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An Investigation of the Effects of Technology-Enhanced Instructional Approaches on Students' Programming Skills at New Amsterdam Secondary School

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ABSTRACT: The purpose of this study was to compare the effectiveness of traditional instruction methods with technology-enhanced instruction methods for delivering the programming curriculum on student academic performance and attitude. This study used an experimental quantitative design. All students were Grade 11 students from the New Amsterdam Secondary School. A random sampling approach was used to choose who would be in the experimental group and the control group. Students in the experimental group were taught using technology, while those in the control group were instructed using a more conventional method. The same teacher taught both groups six lessons, and they both took a pre-and post-test for the Standardized Achievement Test. In addition, during the lessons conducted in both the experimental and controlled groups, anecdotes were recorded at random. The results of this study showed that, despite a correlation between pre-test performance and post-test scores, post-test scores for students in the experimental group were significantly higher than those for students in the controlled group. The outcomes of the paired samples test indicate a statistically significant difference between the performance of the students in the experimental group and the controlled group, with a p-value of less than 0.05 supporting this conclusion. This study also discovered that those who participated in video-based learning had a positive outlook and were more receptive to academic materials. They were more eager, motivated, and actively engaged in the learning process than the students in the controlled group. Also, the video-based method sparked the interest of the students in the experimental group, resulting in a favorable attitude.

KEYWORDS: Active Learning, Programming, Teaching Method, Traditional Instruction, Video-based learning.

INTRODUCTION

Teachers have a significant impact on both, how students perform academically and how the curriculum is executed in the classroom [1]. Every year twenty-five to fifty students at New Amsterdam Secondary School (NASS) are registered to sit the Information Technology (IT) Examination at the Caribbean Secondary Education Certificate Examinations (CSEC). While the pass rate has been above 95% in grades I to III, grades that are approved by CSEC as passes, looking at the IT results for the period 2018-2022, the number of grade ones is quite minimal. The CSEC IT examination is divided into three profile dimensions; Theory, Productivity Tools, and Programming with the weighting on the subject by profile dimension being 35%, 40%, and 25% respectively.

Based on the students' performance by profile dimension the students are awarded an overall grade of I, II, III, IV, V, or VI. An examination of what these grades mean in terms of capabilities is as follows: Grade I represents a comprehensive grasp; Grade II signifies a good grasp; Grade III characterizes a fairly good grasp; Grade IV embodies a moderate grasp; Grade V epitomizes a limited grasp and Grade VI denotes a very limited grasp [2].

The following table shows the performance of the students at the CSEC IT examination for the period 2018-2022.

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Table I- Programming Grade and Profile Letter Grades for the period 2018-2022

			Grade			Programming Profile Grade		
No. of students	**Year**	**I**	II	III	**A**	B	C	D
48	2022	**1**	16	31	**1**	2	30	15
28	2021	**8**	17	3	**9**	10	9	0
24	2020	**5**	17	2	**2**	18	4	0
30	2019	**7**	19	4	**5**	13	12	0
36	2018	**6**	25	5	**6**	16	14	0
Total					**17**	**44**	**55**	**15**

From Table I it can be seen that a small number of students are attaining a profile grade A in programming which is resulting in a small number of grade ones (I). In fact, a close examination reveals that the number of grade A profiles is almost similar to the number of grade ones (I).

The chalk-and-talk approach has been primarily used to provide the curriculum instructions for information technology at NASS. The researchers are of the belief that the use of technology can improve the programming capabilities of the students. Research has shown that computers may be a fantastic educational tool for critical thinking and problem-solving. They provide a way for students to examine many real-world settings and see trends in data, which aids in their learning how to solve issues more successfully [3]. The researchers were enthusiastic to examine this method since it has the potential to boost both student and school performance, hence increasing the institution's overall results, especially given the increase in interest and usage of technology by both teachers and students.

The goal of this study was to examine the impact of learning programming through technology. In addition, it examines whether students' motivation to study programming will improve their performance, and find out how well they can retain the concepts being taught.

This study was guided by the following research questions:

- When learning programming, how do video lessons fare against the more traditional technique in terms of their impact on students' academic performance?
- How do technology-incorporated lessons influence students' attitudes toward learning programming?

MATERIALS AND METHOD

This study was conducted using the experimental quantitative research methodology. Research methodology is the process by which a researcher systematically designs a study to provide valid and trustworthy data that satisfy the goals and objectives of the investigation [4]. In actual fact, quantitative research focuses on analyzing and quantifying variables to generate findings. It demands the use of numerical data and its analysis using sophisticated statistical techniques in order to produce responses [5].

