifteen minutes before the demonstration lesson, the booklets were distributed for the students to provide their bio-information and learning preferences. The bio-information was the Gender (male or female), the class (Basic 7, 8, or 9) of the learners, and the availability and usage of technology tools.

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Here, we categorized the technology tools into computers (Desktops and laptops) and Mobile devices (Smartphones, Tablets and Notepads). Then after the demonstration lesson, the students were given 10 minutes to complete the PU, PEU, BI, and SI surveys.

Instrumentation

To identify the learning preferences of students, O'Brien's, (1989) 30-item learning preference questionnaire was adopted. The learning preferences questionnaire identified learners as visual, auditory, and kinaesthetic. However, the questionnaire on PU, PEU, BI, and SI was an 18-standard instrument (descriptive anchors slightly modified to measure students' PU, PEU, BI, and SI using Scratch to learn coordinate geometry). The 18-standard scale was in two parts: Part 1 (technology acceptance model, TAM questionnaire) and Part 2 (situational interest questionnaire, six items, adapted from Rotgans & Schmidt, 2009). Two constructs of TAM (PU and PEU with four items each) were adapted from Venkatesh and Bala (2008), while the items on BI (four items) were adapted from Mertins and Austermann (2014). A sample of items used for each of the four scales includes PU (e.g., I would find the Scratch technology useful in learning mathematics); PEU (e.g., It would be easy for me to become skillful in the use of the Scratch technology); BI (e.g., I intend to continue using the Scratch technology to learn mathematics); and SI (e.g., I am fully focused in studying coordinate geometry using Scratch). Previous studies have shown that the items defining PU and PEU (Venkatesh & Bala, 2008), BI (Mertins & Austermann, 2014), and SI (Pokuah et al., 2023; Rotgans & Schmidt, 2011), are reliable and valid.

Following an exploratory factor analysis and in harmony with the procedure for ensuring convergent validity (Gaskin & Lim, 2016), one item on the SI scale failed the convergence criteria (factor loadings were less than 0.5). Therefore, 17 items were incorporated into this study. Subsequently, we verified the internal consistency of the four-scale questionnaire using composite reliability (Hair et al., 2019), which proved that the items describing PU, PEU, BI, and SI were appropriate. We also verified the discriminant validity using the procedure involving the square root of the Average Variance Extracted (Gaskin & Lim, 2016). Subsequently, the square root of the AVE of each scale was higher than their respective correlations, confirming discriminant validity as proposed by Fornell and Larcker (1981).

Response Rate and Bio-information

We achieved a survey completion rate of 100%, which means all participants (n = 103) completed the survey. After applying the inclusion criteria, seven responses were dropped (missing data) in line with the recommendation of Garson (2012). Of the 96 remaining responses analyzed, 33% (n = 32) were completed by learners in Basic 7, 27% (n = 26) in Basic 8; and 40% (n = 38 in Basic 9. As Table 1 indicates, female students outnumbered their male counterparts by 6.2%. About 13% of participants (n = 12) use computers; 33% of participants (n = 32) use mobile devices; 20% of participants (n = 19) use both computers and mobile devices; while 34% of participants (n = 33) use neither computers nor mobile devices at home. Regarding learning preferences, most were kinaesthetic learners (40.6%), with auditory learners (21.9%) being the least represented (Table 1). Irrespective of the distribution imbalances, it was only the distributional differences in the use of statistically significant technology tools (Table 1).

Table 1: Bio-information data and situational interest (SI) per demography (N = 96)

Demography	Category	Descriptive		The goodness of fit test		
		f	%	$chi - squared$	df	p
Gender	Male	45	46.9	.375	1	.540
	Female	51	53.1			
Class	Basic 7	32	33.3	2.250	2	.325
	Basic 8	26	27.1			
	Basic 9	38	39.6			
Tech tools use	Computers (Comp.)	12	12.5	13.083	3	.004
	Mobile devices (MD)	32	33.3			
	Comp & MD	19	19.8			
	None	33	34.4			
Learning style	Visual	36	37.5	5.813	2	.055
	Auditory	21	21.9			
	Kinaesthetic	39	40.6			

Statistical Analysis Method

We coded and analyzed the data in SPSS version 21. Descriptive statistics (frequency and percent) were used to summarize the categorical data, while the mean and standard deviations were used to describe the continuous data. The Kolmogorov-Smirnov test (N > 50) was performed to screen for outliers and confirm the normality of data (Garson, 2012). The data did not meet the test for normality and the square root and log transformation did not improve the normality either. Therefore, we used Spearman's correlation test to assess bivariate correlations between the variables (PU, PEU, BI, and SI) (Table 2). All correlations were positive and statistically significant except for the correlation between BI and PEU.

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Table 2: Descriptive statistics (N = 96)

Variables	Correlations				M	SD	CR
	1	2	3	4			
1. Situational interest	***.581***	.470**	.455**	.505**	3.354	.430	.886
2. Perceived usefulness		***.615***	.301**	.203*	3.612	.364	.772
3. Perceived ease of use			***.686***	.176	3.302	.515	.712
4. Behaviour intention				***.816***	3.112	.756	.702

*** & * Correlation is significant at the 0.01 & 0.05 level (2-tailed).*

Diagonal elements in the correlation matrix are the square root of AVE.

