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## Mode of Instructional Delivery and Students' Academic Performance in Mathematics and Non-mathematics Courses

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*Face-To-Face Instruction, Online Instruction, Blended Instruction, Students' Academic Performance, Mathematics-Related Courses, Non-Mathematics-Related Courses*

### ABSTRACT

This paper seeks to establish whether there is a statistically significant difference in students' academic performance in mathematics and non-mathematics courses using face-to-face, online, and blended instruction. The study is quantitative research and employs a case study approach covering 603 students at the Catholic University of Ghana. The paired sampled t-test is adopted to analyze the data set. The study found that at a 5 percent significant level, there is no statistically significant difference in students' academic performance in mathematics and non-mathematics courses using face-to-face instruction. Conversely, a statistically significant difference exists in students' academic performance in mathematics and non-mathematics courses using online and blended instructions. The study concludes that non-mathematics courses can be best taught using online instruction whereas mathematics-related courses can best be taught using blended instruction. However, face-to-face instruction leads to no difference in students' academic performance.

### INTRODUCTION

This study construes modes of instruction as face-to-face, online, and blended instruction. Face-to-face instruction is regarded as the well-tested instructional mode employed by educational institutions for over a decade (Alabdulaziz & Tayfour, 2023). It involves personal contact between the instructor and the learner and it is usually teacher-centered learning. It is conducted within a confined environment and offers the opportunity for learners to have personal contact, share learning experiences, and create bonds. Online instructions offer a more flexible, convenient, and cost-effective learning avenue for both instructor and learner. It is usually conducted with the aid of the Internet, a learning management system, and it is student-centered. Singh and Thurman (2019) observe that the fundamental features of online instruction are flexibility, connectivity, and instructiveness. Online instruction personalized instructional methods aim to address the academic needs of the learner. Blended instruction combines face-to-face and online instruction. The choice between personal contact and online interaction differs depending on the specific content to teach, thus, causing distinct meanings to the blended instructional concept about the instructor and the specialties of learners (Ossiannilsson et al. 2015). Blended learning is seen as a creative educational teaching and learning environment that incorporates traditional teaching methods through the application of advanced media technology (Ali et al., 2023). In addition to conventional teaching and learning, students have the opportunity to access online instructional materials, tutorials, and online lecturing (Nguyen, 2017).

The mode of teaching and learning (face-to-face, online,

and blended) plays a crucial role in attaining learning objectives such as enhancement in students' academic performance (Kirsten & Greefrath, 2023). There exist conflicting opinions on the exact teaching mode that guarantees maximum students' academic performance. Farahi and Saidi (2023) postulate that students' academic performance in non-mathematics courses (English) taught using face-to-face instruction is higher compared to online instruction. They further argued that the effectiveness of teaching English online cannot be compared to face-to-face. Aqdas, Ahmed, and Soomro (2023) revealed that the abrupt shift in the mode of teaching from face-to-face to online led to a reduction in students' academic performance.

Interestingly, Hadžiomerović et al. (2023) argued that online teaching and learning yields higher academic performance than face-to-face instruction. Charytanowicz (2023) finds that online and blended instruction improve students' academic performance by 10 percent or less. Nabayra (2022) is of the view that YouTube-embedded videos in teaching mathematics courses online broaden students' understanding and therefore lead to enhanced students' academic performance. Yu, XU, and Sukjairungwattana (2022) observe that students' academic performance in blended instruction is significantly greater than in face-to-face instruction. Duong, Bui, and Lu (2022) find the academic performance of students taught using blended instruction to be higher than face-to-face instruction. Paul and Jefferson (2022) and Nennig, Idárraga, Salzer, Bleske-Rechek, and Theisen (2020) postulate that there is no difference in student performance irrespective of the mode of instruction (whether face-to-face or online).

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They argued that once quality standards are upheld in the teaching and learning process, the mode of instruction (face-to-face, online, and blended) does not matter, equal academic performance can be realized.