The target population for this study were all three Grade 11 classes of NASS consisting of 35 students (22 boys and 13 girls) who are preparing to sit the IT examination in June of 2023. The students were placed in two groups (Group 1- controlled group and Group 2 – experimental group) using a random sampling technique. The researchers placed the names of the 35 students in a hat, pull the first 17 names, and those students were placed in the controlled group, while the names remaining in the hat were placed in the experimental group.

The test instrument used to gather data was a multiple-choice test on programming. It was designed using the first three levels of Bloom's Taxonomy (knowledge, understanding, and application). Pre-testing and post-testing were conducted using the same test. The test consisted of 20 multiple-choice questions; 6 (30%) of the questions assessed students' knowledge, 6 (30%) of the questions assessed students' understanding and 8 (40%) of the questions assessed students' application skills. Each question had four options,

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one of which is the correct response. The responses were labeled with a letter (A, B, C or D). Students were required to circle the letter next to the correct response.

This study was conducted during the period February 3 to March 27, 2023. The students' performance on the tests in both groups; controlled and experimental was compared as part of the study. Before starting the treatment, the pre-test was conducted to determine their level of basic proficiency and previous knowledge on the topic of Programming, in order to gauge their abilities. Both the control group and the experimental group took the unbiased pretest on programming. The pre-test was administered to both groups separately with the same duration in the same classroom. Following that, both groups of students were taught 6 lessons with the same objectives, each on programming over a three-week period, 2 sessions per week per group. While the experimental group received instruction utilizing video instructions, the control group received instruction using the traditional way of delivery. Following the sixth lesson, both groups took the post-test. To see if there was a significant difference in performance between the two groups, the findings were analyzed.

DATA ANALYSIS

The researchers used a quantitative experimental approach to analyze the data collected in order to answer the research questions. Researchers stated that one can make decisions or reach final conclusions using such information and facts [5]. To answer question one, a t-test was done on the scores between the two groups. The statistical findings of the sample test were computed using Statistical Package for the Social Sciences (SPSS) software. The p-value was used as a determinant of the level of difference in the groups' performances. In addition, the data collected was analyzed using measures of central tendency statistics and measures of variability statistics. To answer question two, frequent observations in both classrooms during content delivery were done and recorded.

RESULTS AND ANALYSIS

Table II- Mean and Standard Deviation for the Experimental Group Pre-Test

	N	Mean	Std. Deviation
Pretest A	18	3.5000	1.61791
Valid N (listwise)	18		

Table II displays the mean and standard deviation of the pre-test for students in the experimental group. A mean of 3.50 was obtained with a standard deviation of 1.62. This showed that 95% of the students scored within the range of 1.88 and 5.12. Normalization of the mean score of 3.50 falls in the 56th percentile which indicates that 44% of the students in the experimental group scored less than 3.50 out of the 20 marks for the pre-test.

Table III- Mean and Standard Deviation for the Controlled Group Pre-test

	N	Mean	Std. Deviation
Pretest B	17	2.9412	1.51948
Valid N (listwise)	17		

Table III displays the mean and standard deviation of the pre-test for students in the controlled group consisting of 17 students. A mean score of 2.94 was observed with a standard deviation of 1.52. This showed that 95% of the students scored within the range of 1.42 and 4.46. Normalization of the mean score of 2.94 falls in the 47th percentile which indicates that 53% of the students in the controlled group scored less than 2.94 out of the 20 marks for the pre-test.

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Table IV- Mean and Standard Deviation for Experimental Group Post-test

	N	Mean	Std. Deviation
Posttest A	18	15.5000	1.24853
Valid N (listwise)	18		

Table IV reveals the mean and standard deviation of the post-test for the experimental group. A mean score of 15.50 was observed with a standard deviation of 1.25. This showed that 95% of the students scored within the range of 14.25 and 16.75 on the post-test for the experimental group. The mean score of 15.50 falls in the 56th percentile which indicates that 56% of the students scored as high as or higher than 15.50.