We further conducted a multiple linear regression and mediation analysis to assess the relationship among the variables (PU, PEU, BI, and SI) while we adjusted for potential confounding variables (gender, class, use of technology tools, and learning preferences). Before fitting the regression model, assumptions underlying multiple regression, which include linearity, independence, homoscedasticity, and absence of multicollinearity were checked, and no significant violation was noted. For example, the Durbin-Watson value (2.283) produced by the stepwise multiple regression model met the assumption of independence of errors (Garson, 2012). Additionally, the correlation statistics (Table 2) showed that PU, PEU, and BI were all significantly correlated ($.2 < r < .7$; Iacobucci et al., 2016) with SI, which fulfilled the multicollinearity test. In accordance with the method used previously by Rezai et al. (2009), a sensitivity analysis was carried out to confirm the confounding variables. At a 95% confidence interval, all covariates (gender, class, use of technology tools, and learning preferences) were not statistically significant ($p > 0.25$). Consequently, none of the covariates was incorporated into the regression model.

RESULTS

Research Question 1

What is the extent of students' situational interest in using Scratch to learn coordinate geometry?

We used the mean, standard deviation, and percentages to analyze students' situational interest in using Scratch to learn coordinate geometry (Table 3).

Table 3: Mean and Standard deviations of students' situational interest

SI	Gender		Class			Use of Technology tools				Learning style		
	Male	Female	B7	B8	B9	Comp.	MD	Comp & MD	None	Visual	Auditory	Kinaesthetic
M	3.35	3.28	3.39	3.41	3.29	3.35	3.38	3.33	3.35	3.36	3.34	3.37
SD	.47	.47	.41	.51	.39	.43	.48	.42	.41	.40	.47	.43

SI = Situational Interest, M = Mean, SD = Standard deviation, Comp. = Computers, MD = Mobile devices

From Table 3, the overall situational interest of students in using Scratch to learn coordinate geometry was high – about 83.9% ($M = 3.354, SD = .430, N = 96$). Regarding the predisposition of the students, the results further showed that the average situational interest of female students was higher than male students. At grade levels, lower graders (B7 and B8) had higher situational interest than the upper-grade students (B8). Relating to students' prior use of technology tools, the situational interest mean score of students who used either computers or mobile devices or both ($M = 3.350, SD = .442$) was lower than the situational interest of students who do not use these technology tools ($M = 3.352, SD = .406$). Moreso, both kinesthetic and visual learners experienced high levels of situational interest than auditory learners (Table 3).

Research Question 2

To what extent do the usefulness, ease of use, and behavior intention predict the situational interest of learners in using Scratch to learn coordinate geometry?

We examined the predictive power of PU, PEU, and BI on SI by fitting a stepwise multiple regression model analysis (Stepwise criteria: Probability-of-F-to-enter $\leq$ .050, Probability-of-F-to-remove $\geq$ .100). As shown in Table 2, significant correlations between SI and the predictor variables PU, PEU, and BI were established. We used Cohen's (1988) effect size benchmarks to illustrate the predictive power of each independent variable. The summary of the regression model is presented in Table 4. From Table, all three models were statistically significant. Model 2 ($F(2, 95) = 29.541, p < .001$) and Model 3 ($F(3, 95) = 23.862, p < .001$) had large effect sizes ($R^2 > .35$) whiles Model 1 ($F(1, 95) = 30.966, p < .001$) had a medium effect size. In Model 1, PEU alone significantly explained 24.8% (Adjusted R^2 = .240). The inclusion of BI in Model 2 increased the predictive power by 14.1% ($R^2 = .388, Adjusted\ R^2 = .375$). Moreso, the inclusion of PU (Model 3) further increased the predictive power by 4.9% ($R^2 = .438, Adjusted\ R2 = .419$). Notedly, Model 3 was seen as the best predictive Model since it had the largest effect size. Indicating that the three variables (PU, PEU, and BI) together better predicted SI. Based on the optimal, Model 3, PEU ($\beta = .407, t = 5.045, p < .001$), BI ($\beta = .333, t = 4.152, p < .001$), and PU ($\beta = .232, t = 2.835, p < .001$) are respectively the first, second, and third important predictors of SI. Algebraically, $y_{SI} = .339_{PEU} +.274_{PU} +.189_{BI}$. Thus, increase in learners' ability to manipulate Scratch with ease, and

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learners' conviction that Scratch is useful have direct positive effect on their situational interest in the use of Scratch for learning coordinate geometry.

Table 4: Model summary of the stepwise multiple regression of learners' PU, PEU, and BI on SI

Variables	Coefficients			t	*p*	95% CI	Tolerance
	B	Standard Error	β				
Model 1							
Intercept	1.983	.249		7.954	.000	±.99	
PEU	.415	.075	.498	5.565	.000	±.30	1.00
Model 2							
Intercept	1.429	.256		5.587	.000	±.1.02	
PEU	.381	.068	.456	5.593	.000	±.27	.988
BI	.215	.046	.377	4.626	.000	±.18	.988
Model 3							
Intercept	.654	.368		1.775	.079	±1.46	
PEU	.339	.067	.407	5.045	.000	±.27	.941
BI	.189	.046	.333	4.152	.000	±.18	.950
PU	.274	.097	.232	2.835	.006	±39	.909

Model fit

	Model 1	Model 2	Model 3
R	.498	.623	.662
R^2	.248	.388	.438
Adjusted R^2	.240	.375	.419
R^2 Change	.248	.141	.049
Durbin Watson			2.283
F	30.966	29.541	23.862
p	.000*	.000*	.000*

Note: Dependent variable = SI; CI = Confidence interval (Upper bound minus lower bound); **Significant at* $p < .05$

Research Question 3

To what extent do the usefulness, ease of use, and behavior intention relate to predicting the situational interest of students in using Scratch to learn coordinate geometry?

