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A Comparison between Online Emergency Remote Learning and Face to Face Learning on Students Academic Scores in Caribbean Secondary Examination Council Chemistry

Camieka Oliver

School of Education
Faculty of Humanities and Education

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Abstract

This study was conducted to compare the academic scores of students in CSC Chemistry Examination for emergency remote learning in 2021 to face to face learning in 2017. This quantitative study takes on a causal comparative design. The variables that are involved in this study are students academic scores in CXC Chemistry Examination in 2021 and 2017. The second set of variables in this study were lesson delivery modes. The lesson delivery modes were emergency remote learning and face to face learning. This study was guided by a positivist worldview and the sample technique used was opportunity sampling. This method of sampling was used because this study involved the use of secondary data and the high schools in Jamaica that were willing to release their data to the researcher were used. The data used in this study were analyzed using a T Test to determine if there was a statistically difference in students academic score in CXC Chemistry Examination for emergency remote learning and face to face learning. Also, A test was used to determine if there was a significant difference in students' academic score in CXC Chemistry Examination based on sex. Based on the analysis of the data, there was a difference in students' academic scores for T tests that were carried out. A bar graph was also used to do a comparison of students' academic score for emergency online learning and face to face learning. Based on the analysis, males received a higher academic score in CXC chemistry examination than females in all areas that were studied.

I. INTRODUCTION

The Coronavirus disease of 2019 (COVID-19) pandemic caused the closure of school and disruption of the education system at all levels worldwide. The departments of education worldwide wanted learning to be continued for students. Instead of face-to-face classroom learning, Information and Communication technologies (ICTs) have been used to support online learning. The governments of the Caribbean region have piloted different types of online learning platforms. The schools in Jamaica engage online using various platforms including Zoom, Google Classroom and Canvas.

Many students living in the subregion, especially those from low income and rural households, were not able to benefit from online learning. Some students were not able to maximize their opportunities to participate in online learning. Less attention was paid to whether students were cognitively and emotionally ready to learn effectively in an online environment. The COVID-19 pandemic also caused social isolation which contributed to learning and emotional challenges. With the drastic changes in students' "social environment", these students have stronger desire for social interaction and are more sensitive to isolation (Blackmore, 2008). Social interaction with teachers, peers and other important elements of the learning experience that can impact students' academic scores.

Also, the online platform delivers instruction using new methods of delivery in a new environment. The students are required to use technology to communicate effectively while remaining focus in the new environment (Aguilera-Hermida, 2020). This study aims at investigating the impact of online learning on students' academic scores in Caribbean Secondary Examinations Council (CSEC) Chemistry in Jamaica during the pandemic. Online learning can be described as a way of utilizing the internet to obtain learning sources or information during the learning process with content, learning material, the

teacher and other learners, as well as getting support throughout the learning process (Ally, 2004). Online learning is a popular way of obtaining instructions **(Demiralay et al, 2016)** and is also defined online learning as a way of obtaining education through a web browser or online application without requiring extra software.

- *The Scoring or Grading of CXC Chemistry Examination*

Chemistry involves the physical and chemical properties of substances and the interaction of energy and matter. The studying of chemistry involves an investigation into chemical reactions and processes. The principle of chemistry helps students to understand everyday life processes, nature and technology as well as the significance of the well being of man and the environment. CSEC chemistry is redesigned to allow students to work individually and with others in practical, field work and interactive activities that are related to theoretical concepts in the course.

The students are expected to apply investigative and problem-solving skills, effectively communicate scientific information and apply the contribution to everyday lives. The CSEC Chemistry consists of a practical and a theoretical component. The students pursuing CSEC Chemistry are expected to perform experiments during the two years which is required to complete the syllabus. The CSEC Chemistry examined general proficiency certification and the report of the candidate profile performance are knowledge and comprehension, use of knowledge and experimental skills. The percentage weighting score for each profile is Knowledge and comprehension 43%, use of knowledge 37 % and experimental skills 20%. The CSEC chemistry examination consists of paper one, paper two and paper three. The percentage weighting for paper one is 30%, the percentage weighting for paper two is 50% and the percentage weighting for paper three is 20%. The total weighting of the CESC Chemistry is 100%.