Despite the conflicting findings by prior literature (Farahi & Saidi, 2023; Hadžiomerović *et al.*, 2023; Duong *et al.*, 2022; Paul & Jefferson, 2022) there exists scarce literature that seeks to establish a difference in students' academic performance in mathematical and non-mathematical related courses using face-to-face, online and blended instruction. These prior studies focused on how the mode of instruction impacts students' academic performance in either mathematical or non-mathematical courses. Farahi and Saidi (2023) and Awada and Diab's (2023) studies were based on non-mathematical related courses (English). Charytanowicz (2023), Nabayra (2022), and Alabdulaziz and Tayfour (2023) studies were based on mathematical-related courses. Again, most of these studies focused on only two instructional modes such as face-to-face and online, face-to-face and blended, and online and blended. However, this study considers all three instructional modes (face-to-face, online, and blended) altogether and establishes which of them is most appropriate for mathematical and non-mathematical-related courses.

## LITERATURE REVIEW

Farahi and Saidi (2022) examined the performance of students in Morocco studying English as a proficiency course using online and face-to-face instructional modes. The study was based on a small sample size of 40 students in the 2020/2021 academic year. The questionnaire was used for the data collection and the data were analyzed using quantitative methods. An Independent sample t-test was used to establish whether statistically significant differences exist between the performance of secondary school students in Morocco based on face-to-face and online instructions. The outcome of the study indicated that there were statistically significant differences between the performance of students taught using face-to-face and online instructional methods. Thus, the performance of students taught using face-to-face instructions was higher than the performance of students using online instructions. Farahi and Saidi (2022) further postulate that online instruction cannot be used as an alternative method for face-to-face instruction when teaching an English as a proficiency course in secondary schools. The limitation of this study is the small sample size which generalizes the study findings problematic. The results are only applicable to teaching English proficiency at the secondary school level. Thus, low students' performance-based online instruction may be attributable to students' low competence in the use of ICT tools. This might be different in tertiary institutions where students' competence in the use of ICT is on the higher side. Likewise, the study fails to assess whether students' competence in the use of ICT tools contributed to their lower performance using online instructions compared to face-to-face instructions.

Charytanowicz (2022) assessed computer science students' performance using online vs face-to-face instructions at Lublin University of Technology (Poland). The study covered 1,827 test scores from two fundamental computer science courses (Introduction to Computer Science and Numerical Analysis and Algorithms). Machine learning tools and sharp additive explanation techniques were used to establish performance differences. The findings suggest that students' performance in online and blended learning increases by 10 percent or less. This is a clear indication that the performance of students in the two computer science courses taught using online and blended instructions was 10 percent or less high than the students' performance using face-to-face instructions. The study concludes that the use of synchronized online instruction to complement face-to-face instruction will enhance the accessibility and affordability of education which in the long run improve students' performance while maintaining quality. The limitation of this study is that it failed to consider the impact of the instructional method on the overall performance of computer science students. Also, failure to include other variables such as student level, non-computer science courses, etc. could have helped to make the study findings more comprehensive.

Nabayra (2022) assessed how online instructions through the creation of YouTube-based mathematics content videos enhance students' arithmetic performance in the Philippines. The study was based on 129 students who are not offering mathematics as a program but rather as a course in a particular program. Data was collated through the use of a validated questionnaire. The data were analyzed quantitatively using the Wilcoxon Signed-Rank test, standard deviation, and mean. The results showed that there was a statistically significant difference in students' performance before online instructions and after the online instructions. The study, therefore, concluded that the inclusion of YouTube-based mathematical content videos in online instruction expands the learning opportunities available to the student and intends to increase his/her performance.

Johnson (2020) studied how the usage of blended learning enhances students' mathematical performance in schools of disabilities in the USA. The study used quasi-experimental and single-case designs. The results show that a significant positive relationship exists between blended learning and students' performance in mathematics. This suggests that when the blended instructional method is employed effectively difficulties in teaching mathematical course content will be addressed.