The object of this research question was to use parallel mediation analysis (Hayes, 2013) to examine the best statistical model that optimally predicts learners' situational interest in using Scratch. The procedures of Hayes' (2013) bootstrap method (5000 samples bootstrapping procedure) were used to test the mediating effect since the method is robust even for data that violate assumptions of normality and is also suitable for small sample sizes. Consequently, three models were tested (Note: DV = dependent variable; IV = independent variable; M = mediating variable). Model 1 (IV = PU; M = PEU and BI; DV = SI), Model 2 (IV = PEU; M = PU and BI; DV = SI), and Model 3 (IV = BI; M = PEU and PU; DV = SI). The significance of these Models was subjected to Hayes' (2013) four conditions guaranteeing the establishment of a mediation effect. Subject to these four conditions, we presented three mediation test results tables (Table 5, Table 6, and Table 7) to test Models 1, 2, and 3, respectively.

For model 1, Table 5 showed that the effect of PU on both PEU and BI was significantly positive. Similarly, both PEU and BI had a significantly positive effect on SI (Table 5). The analysis further showed that the direct effect of PU on SI ($B = .274, t = 2.835, p < .01$) was less than the total effect of PU on SI ($B = .471, t = 4.224, p < .001$). More so, the total indirect effect for Model 1 was positively significant ($B = .197, BootCI(.061, .364)$). Notably, the effect size of PEU ($\beta = .096, BootCI(.009, .197)$) was larger than BI ($\beta = .071, BootCI(.000, .177)$). Therefore, Model 1 produced a significant parallel mediation model in which sufficient statistical evidence suggested that PEU and BI partially accounted for the relationship between PU and SI.

Table 5: Total, direct, and indirect relationships in Model 1

Model	F	R^2	p	Path	B	β	t	p
1	*Total effect*							
	17.841	.160	.000	$PU \rightarrow SI$	.471	.399	4.224	.000
	Direct effect							
	5.489	.055	.021	$PU \rightarrow PEU$	.332	.235	2.343	.021
	4.533	.046	.036	$PU \rightarrow BI$	.445	.214	2.129	.036
	23.862	.438	.000	$PU \rightarrow SI$	.274	.232	2.835	.006
				$PEU \rightarrow SI$	.339	.407	5.045	.000
				$BI \rightarrow SI$	.189	.333	4.152	.000

Indirect effect Path	B	SE	$LLCI$	$ULCI$	β	SE	$LLCI$	$ULCI$
Total	.197	.076	.061	.364	.167	.059	.055	.286
$PU \rightarrow PEU \rightarrow SI$	.113	.062	.010	.250	.096	.049	.009	.197
$PU \rightarrow BI \rightarrow SI$	.084	.054	.000	.211	.071	.046	.000	.177

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For Model 2, Table 6 showed that the effect of PEU on PU was statistically significant while the effect of PEU on BI did not reach statistical significance. This initial step was sufficient to conclude that PEU is not having an effect on BI and therefore cannot be operating through the BI to affect the SI. Nevertheless, PEU still had a direct effect on the SI (Table 6). The analysis (Table 6) further showed that the direct significant effect of PEU on SI ($B = .339, t = 5.045, p < .001$) was less than the total effect of PEU on SI ($B = .415, t = 5.565, p < .001$). More so, the total indirect effect for Model 2 was positively significant ($B = .076, BootCI(.004, .201)$) attributable to PU ($\beta = .046, BootCI(.006, .127)$). Hence, Model 2 produced a significant simple mediation model in which sufficient statistical evidence suggested that PU partially accounted for the relationship between PEU and SI.

Table 6: Total, direct, and indirect relationships in Model 2

Model	F	R^2	*p*	Path	B	*β*	*t*	*p*
2	*Total effect*							
	30.966	.248	.000	$PEU \rightarrow SI$	.415	.498	5.565	.000
	Direct effect							
	1.149	.012	.287	$PEU \rightarrow BI$	.161	.110	1.072	.287
	5.489	.055	.021	$PEU \rightarrow PU$	.116	.235	2.343	.021
	23.862	.438	.000	$PEU \rightarrow SI$	.339	.407	5.045	.000
				$BI \rightarrow SI$	.189	.333	4.152	.000
				$PU \rightarrow SI$	.274	.232	2.835	.006

Indirect effect Path	B	*SE*	*LLCI*	*ULCI*	*β*	*SE*	*LLCI*	*ULCI*
Total	.076	.051	.004	.201	.091	.059	.005	.232
$PEU \rightarrow BI \rightarrow SI$	.031	.035	-.021	.118	.037	.041	-.025	.138
$PEU \rightarrow PU \rightarrow SI$	.046	.031	.006	.127	.055	.036	.008	.147