CSEC Chemistry is graded on a five -point grading scheme from June 1998. The five- point scheme reports candidate performance over five points. The description of each point is that students that received grade 1 demonstrate a comprehensive grasp of the key concepts, knowledge, skills and competencies required by the syllabus. The students that received grade two demonstrate a good grasp of the key concepts, knowledge, skills and competencies required by the syllabus.

The students that received grade demonstrate a moderate grasp of the key concepts, knowledge, skills and competencies required by the syllabus. The students that receive grade 4 demonstrate a limited grasp of the key concepts, knowledge, skills and competencies required by the syllabus. The students that receive grade five demonstrate a very limited grasp of the key concepts, knowledge, skills and competencies required by the syllabus. However, students that missed or did not submit the School Based Assessment will receive ungraded. The students also have the chance to differ from the CSEC chemistry Examination to the next sitting since the COVID 19 pandemic.

- *The Caribbean Secondary Council Online Chemistry Learning Experiences*

The CSEC Chemistry requires the students to develop five experimental skills to complete the course successfully. The experimental skills are observing, reporting and recording (ORR), measurement and manipulating, planning and designing, and drawing. During the pandemic students were studying Chemistry fully online. They do not get an opportunity in hands-on experimental activities. As a result, students did not get a chance to interact with laboratory instruments to develop their measurement and manipulation skills. However, most Chemistry students engage in virtual labs which expose students to an opportunity to develop the remaining four experimental skills. The students pursuing CSEC Chemistry in June 2021 were also exposed to different teaching strategies such as virtual quizzes and games, online exams and online meeting.

- *Rationale*

This study aims to compare Caribbean Secondary Examination Council (CSEC) Chemistry examination academic score for online emergency remote learning and face-to-face learning. The emergency remote learning experience introduces a variety of teaching strategies such as virtual laboratory activities to provide an opportunity for students to develop their experimental skills, and online games. The reason for doing this study is to compare the results for CSEC Chemistry examination for remote emergency learning in June 2021 and June 2017 for face-to-face learning. There is limited literature on online emergency learning, and student academic scores compared to face-to-face learning.

II. PURPOSE OF STUDY

The purpose of this empirical quantitative study using secondary data is to compare online emergency remote learning academic score in CSEC Chemistry examination result in June 2017 to face to face learner CSEC Chemistry academic score in 2017. The independent variable, online emergency remote learning, is defined as a method used to deliver instruction using Information Communication Technologies (ICT) during the pandemic to continue learning. The dependent variable is students' grade or score in the CXC Chemistry Examination in 2021.

- *Research Questions*

- Is there a significant difference in students' academic score in CXC Chemistry Examination for online emergency remote learning compared to face-to-face learning based on sex?

- Is there a significant difference between students' academic score on CXC chemistry examination for online emergency remote learning compared to face-to-face learning?

- Is there a difference in males CXC academic score in 2017 compared to 2021?

- Is there a difference in CXC Chemistry academic score in 2017 and compared to 2021 based on sex?

➢ *Theoretical Framework*

Achievement goal theory is a theory used to understand the performance of students and was proposed by four scholars in the late 1970s (Elliot, 2005). Elliott & Dweck (1988) define that "an achievement goal involves a program of cognitive processes that have cognitive, affective and behavioral consequences". This theory suggests that the motivation of a student's academic achievement is related to behavior and can be easily understood by the purpose and the reason why they adopt while engaging in learning activities.

The environment also affects the performance of students (Ames & Archer,1988). Traditionally, classroom teaching is an effective method to achieve the goal (Ames & Archer, 1988). However, in the modern era, the internet-based teaching is also one of the effective tools to deliver lectures, and web-based applications are becoming modern classrooms (Azlan et al.,2020)

III. LITERATURE REVIEWED

➢ *Introduction to Online Education*

Online education is not a new phenomenon; it was first initiated in the mid-1800s, by the University of London which depends on postal services. Online education was observed in America in the nineteenth century. The official educational program was established in Boston in 1873, known as the Society to Encourage Home Studies. Online education surged in the Caribbean in the late 1990s as a wave of technologies supporting distance education initiatives.

Information and communication technologies influence all areas of life. The use of technology in education has become important due to personal and social reasons (Usta, 2011). Online education is a very popular way of using technology to obtain instruction (Demiralay el al, 2016). Online education approaches were used as an alternative learning approach in education for a long time to promote and enhance the academic achievement of students. Based on readings, academicians worldwide have conducted many studies on the evaluations of online approaches impacting on students' academic achievements the use of educational games to promote learning.