Alabdulaziz and Tayfour (2023) performed a comparative analysis of how face-to-face instructions and online instructions influence students' performance in specific mathematics concepts in Bahrain. The study was based on 120 primary students in grade four. This sample size was subdivided into two equal groups of 60 students taught using face-to-face and online instructions. These students' understanding of mathematics was

assessed using a diagnostics test and content analysis. A comparative research design based on quantitative data analysis was used for this study. The findings generated mixed results depending on the particular concept in mathematics using a particular instructional method (face-to-face vs online). No statistically significant differences in students' performance were established for ordering numbers, rounding numbers, graph, perimeter, and space concepts using face-to-face instructions or online instructions. Conversely, for mathematical concepts such as basic mathematical operations, comparing figures, units of measurement, shapes of geometry, and sides there were statistically significant differences in students' performance between those who were taught using face-to-face and those taught online. Thus, the students taught using face-to-face instructions performed better compared to students taught using online instructions. This is an indication that some mathematics concepts can best be learned using face-to-face instructions and others can be effectively delivered via online media.

Awada and Diab (2023) studied the influence of online and face-to-face instructions on students' performance in argumentative writing for English proficiency learners. Their study was an experimental design covering 122 students. The sample was made up of 74 students in the experimental group taught online and 48 students in the control group taught face-to-face. The study employed mixed methods. Thus, multivariate analysis of covariance test (MANCOVA) and qualitative analysis were used. The quantitative analytical findings showed that the performance of students taught to review and construct argumentative writing online performance was higher compared to students taught face-to-face. This suggests that statistically significant differences exist between the instructional methods used in teaching the English proficiency course in argumentative writing.

Nennig, Idárraga, Salzer, Bleske-Rechek, and Theisen (2020) assessed students' performance in chemistry courses delivered online and face-to-face. The students were assessed based on ten (10) different examinations. The results suggest that there are no statistically significant differences between the performance of students taught using face-to-face instruction and those taught using online instructions. Thus, students' performance based on the two instructional methods is similar. This is a clear indication that irrespective of the mode of instruction that is applied, once the quality and effective teaching and learning activities are carried out same academic performance will manifest. Hence, educational policies on instructional methods adoption should focus on how to maintain quality of delivery and not merely the use of an instructional method.

## METHODOLOGY

This paper adopted the positivist approach to the conduct of research. This is because, the study employs a quantitative approach (paired sampled t-test) to find the objective way of establishing whether statistically

significant differences exist in students' academic in mathematics and non-mathematics courses using face-to-face, online, and blended instruction. The study choice of quantitative research design is due to the statistical, unbiased, and logical nature of its findings. Thus, its analysis and findings are devoid of the researcher's sentiments and perceptions and the possibility of generalizing the findings based on the sample to a larger population. A case study approach was used to examine the academic performance of 603 students in mathematics and non-mathematics courses using face-to-face, online, and blended instruction. The study is centered on students at the Catholic University of Ghana. The purposive sampling technique was used in the determination of a sample size of 603 students. Thus, students to be included in the sample must be studying programs whose GPA is calculated on a 4.0 scale and whose assessment is based on continuous assessment (CA) = 40 and Exams = 60. Also, the student must be studying a program whose minimum duration is 2 years and was present in the 2019/2020 and 2020/2021 academic years. Given this, the sampled students were limited to those studying Bachelor of Science in Business Administration (accounting, banking and finance, economics, management, procurement and supply chain and human resource management), master of business administration (accounting, finance, marketing, and human resource management), bachelor of science in general nursing, bachelor of science in computer science, bachelor of science in public health and bachelor of arts in religious studies. Thus, only students studying programs affiliated with the University of Ghana and the University of Cape Coast were considered.