For Model 3, Table 7 showed that the effect of BI on PU was statistically significant while the effect of BI on PEU did not reach statistical significance. This initial step was sufficient to conclude that BI is not influencing PEU and therefore cannot be operating through the PEU to affect the SI. Nevertheless, BI still had a direct significant effect on the SI (Table 6). The analysis (Table 7) further showed that the direct effect of BI on SI ($B = .189, t = 4.152, p < .001$) was less than the total effect of BI on SI ($B = .243, t = 4.585, p < .001$). However, the total indirect effect for Model 3 was not significant ($B = .054, BootCI(-.007, .120)$). Invariably, Model 3 did not produce a statistical, which implies that neither PEU nor PU mediated accounted for the relationship between BI and SI.

While Model 1 produced a significant parallel mediation result, Model 2 produced a simple significant mediation result. Markedly, all the significant mediators positively affected the situational interest in using Scratch technologies. Using effect sizes to justify the optimal mediations, Model 1 and Model 2 produced significant effect sizes. The mediation effect of perceived ease of use on the positive relationship between perceived usefulness and situational interest was the largest, 9% ($\beta = .096, BootCI(.009, .197)$). The next large mediation effect was the effect of behavior intention on the positive relationship between perceived usefulness and situational interest, 7% ($\beta = .071, BootCI(.000, .177)$). The mediation effect of behavior intention on the positive relationship between perceived ease of use and situational interest was the least, 6% ($\beta = .055, BootCI(.008, .147)$).

Table 7: Total, direct, and indirect relationships in Model 3

Model	F	R^2	*p*	Path	B	*β*	*t*	*p*	
3	*Total effect*								
	21.023	.183	.000	$BI \rightarrow SI$	.243	.428	4.585	.000	
	Direct effect								
	4.533	.046	.036	$BI \rightarrow PU$	.103	.214	2.129	.036	
	1.149	.012	.287	$BI \rightarrow PEU$	.075	.110	1.072	.287	
	23.862	.438	.000	$BI \rightarrow SI$	.189	.333	4.152	.000	
				$PU \rightarrow SI$	.274	.232	2.835	.006	
				$PEU \rightarrow SI$	.339	.407	5.045	.000	
	Indirect effect								
	Path	B	*SE*	*LLCI*	*ULCI*	*β*	*SE*	*LLCI*	*ULCI*
	Total	.054	.032	-.007	.120	.095	.055	-.012	.203
	$BI \rightarrow PEU \rightarrow SI$	.025	.026	-.019	.084	.045	.042	-.035	.134
	$BI \rightarrow PU \rightarrow SI$	.028	.021	.000	.077	.050	.038	-.001	.143

DISCUSSION

The main objective of this study was to explore students' situational interest in learning coordinate geometry using the Scratch. Using the Scratch technology, we introduced learners to the Cartesian coordinate system interactively and engagingly. This allowed learners to appreciate the connection between algebraic equations and geometric representations. It also offered hands-on programming exercises that helped learners appreciate creativity and critical thinking skills and encouraged peer participation and collaborative learning. The 90-minute instructional session had multiple positive results. Like the findings of SantClair et al. (2021), who also experimented with novice students' engagement and interest with Scratch, we found that students' interest and engagement were piqued by Scratch's interactive and practical elements. They were engaged fully in the lessons since an ideal setting for learning was created. Students understood coordinate geometry by putting it into pictorial form using Scratch. Students' ability to solve challenging coordinate geometry problems was enhanced by the logical and critical thinking skills that Scratch programming demanded of them. Scratch's user-friendly interface also made it easier for the students to collaborate and share information. Students

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collaborated to address coding and transformation issues, shared thoughts, and gave constructive criticism of one another's creations.

Generally, students' situational interest in coordinate geometry and coding was high, similarly reported by Iyamuremye and Nsabayezu (2022). Although several factors could explain the results of this study, the instructional practices undertaken in the lesson cannot be discounted. This is because several studies, including TIMSS studies, which have examined mathematics achievement in relation to elements of motivation have concluded that when teachers use teaching techniques like discovery-based procedures, students can have a greater comprehension of the subject, a favorable disposition towards mathematics, and high self-efficacy in the subject. Another reason that may be used to explain the high level of students' situational interest in coordinate geometry is the integration of technology. As opined by Costley (2014), the learning culture of students nowadays makes it difficult to enact impacting mathematics instruction without technology tools. To this end, integrating technology tools such as the Scratch technology can by itself raise the interest of the students and provide enjoyable learning opportunities to study mathematical concepts of geometry and measurements. Although the students in this study were novices to the Scratch technology, the claims of Han et al. (2016) that novices find Scratch not interesting were not confirmed. Besides, the results on the situational interest confirm the assertion by Calder (2010) that Scratch is intrinsically motivating. This study's finding aligns with the findings of prior research (Calder, 2010; Pelton & Francis Pelton, 2008) that Scratch has the potential to be a successful alternate learning environment for mathematics instruction.