➢ *Benefits of Online Learning and Face to Face Learning*

Both online education and face to face education share similar characteristics. The students are still required to attend classes, learn the material, submit assignments, and complete group projects. The teachers are required to prepare lessons, grade assignments, maximize instructional qualities, answer questions and address concerns, and motivate students to learn material. Although online learning and face to face share many similar characteristics, there are also differences between the two methods of instructional mode of delivery.

Face to face learning is known as the traditional classroom instructional delivery method and requires passive learning by students. The teacher or instructor controls the classroom dynamics for example the teacher comments while the students listen, take notes, and ask questions. In a student-centered classroom the students normally determine the classroom dynamics as they are independently analyzing the information, constructing questions and asking the teacher for clarification. In this case, the teacher is the listening and formulating instructions (Salecedo, 2010).

There are many questions that arise from changes in education. One of the main questions associated with online education is its efficacy. Studies have been conducted on the effectiveness of computer assisted teaching and learning such as the use of various online learning programs. The factors that educators consider when determining the effectiveness of online education and whether online learning is a substitute for face-to-face learning are cost analysis, student experience and students' performance. The traditional face to face classroom learning is favored by some studies and state that online learners will quit more easily, and online learners can lack feedback for the teachers and students (Atchley el al, 2013). Due to these shortcomings of online learning retention, satisfaction and. performance can be compromised. However, online learning has benefits such as independently learning at any time and place (Vrasidas & Issacc,1999) self-regulation skills and learning with collaboration and opportunity to plan self-learning process (Usta,2011).

➢ *Students' Attitudes toward Online Learning Compared to Face-to-Face Learning.*

Online learning, also known as computer-based learning or digital learning, is a form of remote teaching that uses a digital device and electric teaching (Clark and Mayor, 2016). In comparison to face to face learning online learning has higher flexibility. The use of online learning has increased drastically during COVID-19 pandemic, which is found to have strengthened higher learning satisfaction and substantial educational resources. According to studies, the major concerns for online learning are lack of social interaction and control situations (Simamora, 2020).

The enforcement of students into online learning, triggered by COVID-19, may aggravate rich–poor polarities, to disrupt educational equities (Hammond et al,2020). There were considerable findings for the close association between learning attitude and learning performance. There is limited literature on the comparison between online emergency remote learning and face to face learning on students' academic score in CSEC Chemistry examination score. The result for this study may be beneficial for policymakers to rethink educational measures that were taken during the COVID-19 pandemic or when designing online curriculum.

➢ *Research Design*

The research is guided by the postpositivist worldview. Creswell (2014) discussed the paradigms that are associated with research design. According to Creswell the assumptions made by a positivist worldview are applicable to Quantitative design than qualitative design. This study used a causal comparative design. Causal comparative design is non-

experimental research in which the researcher compares two groups in terms of cause or independent variable that has already happened.

➢ *Sample size and participants*

The sampling techniques used in the study was opportunity Sampling. Opportunity sampling is a sampling technique that uses participants that are available and willing to participate in the study. The high schools that were used in this study were selected based on their willingness to provide the Caribbean Examination Council examination results for June 2017 and June 2021. This study involves three coed high schools located in Kingston, Jamaica. The age of the students involved in this study is between 17 and 18 years old. The number of participants for the controlled group is 340 students that wrote the CXC Chemistry in 2017. The number of participants for the experimental group is 560 students who wrote the CXC Chemistry exam in 2021. The total participants of this study were 900 high school students. All the participants in this study were grade 11 students.

The CSEC Chemistry Examination results for online emergency remote learning and face to learning were compared using a bar graph.

➢ *Ethical Criteria*

A letter was written to the school seeking permission from the principal and the school board to use the CXC Chemistry Examination results for each school. The name of the students that is on the CSEC board sheet were blotted out to de-identified the data before releasing the data to the researcher. The outcomes of the analysis of this research were not used to re-identify the participants. The use of the secondary data will be kept private and confidential and was not used to cause any distress.