Table V- Mean and Standard Deviation for Controlled Group Post-test

	N	Mean	Std. Deviation
Posttest B	17	11.2941	2.25734
Valid N (listwise)	17		

Table V reveals the mean and standard deviation of the post-test for the controlled group. A mean score of 11.29 was observed with a standard deviation of 2.26. This showed that 95% of the students scored within the range of 9.03 and 13.55 on the post-test for the controlled group. The mean score of 11.29 falls in the 47th percentile which indicates that 47% of the students scored as high as or higher than 11.29.

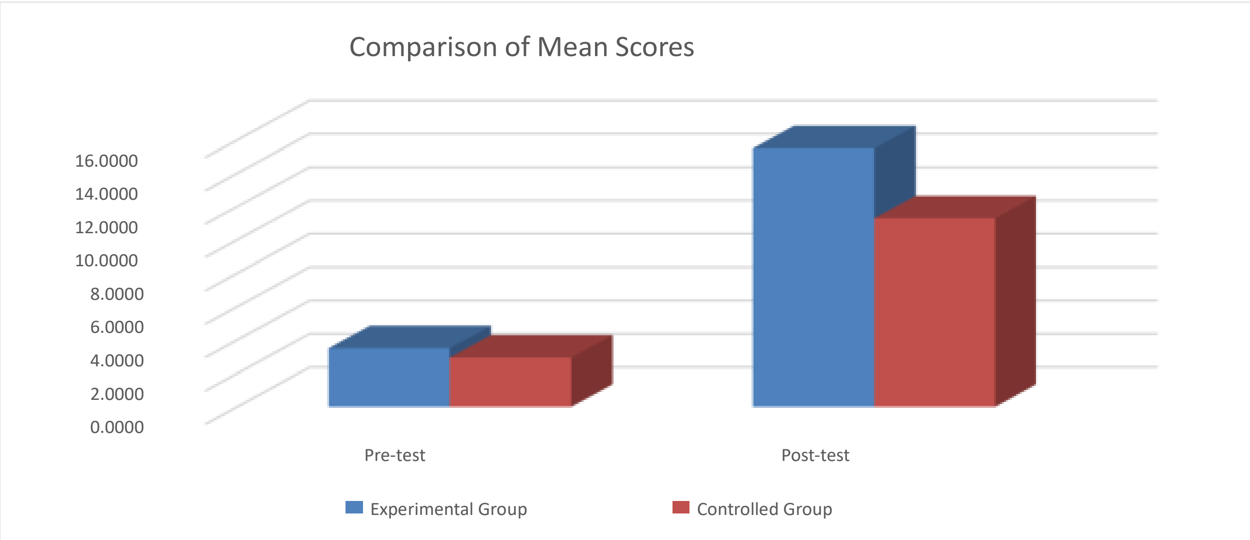

Figure 1- A comparison of the mean scores between the Pre-test and Post-test for the two groups of students.

Figure 1 presents the comparison of the mean scores between the pre-test and post-test for the experimental and controlled groups. It reveals a difference of 0.56 between the pre-test means for the experimental and controlled groups and a difference of 4.21 for the post-test means. It conceals a mean difference of 12.00 between the pre-test and post-test means for the experimental group. A difference of 8.35 was obscured between the pre-test and post-test means for the controlled group.

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DISCUSSION

A. Research Question One

With respect to the first research question: When learning programming, how do video lessons fare against the more traditional technique in terms of their impact on students' academic performance?

Gain 1 depicts the difference between the pre-test and post-test of the experimental group, whereas Gain 2 depicts the difference between the pre-test and post-test of the controlled group. The t-test paired samples correlations were computed on Gain 1 and Gain 2.