Another observation revealed in this study was that underprivileged students, such as female students and lower graders as well as students whose learning preferences rely greatly on movement and manipulations experienced higher interest in coordinate geometry enacted through Scratch programming. Deducing on the data, it is ripe to hazard that the desire to use computers or coding processes was the driving force behind the higher levels of interest among underprivileged students. Whereas this result did not holistically deviate from previous findings, for example, the findings by Zdawczyk and Varma (2022), which intimated that Scratch improved the interest of girls in mathematics, it is imperative to opine that by incorporating Scratch technology into the teaching of coordinate geometry, gender stereotypes that potentially discourage female students from active participation in mathematics lessons were loosened. As mentioned by Pérez Sabater, C., and Pérez Sabater, M. (2013), the use of technology and a creative platform like Scratch can challenge the idea that mathematics is better suited for male students, hence fostering an inclusive learning atmosphere where female students feel empowered to study coordinate geometry. For kinaesthetic and visual learners, our results confirmed the findings of Chang et al. (2012) that visual learners have higher levels of engagement with Scratch. It is suspected the interactive and visual nature of the Scratch technology learning environment raised their interest in the lesson. Scratch's interactive and visual features generally fit kinaesthetic and visual learners' inclinations and learning preferences. It provides them with chances for creative expression, rapid feedback, a hands-on learning experience, and a visual representation of the code, making it an engaging teaching tool for these students studying programming and mathematics.

Undoubtedly, this study agrees with previous research that upholds the adaptation of the TAM model to explain the use of technology tools (e.g., Venkatesh & Bala, 2008) and students' interest in learning mathematics (e.g., Arthur, 2022). While at it, we observed students' decision to use Scratch technology, believe that using Scratch will improve performance, and the thought of using Scratch will be effortless, variedly contributing positively to students' situational interest. In order of significance, the result emphasizes firstly, how crucial it is to guarantee that students have the abilities and self-assurance to use Scratch efficiently during their learning process. Secondly, students' situational interest is likely to be higher when they have a strong conviction and motivation to use Scratch as a learning tool, and it is also likely that their interest in using Scratch in coordinate geometry will be higher when they are aware of the value and advantages of doing so. It might be argued that PEU is more likely to influence situational interest than PU in the context of novices with Scratch technology. This is due to the likelihood that novices will be more focused on Scratch's ease of use than on its potential usefulness. Even if students think Scratch will be beneficial, they are less likely to be interested in using it if they find it difficult to use. This result supports the finding of previous studies (e.g., Prasetya et al., 2021; Arpaci et al., 2019) that both PEU and PU can impact the interest in the use of Scratch. Moreover, Hwang and Chang's (2011) finding that PEU had a higher influence on situational interest than PU is confirmed in this study. The results consistently underscore the importance of enhancing learners' ease of use, perceived usefulness, and behavioral intention to maximize their situational interest in applying Scratch as a tool for learning coordinate geometry.

Another key aspect we considered in this study was to explore the interrelatedness of PEU, PU, and BI in predicting students' situational interest in using Scratch technology for learning coordinate geometry. Although we had no theoretical and empirical basis to expect that these processes would play any role in forming judgments about perceived situational interest, we were inspired by the mediating role of BI between user perception factors and learning outcomes. Interestingly, the results pointed out that students' perception of ease of use and their behavioral intention played a role in explaining the association between perceived usefulness and situational interest. Additionally, students' perception of ease of use also influenced their situational interest through their perception of usefulness. Nevertheless, the former had a greater mediating effect. As expected from the TAM models, students' behavioral intention did not significantly impact their situational interest through the mediating variables of ease of use or usefulness.

CONCLUSION

Enhancing students' involvement and understanding of coordinate geometry using Scratch has shown to be a highly successful strategy. Students gained a stronger understanding of coordinate geometry while boosting their creativity and critical thinking skills by fusing programming knowledge with

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mathematical ideas. The potential of cutting-edge technologies to improve the learning process can be illustrated by the usage of Scratch as a teaching tool. In conclusion, the study's findings offer an understanding of the connections between perceived usefulness, perceived ease of use, behavioral intention, and situational interest in applying Scratch to learn coordinate geometry. The results imply that the relationship between perceived usefulness and situational interest is mediated by both perceived ease of use and behavioral intention. These findings emphasize the significance of students' perceptions of usability and intent in predicting their situational interest in using Scratch technology to study coordinate geometry.

LIMITATION

In this study, a one-shot case study quasi-experimental design without a comparison condition to assess the extent of improvement directly attributable to using Scratch in teaching coordinate geometry was used. Besides, the random assignment of participants to groups was absent. Consequently, it is uncertain to attribute the entire results solely to the intervention. Perhaps, participants in this may have been more interested in using Scratch than those who did not volunteer. That notwithstanding, a well-established theoretical framework (the Technology Acceptance Model) and data on a variety of important constructs (perceived usefulness, perceived ease of use, behavior intention, and situational interest) were collected and analyzed to minimize the limitations of the study on the research findings.

RECOMMENDATION FOR FUTURE STUDIES

Since the results showed enhanced students' situational interest in coordinate geometry using Scratch, it is recommended that researchers replicate this study using similar methodologies in different educational contexts to validate the findings and further establish the effectiveness of Scratch technology on situational interest. Additionally, the inclusion of instructional quality in the exploration study on students' learning outcomes and use of Scratch technology might be interesting to explore in future research. By merging the findings of this current study with the results of prior research that focused on instructional quality (e.g., Frommelt et al., 2023; Taley, 2022; Dorfner et al., 2018), valuable empirical contribution to the ongoing discourse of whether technology can replace quality instruction would be made. For instructional practice, the findings of this study showed that teachers can help foster situational interest in coordinate geometry by designing lessons that are relevant, meaningful, and engaging for students, and by providing opportunities for hands-on learning using Scratch.

DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

Ahmad Shahrizal, A.Z.S., Rahmatullah, B., Ab Majid, M.H., Mohamad Samuri, S., Hidayanto, A,N,, & M. Yas, Q. A systematic literature review on the use of podcasts in education among university students. *ASEAN Journal of Teaching & Learning in Higher Education. 14*(1):222–36. http://dx.doi.org/10.17576/ajtlhe.1401.2022.10

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies, 2*(4), 314-324. https://doi.org/10.1002/hbe2.195

Akaazua, J. T., Bolaji, D. C., Kajuru, K., Musa, M., & Bala, K. (2017). Effect of concrete manipulative approach on attitude, retention and performance in Geometry among junior secondary school students in Benue State, Nigeria. *Journal of Research & Method in Education*, *7*(6), 80–85. https://doi.org/10.9790/7388-07060180175

Akinyemi, A. L., Ogundipe, T., & Adelana, O. P. (2021). Effect of scratch programming language (SPL) on achievement in Geometry among senior secondary students in Ibadan, Nigeria. *Journal of ICT in Education*, *8*(2), 24–33. https://doi.org/10.37134/jictie.vol8.2.3.2021

Akudo, O. K. (2021). Effects of JIGSAW-IV instructional strategy on students' attitude towards co-ordinate Geometry. *Nigerian Online Journal of Educational Sciences and Technology*, *3*(2), 109–119.

Arpaci, I., Durdu, P. O., & Mutlu, A. (2019). The role of self-efficacy and perceived enjoyment in predicting computer engineering Students' continuous use intention of scratch. *International Journal of E-Adoption (IJEA)*, *11*(2), 1–12. https://doi.org/10.4018/IJEA.2019070101

Arthur, Y. D. (2022). Mathematics teachers' acceptance of ICT in teaching and learning: An extended technology acceptance model. *Problems of Education in the 21st Century*, *80*(3), 408–425. https://doi.org/10.33225/pec/22.80.408

Budiastuti, P., Khairudin, M., Santosa, B., & Rahmatullah, B. (2023). The use of personal learning environment to support an online collaborative strategy in vocational education pedagogy course. *International Journal of Interactive Mobile Technologies, 17*(2), 24–41. https://doi.org/10.3991/ijim.v17i02.34565.

Byrne, P., & Lyons, G. (2001). The effect of student attributes on success in programming. *ACM SIGCSE Bulletin*, *33*(3), 49–52. https://doi.org/10.1145/507758.377467

Calder, N. (2010). Using Scratch: An integrated problem-solving approach to mathematical thinking. *Australian Primary Mathematics Classroom, 15*(4), 9–14.

Campbell, O. O., & Atagana, H. I. (2022). Impact of a Scratch programming intervention on student engagement in a Nigerian polytechnic first-year class: Verdict from the observers. *Heliyon*, *8*(3), 1–11. https://doi.org/10.1016/j.heliyon.2022.e09191

Chang, C. K., Chuang, T. Y., & Kuo, W. L. (2012). Relationships between engagement and learning style for using VPL on game design. *Proceedings of IEEE Fourth International Conference on Digital Game and Intelligent Toy Enhanced Learning*, 153–155. https://doi.org/10.1109/digitel.2012.43

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd Ed). Hillsdale: Lawrence Erlbaum Associates.

Costley, K. C. (2014). *The positive effects of technology on teaching and student learning* (ED554557). ERIC. https://files.eric.ed.gov/fulltext/ED554557.pdf

Creswell, J. W. (2014). *Research design: Qualitative, quantitative and mixed methods approaches (4th ed)*. Thousand Oaks, CA: Sage

Dohn, N. B. (2019). Students' interest in Scratch coding in lower secondary mathematics. *British Journal of Educational Technology*, *51*(1), 71–83. https://doi.org/10.1111/bjet.12759

Dorfner, T., Förtsch, C., & Neuhaus, B. (2018). Effects of three basic dimensions of instructional quality on students' situational interest in sixth-grade biology instruction. *Learning and Instruction*, *56*, 42–53. https://doi.org/10.1016/j.learninstruc.2018.03.001

Fasinu, V. G., Govender, N., & Kumar, P. (2023). An empirically-based practical-realistic pedagogic mathematical model for teaching and learning of an antenna theory and design course. *EURASIA Journal of Mathematics, Science and Technology Education*, *19*(1), 1–14. https://doi.org/10.29333/ejmste/12769

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence*, *20*(2), 507–537. https://doi.org/10.1111/j.1532-7795.2010.00645.x

Frommelt, M. C., Schiefele, U., & Lazarides, R. (2023). The contributions of teachers' educational interest and relational goals to instructional quality and student interest in mathematics classrooms. *Contemporary Educational Psychology*, *73*, Article 102184. https://doi.org/10.1016/j.cedpsych.2023.102184

Garson, G. D. (2012). *Testing statistical assumptions* (Blue Book). Fargo: Statistical Associates Publishing.