IV. METHOD

- In this design, the students that were exposed to treatment are the students that sat CXC Chemistry Examination in June 2021 and exposed to online emergency remote learning. This group of students is also considered as the independent variable.
- The control group was the students that were exposed to face-to-face learning in 2016 and 2017 and sat the CXC Chemistry Examination in 2017.
- The dependent variable for the outcomes was the students CSEC Chemistry Examination results in 2021 and 2017.

➢ Limitation

- Secondary data may lack information that the researcher needs to answer the research questions.
- The researcher was not sure of the lesson delivery mode that the students in the control group were exposed to in 2017. The students in 2017 may be exposed to different modes of lesson delivery such as blended which could have effects on the data collected.

V. DATA COLLECTION AND ANALYSIS

Secondary data was used in this study. The results of the Caribbean Examination Council Examination results were obtained for the June 2017 and June 2021 Examination for three high schools in Kingston, Jamaica. The results were sorted from the results sheet to determine the student's examination score in Chemistry. The number of students that received grade one (1) to Five (5) was recorded in a table. The number of students that differed from the exam to next sitting and received ungraded were also recorded in the table.

➢ *Research Question 1*

Is there a significant difference in student academic score in CXC Chemistry for face-to-face learning compared to online learning?

Table 1. Students academics score in CXC Chemistry Examination 2017 and 2021

Score	Face to face (2017)	Online (2021)
1	124	80
2	200	82
3	86	47
4	60	50
5	60	45
Ungraded	30	20
# of students differ	0	16
Total	560	340

A passing grade for the CXC Chemistry Examination is any grade received from grade one (1) to grade (3). The results were analyzed using SPSS. A T-test was used to compare the means of students' academic scores between grade 1 and grade 3 in CXC Chemistry Examination results in 2017 and 2021 to determine the impact of online learning on Chemistry students' academic score. T-tests are used to compare means to see if there is sufficient evidence to conclude if the means of the data collected is differed (Warmer, 2013). Independent T-test were to compare the means of students score in CXC Chemistry examination in 2017 and 2021, as these data has no relationship. The two groups of data collected are independent.

According to Pallant (2016) the results show that the means of students received grade 1-3 in CXC Chemistry in 2017 (M= 63.331, SD=10.9180) against students score in CXC Chemistry Examination in 2017 (M=70.81, SD = 8.222;

t (144.655) = -2.949, p = 0.004). The magnitude of the differences in the means (mean differences = -3.501, 95% Cl: -5.848 to -1.155) was very small (0.022) based on eta squared. This indicates that only 2% of the variance in students score in CXC Chemistry Examination in 2017 and 2021. Hence, the null hypothesis was rejected.

➢ *Research Question 2*

- Is there a difference between students' academic scores on CXC chemistry examination for online emergency remote learning compared to face-to-face learning?

Table 1. Students' Academic Score in CXC Chemistry Examination in 2017 and 2021 for Males and Females

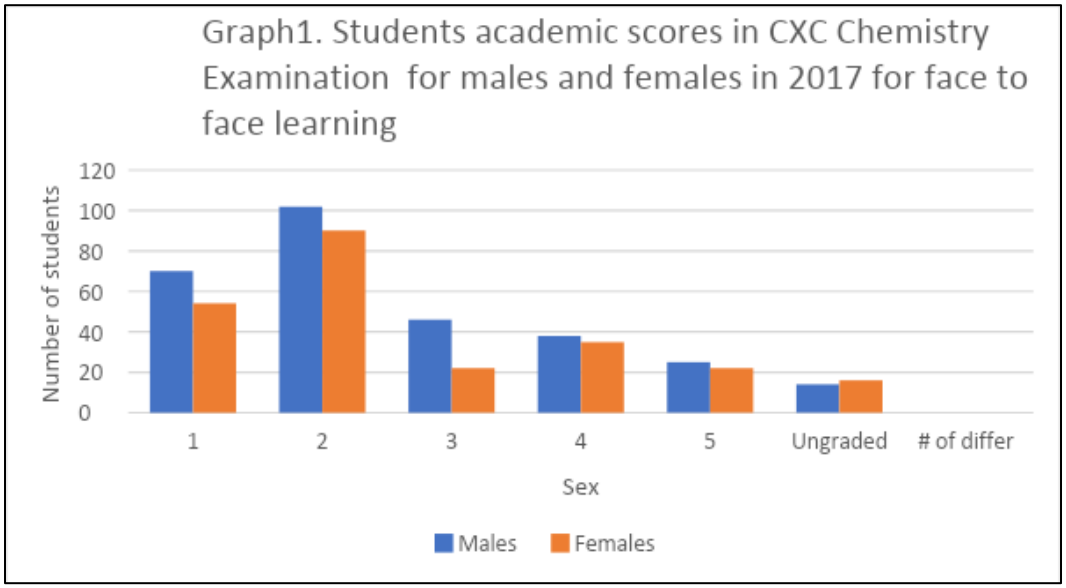
Score	Face to Face learning (2017)		Online Learning (2021)	
	Male	Female	Male	Female
1	70	54	50	30
2	102	98	36	46
3	46	40	22	25
4	38	22	25	25
5	25	35	25	20
Ungraded	14	16	6	10
# of students differ	0	0	10	6
Total	295	265	164	156