Secondary data were gathered for this study. These secondary data relating to students' academic performance were measured using average final course marks for a particular mathematics and non-mathematics courses semester under consideration. The data gathered were grouped into three streams, thus, face-to-face instruction, online instruction, and blended instruction. In totality, the data consisted of 603 students. The number of observations between face-to-face, online, and blended instructions was balanced.

Concrete and measurable constructs were used to measure the variables under consideration. Specifically, the most important measure of students' academic performance is the course final mark. Hence, the study adopted course final marks as a valid measure of students' academic performance. Likewise, instructional modes were construed to be the three (3) most acceptable and used methods of teaching and learning, thus, face-to-face, online, and blended instruction. Also, to ensure the soundness and accuracy of the study findings, the most appropriate statistical model that best fits the data gathered was used. Statistical tests such as paired t-tests were deemed suitable and appropriate to address the study objectives.



## RESULTS

### Descriptive Statistics

Table 1 shows that under face-to-face instruction students' academic in mathematics-related courses records a mean

of 72.07 and a standard deviation of 12.875 whereas that of non-mathematics-related courses is 73.05 and a standard deviation of 9.854. Thus, students' final course mark (academic performance) in non-mathematics-related

**Table 1:** Descriptive Statistics

Instructions	Nature of courses	Mean	N	Std. Deviation	Std. Error Mean
Face-to-face	Mathematics	72.07	603	12.875	.524
	Non-mathematics	73.05	603	9.854	.401
Online	Mathematics	69.29	603	11.852	.483
	Non-mathematics	73.98	603	9.817	.400
Blended	Mathematics	77.86	603	12.497	.509
	Non-mathematics	74.38	603	9.937.	.405

Source: Catholic University Exams Database (2019/2020 – 2020/2021 Academic Year).

courses is slightly higher compared to mathematics-related courses. The student's academic performance in mathematics-related courses was more dispersed from the mean compared to the non-mathematics-related courses as dictated by their respective standard deviation. Also, under online instructions, mathematics-related course has a mean of 69.29 with a standard deviation of 11.852 whereas non-mathematics reports a mean of 73.98 and a standard deviation of 9.817. This suggests that students' academic performance in the mathematics-related course was lower than that of the non-mathematics-related course. Again, for online instructions students' academic performance in the mathematics-related course was more dispersed from the mean than the non-mathematics-related course. Finally, in the case of blended instruction

mathematics-related courses reported a mean of 77.86 with a standard deviation of 12.497 while non-mathematics-related courses recorded a mean of 74.38 and a standard deviation of 9.937. This connotes that for blended instructions in the mathematics-related course, student's academic performance was higher compared to non-mathematics-related courses. However, academic performance for mathematics-related courses was more dispersed from the mean than the non-mathematics-related courses.

To establish whether there is a statistically significant difference in students' academic performance for mathematics and non-mathematics-related courses in face-to-face, online, and blended instruction.

**Table 2:** Paired Samples Test for students' academic performance in mathematics and non-mathematics-related courses in face-to-face, online, and blended instructions.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Face-to-face	Mathematics - Non-mathematics	-0.973	12.504	0.509	-1.974	0.027	-1.912	602	0.056
Online	Mathematics - Non-mathematics	-4.688	11.906	0.485	-5.640	-3.736	-9.669	602	0.000*
Blended	Mathematics-Non-mathematics	3.481	14.194	0.578	2.346	4.616	6.022	602	0.000*

Source: Catholic University Exams Database (2019/2020 – 2020/2021 Academic Year).

$H_0$

The mean difference in students' academic performance for mathematics and non-mathematics-related courses is zero for face-to-face/online/blended instructions.

$H_1$

The mean difference in students' academic performance for mathematics and non-mathematics-related courses is not zero for face-to-face/online/blended instructions.