Gaskin, J., & Lim, J. (2016). *Model fit measures: AMOS Plugin*. Gaskination's StatWiki.

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Ghafar, N. A., Rahmatullah, B., Razak, N. A., Muttallib, F. H. A., Adnan, M. H. M., & Sarah, L. L. (2023). Systematic literature review on digital courseware usage in Geography subjects for secondary school students. *Journal of ICT in Education, 10*(1), 26-39. https://doi.org/10.37134/jictie.vol10.1.3.2023

Graßl, I., Geldreich, K., & Fraser, G. (2021). Data-driven analysis of gender differences and similarities in Scratch Programs. *The 16th Workshop in Primary and Secondary Computing Education*, 1–10. https://doi.org/10.1145/3481312.3481345

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis (7th ed.)*. New Jersey: Prentice-Hall.

Han, B., Bae, Y., & Park, J. (2016). The effect of mathematics achievement variables on Scratch programming activities of elementary school students. *International Journal of Software Engineering and Its Applications*, *10*(12), 21–30. https://doi.org/10.14257/ijseia.2016.10.12.03

Hasbullah, N. H., Rahmatullah, B., Mohamad Rasli, R., Khairudin, M., & Downing, K. (2022). Google meet usage for continuity and sustainability of online education during pandemic. *Journal of ICT in Education*, *9*(2), 46–60. https://doi.org/10.37134/jictie.vol9.2.4.2022

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach (2nd ed.)*. New York: Guilford Press.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hsu, H. M. J. (2014). Gender differences in Scratch Game design. *International Conference on Information, Business and Education Technology (ICIBET)*, 100–103. https://doi.org/10.2991/icibet-14.2014.28

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*(4), 1023–1031. https://doi.org/10.1016/j.compedu.2010.12.002

Iacobucci, D., Schneider, M. J., Popovich, D. L., & Bakamitsos, G. A. (2016). Mean centering helps alleviate "micro" but not "macro" multicollinearity. *Behavior Research Methods, 48*(4), 1308–1317. https://doi.org/10.3758/s13428-015-0624-x

Iyamuremye, A., & Nsabayezu, E. (2022). Mathematics and Science teachers' conception and reflection on computer programming with Scratch: Technological and pedagogical standpoint. *International Journal of Education, Training and Learning*, *6*(1), 11–16. https://doi.org/10.33094/ijetl.v6i1.488

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Lederer, A. L., Maupin, D. J., Sena, M. P. & Zhuang, Y. (2000). The technology acceptance model and the World Wide Web. *Decision Support Systems,* 29(3), 269–282.

Lee, J. W., Kester, M. S., & Schulzrinne, H. (2011). Follow the river and you will find the C. *Proceedings of the 42nd ACM Technical Symposium on Computer Science Education*, 411–416. https://doi.org/10.1145/1953163.1953285

Liu, B., & Jiao, S. (2020). Analysis of supply and demand and behavioral intention of children's programming education market: Taking Beijing as an example. *International Conference on Modern Education and Information Management (ICMEIM)*, 726–729. https://doi.org/10.1109/icmeim51375.2020.00162

Lokkila, E., Christopoulos, A., & Laakso, M. J. (2022). Automatically detecting previous programming knowledge from novice programmer code compilation history. *Informatics in Education*, *22*(2), 277–294. https://doi.org/10.15388/infedu.2023.15

Makar, K., Ali, M., & Fry, K. (2018). Narrative and inquiry as a basis for a design framework to reconnect mathematics curriculum with students. *International Journal of Educational Research*, *92*, 188–198. https://doi.org/10.1016/j.ijer.2018.09.021

Meier, K. (2015). *Overcoming math anxiety: How does teaching math conceptually impact students learning math*. Toronto: University of Toronto.

Mertins, B., & Austermann, J. (2014). *Technology Acceptance Model revised: An investigation on the managerial attitudes towards using social media in innovation processes.* Linnaeus University.

Ministry of Education [MoE]. (2020). *Mathematics curriculum for B7- B10 (Common core programme)*. Accra: National Council for Curriculum and Assessment (NaCCA).

Mo, W., Zhang, Y., Fu, Y., Lin, J., Gao, H., & Lin, Y. (2021, August). Effects of A Scratch-based experiential learning approach on students' math learning achievements and interest. In *2021 International Symposium on Educational Technology (ISET)* (pp. 261-265). IEEE. https://doi.org/10.1109/iset52350.2021.00062

O'Brien, L. (1989). Learning styles: Make the student aware. *National Association of Secondary School Principals Bulletin*, *73*, 85–89. https://doi.org/10.1177/019263658907351913

Ortiz-Colon, A. M., & Romo, J. L. M. (2016). Teaching with Scratch in compulsory secondary education. *International Journal of Emerging Technologies in Learning*, *11*(2), 67. https://doi.org/10.3991/ijet.v11i02.5094

Oviawe, J. I., & Uddin, P. S. O. (2020). Impact of geometrical construction on students' creativity skills for sustainable development. *EDUCATU Journal of Science, Mathematics and Technology*, 7(2), 40-49

Papadakis, S., & Kalogiannakis, M. (2019). Evaluating a course for teaching advanced programming concepts with scratch to preservice kindergarten teachers: A case study in Greece. In D. Farland-Smith (Eds.), *Early Childhood Education* (pp. 1–19). https://doi.org/10.5772/intechopen.81714

Park, J. (2019). The development and application of computational fairy tales for elementary students. *International Journal of Higher Education*, *8*(3), 159–170. https://doi.org/10.5430/ijhe.v8n3p159

Pelton, T., & Francis Pelton, L. (2008). Technology outreach workshops: Helping teachers to climb over the technology threshold by engaging their classes. In K. McFerrin, R. Weber, R. Carlsen, & D. Willis (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2008* (pp. 4273–4278). AACE.