The data collected was analyzed by SPSS using a T-test to compare the mean scores for male and female in 2017 and 2021 to determine the impact of online learning on Chemistry students' academic scores between grades 1 and 3 based on sex. There is a statistically significant difference in students' score (Grade 1-3) in CXC Chemistry Examination in 2017 and 2021 based on sex. The analysis of students' scores based on sex in CXC Chemistry Examination in 2017 compared to CXC Chemistry Examination score in 2021 was done using a T Test. The analysis for the comparison of the CXC Chemistry Examination results for males in 2017 is (M= 67.36, SD11). The T- test analysis for females in 2017 is (M = 70.90, SD 8; $t_{(139)}$ =-2.93, $p<0.05$). The magnitude of the difference in the mean was very small (eta =0.02).

The T- test analysis for the CXC Chemistry Examination for males in June 2021 is as follows (M=65.26, SD=10). The Test analysis for Female in June 2021 CXC Chemistry result is as follows (M=75.1, SD=10) $T_{(139)}$. The magnitude in the difference of the mean was big and this means that there is a statistical difference in the CXC Chemistry score based on sex in 2021.

➢ *Research questions*

- Is there a difference in males CXC academic score in 2017 compared to 2021?
- Is there a difference in CXC Chemistry academic score in 2017 and compared to 2021 based on sex?

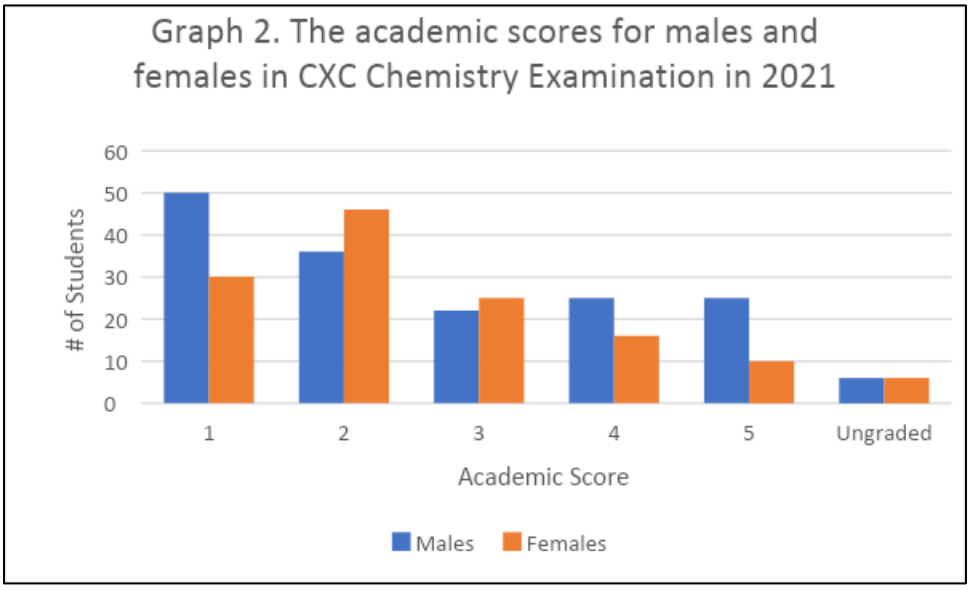


The graph above compares students' academic score in Caribbean Secondary Examination Council Chemistry for males and females in 2017. According to the graph above, there are more males achieving grades one to three in CXC Chemistry Examination compared to females. Also, the number of males that receive ungraded is less than that of females.