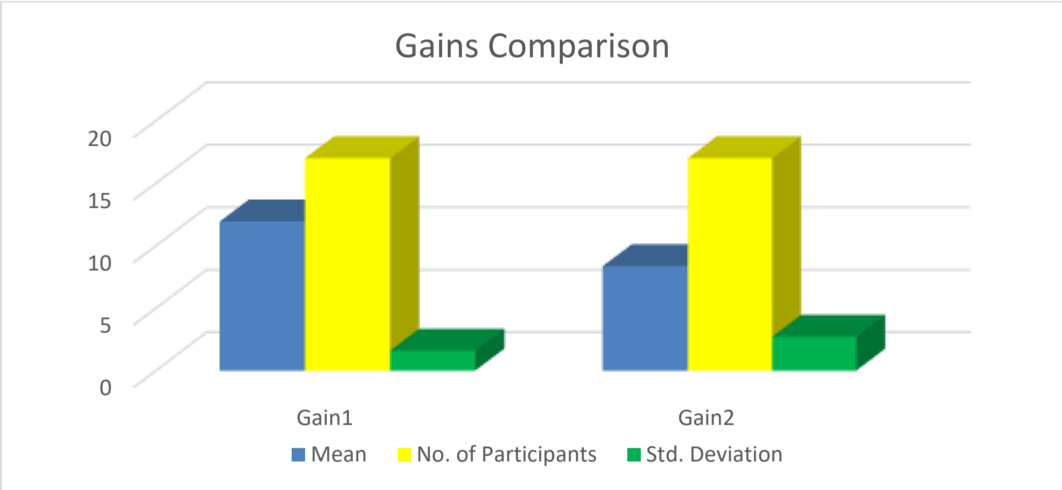

Figure 2- A comparison between Gain 1 and Gain 2.

For the comparison, 17 of the 18 experimental group students and all 17 controlled group students were included. Gain 1 had a mean difference of 11.94 with a standard deviation of 1.60, whereas Gain 2 had a mean difference of 8.35 with a standard deviation of 2.71. This indicates that a major difference exists between the teaching methodologies used with the experimental group and the controlled group as it relates to students' academic performance [7]. These findings have been supported by previous studies. Many comparable studies conducted on the use of technology in the classroom concluded that technology is beneficial to academic achievement [3]. A similar study conducted on the use of video in the classroom discovered that there was a positive impact on students' performance [8].

Table VI- Paired Sample T-test

		Mean	Std. Deviation	t	df	Sig. (2 tailed)
Pair 1	Gain 1 Gain 2	3.58824	2.76267	5.355	16	.000

The result of the paired samples test is indicated in Table VI shows a mean difference of 3.59 was observed between Gain1 and Gain 2 with a standard deviation of 2.76. The test exhibited a t-value of 5.36 with a degree of freedom of 16. The significance of the two-tailed test is less than 0.05 which indicates a statistical significance. Thus, there is a significant difference between the two gains, with Gain1 being significantly higher [7].

B. Research Question Two

As it relates to the second research question: How do technology-incorporated lessons influence students' attitudes toward learning programming?

During the lessons conducted in both the experimental and controlled groups, anecdotes were recorded at random. Recordings were done on observations during and after each lesson. With the experimental group, during the lessons, comments such as "look at how

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I am solving it", "do not ask Sir, I will help you", let me show you how it is done", were noted, these comments brought out cooperation among the students. Their level of involvement in the lessons was also noted through statements such as "look how fast I can do this problem" – inciting competition amongst each other, "give us more problems to solve Sir", "programming is easy, the videos have all the steps, we can watch it again later to revise". A similar study proposed that video-based learning can improve student interaction [9]. Additionally, research demonstrates that students are more motivated to learn through video and have good views toward learning programming [8]. Furthermore, video-based learning has the potential to improve secondary school students' attitudes and motivation toward learning their subject matter [10].
The anecdotal records showed motivation coming out from comments like, "give us one more problem; a different one involving both if constructs and looping structures; make it challenging", "what topic we looking at next Sir", "could we stay a bit longer and do another question". However, in the controlled group the researcher overheard comments such as "what step comes next again', "I don't know where to start Sir, where to start", and "why is this so difficult, Sir can you explain it again". Videos can assist students by allowing them to visualize how something works and by displaying information and details that are difficult to describe using text or static photographs [8]. In addition, videos can capture students' interest, motivating and engaging them to collaborate [11]. Further, using videos in the classroom improves students' positive attitudes toward programming [8]. Moreover, the anecdotal records from this study showed that the students in the controlled group took longer to understand the concepts, leaving little possibility for assistance or encouragement among themselves.

CONCLUSION

This research was done to determine if video-based learning has any significance on students' performance in comparison to the traditional approach of learning programming and to determine if video-based learning has an influence on students' attitudes. This study's findings demonstrated that although pre-test performance was correlated, post-test scores for students in the experimental group were noticeably higher than those for individuals in the controlled group. The results of the paired samples test with a p-value of less than 0.05 suggest a statistically significant difference between the performance of the students in the experimental group and the controlled group. Additionally, this study found that students in the experimental group who were exposed to video-based learning had a positive attitude and were more responsive to programming content. Compared to the students in the control group, they were more enthusiastic, driven, and actively involved in the learning process. The experimental group's students' curiosity was piqued by the video-based approach, which resulted in a positive attitude.

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