Pérez Sabater, C., & Pérez Sabater, M. L. (2013). Breaking gender stereotypes in technology education: Developing strategies in the English classroom. *English for Specific Purposes World*, *14*(38), 1–14.

Phan, H. P., & Ngu, B. H. (2021). Perceived 'optimal efficiency': Theorization and conceptualization for development and implementation. *Heliyon*, *7*(1), 1–13. https://doi.org/10.1016/j.heliyon.2021.e06042

Plotz, M. (2015, July). Mathematics teachers that can prepare learners for the transition to real-life and tertiary mathematics. In *The Mathematics Education for the Future Project. Proceedings of the 13th International Conference Mathematics Education in a Connected World: Sep 16–21, 2015, Grand Hotel Baia Verde, Catania, Sicily, Italy* (Vol. 1, p. 301). WTM-Verlag Münster.

Pokuah, E., Markin, R. K., & Taley, I. B. (2023). Exploring factors influencing high school graduates' decision to become technical teachers: A quantitative analysis. *West African Journal of Educational Sciences and Practice*, *2*(2), 53–63. https://doi.org/10.57040/wajesp.v2i2.442

Prasetya, D. D., Pinandito, A., Hayashi, Y., & Hirashima, T. (2021). Analysis of perceived ease of use, perceived usefulness, and behavioral intention on extended scratch-build concept mapping tool. *Preceedings of 2021 7th International Conference on Electrical, Electronics and Information Engineering (ICEEIE)*, 1–5. https://doi.org/10.1109/ICEEIE52663.2021.9616709

Rezai, M., Cote, P., Cassidy, J. D., & Carroll, L. (2009). The association between prevalent neck pain and health-related quality of life: a cross-sectional analysis. *European Spine Jornal*, *18*(3), 371–381. https://doi.org/10.1007/s00586-008-0823-6

Rotgans, J. I., & Schmidt, H. G. (2011). Situational interest and academic achievement in the active-learning classroom. *Learning and Instruction*, *21*(1), 58–67. https://doi.org/10.1016/j.learninstruc.2009.11.001

Rotgans, J., & Schmidt, H. (2009). Examination of the context-specific nature of self-regulated learning. *Educational Studies*, *35*(3), 239–253. https://doi.org/10.1080/03055690802648051

SantClair, G., Godinho, J., & Gomide, J. (2021). Affordable robotics projects in primary schools: A course experience in Brazil. *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, 66–72. https://doi.org/10.1145/3408877.3432555

Sun, L., Hu, L., & Zhou, D. (2022). Programming attitudes predict computational thinking: Analysis of differences in gender and programming experience. *Computers & Education*, *181*, Article 104457. https://doi.org/10.1016/j.compedu.2022.104457

Taley, I. B. (2022). Do students like us because we teach well? The popularity of high school mathematics teachers. *Asian Journal for Mathematics Education*, *1*(4), 384–407. https://doi.org/10.1177/27527263221142906

Taley, I. B., & Ndamenenu, D. K. (2022). The phobia and contentment for mathematics. What context factors can do? *Open Access Library Journal*, *9*(4), 1–21. https://doi.org/10.4236/oalib.1108636

Thangavelu, S., Rao, V., Shyamala, C. K., & Velayutham, C. S. (2019). Introductory programming using non-textual modalities - An empirical study on skill assessment using rainfall problem. *Preceedings of IEEE Global Engineering Education Conference (EDUCON)*, 108–117. https://doi.org/10.1109/educon.2019.8725122

Ubi, E. E., Odiong, A. U., & Igiri, O. I. (2018). Geometry viewed as a difficult mathematics. *International Journal of Innovative Science and Research Technology*, *3*(11), 251--255.

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

West African Examination Council. (2013). *BECE reports*. WAEC. https://ghana.waecdirect.org/

West African Examination Council. (2014). *BECE reports*. WAEC. https://ghana.waecdirect.org/

West African Examination Council. (2015). *BECE reports*. WAEC. https://ghana.waecdirect.org/

West African Examination Council. (2017). *BECE reports*. WAEC. https://ghana.waecdirect.org/

West African Examination Council. (2019). *BECE reports*. WAEC. https://ghana.waecdirect.org/

Zdawczyk, C., & Varma, K. (2022). Engaging girls in computer science: Gender differences in attitudes and beliefs about learning scratch and python. *Computer Science Education*, 1–21. https://doi.org/10.1080/08993408.2022.2095593

Zhang, D. (2021). Teaching geometry to students with learning disabilities: Introduction to the special series. Learning Disability. *Quarterly*, 4–10. https://doi.org/10.1177/0731948720959769