Table 2 outlines the paired sample t-test between students' academic performance in mathematics and non-mathematics-related courses using face-to-face, online, and blended instructions. The results reveal that for face-to-face instructions because the p. value = 0.056 is higher than the alpha value of 0.05, the study fails to reject the null hypothesis and concludes that with  $[t_{602} = -1.912, p = 0.056]$ , the paired t-test shows no significant difference between students' academic performance in mathematics and non-mathematics related course under face-to-face instruction.

The finding for online instruction recorded a p-value of 0.000. Since this p. value is lower than the alpha value of 0.05, the study, therefore, rejects the null hypothesis and concludes that given  $[t_{602} = -9.669, p = 0.056]$ , the paired t-test result shows a significant difference between students' academic performance in mathematics and non-mathematics related course under online instructions.

Similarly, the results under blended instructions recorded a p. value = 0.000 which is lower than the alpha value of 0.05. Hence, the study, therefore, rejects the null hypothesis and concludes that there is a significant difference between students' academic performance in mathematics and non-mathematics-related courses under blended instructions.

## DISCUSSION

The results from the study indicate that for face-to-face instruction, the academic performance of students in mathematics and non-mathematics-related courses is statistically indifferent. This is supported by the mean difference (MD = -0.98) as deduced from the descriptive statistics. Thus, non-mathematics-related courses mean academic performance was marginally higher than mathematics-related courses by a 0.98 mark. This result is in support of Paul and Jefferson (2022), Nennig et al. (2020), and Theisen (2020) whose study proposes that no statistical difference exists between students' academic performance based on an instructional method. Thus, the adoption of face-to-face instruction produces equal academic performance irrespective of the nature of the course whether mathematical or non-mathematical. In contrast, for online instruction and blended instruction, statistically significant differences are identified in students' academic performance between mathematics and non-mathematics-related courses. Thus, the mean difference between mathematics and non-mathematics-related courses using online instruction was -4.69 marks. This finding implies that for non-mathematics-related courses students performed 4.69% higher than that of mathematics-related courses. In the case of blended instruction, the mean difference was 3.48. This connotes that students performed 3.48% higher in mathematics-related courses than in non-mathematics-related courses.

It is interesting to note that while for non-mathematics-related courses students' academic performance is higher than mathematic-related courses in online instruction, the case of blended instruction is directly opposite. Thus, in

blended instruction students' academic performance in mathematics courses is better than in non-mathematics courses. This result contradicts Mwembe and Chari's (2023) assertion that for non-mathematical courses the use of online instruction will not guarantee an enhancement in students' academic performance. However, it affirms the results of Mwembe and Chari (2023), Duong et al. (2022), Charytanowicz (2022), and Johnson (2020) assumption that blended instructions contribute to the enhancement of student's academic performance in mathematics-related courses. Similarly, the study's outcome affirms Farahi and Saidi (2022) and Awada et al. (2023) assertion that online instruction for non-mathematics-related courses like English helps increase students' academic performance.

## CONCLUSION

The study fails to reject the null hypothesis that equal students' academic performance exists between mathematics and non-mathematics-related courses in face-to-face instruction. However, rejects the null hypothesis that equal students' academic performance exists between mathematics and non-mathematics-related courses in online and blended instructions. Emphasis must be made that online instruction ensures higher student academic performance in non-mathematics-related courses whereas blended instruction offers higher students' academic performance in mathematics-related courses. Hence, it can be concluded that non-mathematics courses can be best taught using online instruction but mathematics-related courses can best be taught using blended instruction.

In conclusion, the study reiterates the fact that the predominance advancement in the use of technology in today's current dispensation can not only be limited to businesses but also can be adopted in teaching and learning methodologies within educational institutions. Hence, the integration of information technology in teaching and learning requires the use of blended instruction so far as the quality of education is to be maintained. Given this, the face-to-face component of blended learning can be focused on the mathematical aspect of the course whereas the non-mathematics aspect can be done online. Nevertheless, effective implementation and organization of blended instruction coupled with the required IT infrastructure and software management system as well as properly designed instructional materials can ensure quality teaching and learning activities that guarantee improvement in students' academic performance.