Table 2. The percentage of Males Compared to Females that Score Grade 1to Five on CSEC Chemistry Examination

Score	% of males for each score	% of females for each score
1	23.7	20.3
2	34.5	36.9
3	15.5	15.09
4	12.8	8.30
5	4.7	6.03
Ungraded	0	0

Based on the results in the table above, males have obtained a higher academic score in CXC Chemistry Examination in 2017 compared to females. Also, the percentage of females that receive grade 5 is higher than males. 73.67% of males receive grade one to three compared to 72.29 % of females received grade one to three. The percentage of males that receive grade one to three is 1.38 higher than the percentage of females that received grade one to three. Based on this result, it can be said that males' academic score is higher than females. There is a 1.38% difference in males academic score compared to females in 2017.



Based on the data in the graph, more males received grade one compared to females. Also, more males receive grade 4 and 5 when compared to males in 2021 CXC Chemistry Examination.

Table 3. Percentage of males and females received grade 1 to 5 in CXC Chemistry Examination 2021

Academic Score	% of Males for Each Score in 2021	% of Females for Each Score in 2021
1	30.4	19.3
2	21.9	29.4
3	13.9	16
4	15.2	12.8
5	15.2	6
Ungraded	6	3.7

According to the information in the table above, 69.2% of males received grade 1 to three compared to 64.7 percent of females that received grade to three. The academic score of males is 4.5 % higher than females 2021. Therefore, there is a difference in CXC Chemistry Examination academic score based on sex for emergency remote learning.

Table 4: The Percentage of Males Academic Score in CXC Chemistry Examination 2017 and 2021

Score	% of males for each score in 2017	% of males for each score in 2021
1	23.7	30.4
2	34.5	21.9
3	15.5	13.9
4	12.8	15.2
5	4.7	15.2
Ungraded	0	6

Based on the result in the table, 23.7% of males received grade 1 in 2021 when compared to 30.4 % of males that received Grade 1. In 2017, 73.7 % of males received grade one to three compared to 2021 where 66.2% of males received grade one to three. The academic score of males decreased by 7.5% in 2021 compared to 2017. Therefore, males have higher academic performance for face-to-face learning compared to emergency remote learning.

VI. DISCUSSION

The purpose of this study was to compare Students academic scores in CXC Chemistry for Emergency remote learning in 2021 to face to face learning in 2017. The CXC Chemistry syllabus requires students to work individually and in groups. Also, it is a requirement that students interact with laboratory instruments and material to develop the required scientific skills. During the COVID 19 pandemic students were required to be socially isolated. Therefore, students were not able to interact with each other. Also, Students were not able to perform experiments in the laboratory or do any form of scientific hand-on activities. Instead, students would watch videos of others conducting experiments and record the observation and results which limits the students to develop the required experimental skills.

Based on the data analysis in this study, the p-value is less than the confidence level. The data favor the alternative hypothesis which means that online learning negatively impacts students' academic scores in CXC Chemistry Examination in 2021. Also, there is a statistically significant difference in students' score (Grade 1-3) in CXC Chemistry Examination in 2017 and 2021 based on sex. According to this information, it can be deduced that males performed better in science than females. When the data were examined deeply, it was concluded that males are also better online learners of science compared to females. Males adapted more behavioral strategies than females to deal with their disorientation during online learning hence make them better academic performers than females (Wu and Chang, 2019).

Also, the difference in male academic score compared to females may be due to gender stereotype. A study shows by Archer et al (2010) suggest that young children do not have profound knowledge about science. However, they characterize science by masculinity trait. Also, several studies as shown science as a male domain subject which may influence the of academic performance of males compared to female.

VII. CONCLUSION

This study compares the academic performance of students in the CXC Chemistry Examination for emergency remote learning (2021) and face-to-face learning (2017). Based on the data analysis, males achieved a higher academic score for emergency remote learning compared to females. Overall, based on the data analysis, males achieved a higher academic performance when compared to females for emergency remote learning and face to face learning. Also, there was a statistical difference in the performance of students in 2021 when students were exposed to emergency remote learning and 2017 when the students were exposed to face-to-face learning. There can be several factors that may result in the difference in academic score. However, further students will need to carry out before determining some of the factors that may result in the difference.

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