## REFERENCES

- Alabdulaziz, M. S., & Tayfour, E. A. (2023). A comparative study of the effects of distance learning and face-to-face learning during the COVID-19 pandemic on learning mathematical concepts in primary students of the Kingdom of Bahrain. *Education Sciences*, 13(2), 133.
- Ali, A., Khan, R. M. I., & Alouraini, A. (2023). A

- comparative study on the impact of online and blended learning. *SAGE Open*, 13(1), 1-10. DOI: 10.1177/21582440231154417.
- Aqdas, S., Ahmed, A., & Soomro, M. A. (2023). Exploring the impact of online classes on students' performance during Covid-19: Voices from Pakistan. *International Journal of Instruction*, 16(1), 753-766.
- Awada, G. M., & Diab, N. M. (2023). Effect of online peer review versus face-to-face peer review on argumentative writing achievement of EFL learners. *Computer Assisted Language Learning*, 36(1-2), 238-256.
- Charytanowicz, M. (2023). Online education vs traditional education: Analysis of student performance in computer science using Shapley additive explanations. *Informatics in Education*, 22(3), 351-368. DOI: 10.15388/infedu.2023.23.
- Farahi, M., & Saidi, R. (2023). Online and face-to-face English as a foreign language proficiency in Morocco: The case of the Moroccan Baccalaureate students during the Covid. *International Journal of English Language Studies*, 5(1), 01-10.
- Hadžimerović, N., Hadžimerović, A. I., Avdić, R., Muminović, A., Tandir, F., Bejdić, P., & Pandžić, A. (2023). Students' performance in teaching neuroanatomy using traditional and technology-based methods. *Anatomia, Histologia, Embryologia*, 52(1), 115-122.
- Johnson, Zachary G. (2020). Using blended learning to improve the mathematics achievement of students with high incidence disabilities in an alternative education school. [Doctoral Dissertation, Georgia State University]. ScholarWorks @ Georgia State University.
- Kirsten, K., & Greefrath, G. (2023). On-campus vs distance tutorials in preparatory courses for mathematics student teachers—performance gains and influencing factors. *International Journal of Research in Undergraduate Mathematics Education*, 1-30. <https://doi.org/10.1007/s40753-023-00221-3>.
- Nabayra, J. (2022). Mathematics learning in the new normal through teacher-created videos: The freshmen university students' experience. *International Journal of Arts and Humanities Studies*, 2(1), 22-27.
- Nennig, H. T., Idárraga, K. L., Salzer, L. D., Bleske-Rechek, A., & Theisen, R. M. (2020). Comparison of student attitudes and performance in an online and a face-to-face inorganic chemistry course. *Chemistry Education Research and Practice*, 21(1), 168-177.
- Nguyen, V. A. (2017). The impact of online learning activities on student learning outcome in a blended learning course. *Journal of Information & Knowledge Management*, 16(04). <https://doi.org/10.1142/S021964921750040X>
- Ossiannilsson, E., Williams, K., Camilleri, A. F., & Brown, M. (2015). *Quality models in online and open education around the globe. State of the art and recommendations*. Oslo: International Council for Open and Distance Education.
- Paul, J., & Jefferson, F. (2019). A comparative analysis of student performance in an online vs. face-to-face environmental science course from 2009 to 2016. *Frontiers in Computer Science*, 1, 7.
- Singh, V., & Thurman, A. (2019). How many ways can we define online learning? A systematic literature review of definitions of online learning (1988-2018). *American Journal of Distance Education*, 33(4), 289-306.
- Yu, Z., Xu, W., & Sukjairungwattana, P. (2022). Meta-analyses of differences in blended and traditional learning outcomes and students' attitudes. *Frontiers in Psychology*, 13, 926947.