MOBILE LEARNING AND SELF-STUDY PACKAGE EFFECTS ON NCE STUDENTS' MATHEMATICS ACHIEVEMENT AND RETENTION

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Abstract
This study examined mobile learning and self-study package effects strategies on achievement and retention in Mathematics among NCE students in North-Central Nigeria. A quasi-experimental design with two experimental groups and one control group (lecture method) was used. The sample comprised 153 students from selected Colleges of Education. Pre-test scores established group equivalence. The Mathematics Achievement Test (MAT), validated by experts, had a KR-20 reliability coefficient of 0.79. After treatment, a retention test was administered two weeks later using reshuffled MAT items. Mean and standard deviation answered research questions, while ANCOVA tested hypotheses at 0.05 significance. Results showed higher mean gains for students taught with the self-study package, followed by mobile learning. ANCOVA indicated a significant difference among groups, $F(2,149) = 10.423$, $p < 0.05$, including retention scores. Analysis revealed that the treatment significantly improved students' achievement and retention, with effect sizes of $\eta^2 = 0.123$ for achievement and $\eta^2 = 0.066$ for retention.The study concluded that the self-study package was most effective and recommended adopting both innovative strategies in Colleges of Education.

Keywords: Mobile learning, Self-study package, Achievement, Retention and College of Education.

Introduction

Mathematics occupies a central position in science, technology, and national development and remains a core subject in the Nigerian senior secondary school curriculum. Its significance lies in providing the foundation for scientific modelling, logical reasoning, problem solving, and innovation across disciplines such as engineering, medicine, computing, finance, and the natural sciences (Krauss, 2024; Patil, 2025). Beyond formal education, Mathematics is embedded in everyday human activities including counting, measuring, trading, and decision-making, making it indispensable to daily life. Consequently, a minimum pass in Mathematics is a key requirement for progression and admission into tertiary institutions in Nigeria. In addition, Mathematics fosters essential cognitive skills such as abstraction, reasoning, and the ability to translate real-world problems into meaningful representations (Ndlovu & Mji, 2023).

The rapid advancement and integration of digital technologies, including smartphones, tablets, laptops and mobile applications have significantly transformed contemporary teaching and learning processes. These technologies provide flexible and powerful instructional tools that expand access to learning, promote skill development, and support career exploration (Brew et al., 2023). Mobile devices, defined by UNESCO as portable and connected digital technologies, have become integral to modern learning environments (UNESCO, 2020). When effectively integrated into instruction, technology extends beyond content delivery to foster creativity, innovation, and digital literacy (Zhou et al., 2025). With mobile network coverage reaching approximately 95% of the global population and the emergence of high-speed networks, learners can now access interactive and personalized learning experiences irrespective of location (Hallak, G.,et al, 2021). The COVID-19 pandemic further underscored the transformative role of mobile technologies in reshaping learning, reasoning, and knowledge acquisition (Tang et al., 2023).

Within this evolving educational context, Colleges of Education play a pivotal role in preparing future teachers and advancing pedagogical innovation. Beyond professional training, these institutions serve as centers of intellectual development and inquiry, tasked with adapting teaching practices to societal and technological changes (Murray & Thomas, 2023). One instructional approach gaining increasing attention is self-study, which promotes learner autonomy, self-regulation, creativity, and confidence. Self-study strategies enable learners to engage actively with content, manage their learning pace, and develop deeper conceptual understanding (Das et al., 2021; Roul, 2020). Recent evidence further highlights the effectiveness of digital self-study platforms in supporting personalized learning, motivation, and academic resilience (Chen & Lin, 2023).

Academic achievement remains a key indicator of educational success, reflecting the extent to which learners acquire knowledge, skills, and competencies. Achievement is influenced by multiple factors, including instructional strategies, learning resources, learner motivation, cognitive ability, and environmental conditions (Yemi, 2018). In Nigeria, academic achievement is commonly measured through standardized assessments, which serve as benchmarks for educational outcomes (Umar, 2020). Retention, another critical learning outcome, refers to learners' ability to store, recall, and apply previously acquired knowledge over time. It is fundamental to meaningful learning and long-term academic success (Andriolis, 2017). Retention occurs when information is effectively encoded into long-term memory, a process enhanced by active learner engagement and meaningful learning experiences (Jimoh, 2019; Musa et al., 2021). Information that is interesting, well-structured, and contextually relevant is more likely to be retained and recalled when needed (Egbulefu et al., 2015). Retention is commonly assessed through delayed testing, administered weeks after initial instruction, to determine the durability of learning (Mohammed, 2015). Given persistent concerns about achievement, retention, and gender disparities, the Nigerian educational system has undergone several reforms aimed at improving learning outcomes and bridging observed gaps (Achor et al., 2018).

Empirical studies have consistently demonstrated the potential of technology-enhanced learning to improve students' academic achievement and retention across disciplines. Jimoh et al. (2019) reported significant improvements in achievement and retention among Mathematics students exposed to Skype-based instruction. Similarly, Olatunde-Aiyedun and Adams (2022), using a quasi-experimental design, found that blended learning models significantly enhanced students' academic achievement and retention in science education, recommending their adoption to promote long-term learning outcomes.

Recent studies have also highlighted the effectiveness of learner-centered and technology-supported instructional strategies. Suleiman et al. (2023) found that computer-aided instruction significantly improved secondary school students' achievement, interest, and retention in Mathematics compared to traditional methods. In a related study, Babayo et al. (2023) reported higher achievement and improved retention among students taught telecommunications using peer tutoring and play-way methods, although no significant difference in retention was observed between experimental and control groups. Despite variations in subject area and context, these findings collectively support the effectiveness of innovative instructional approaches in enhancing learning outcomes.

Although previous studies have established the benefits of technology-enhanced and learner-centered strategies, limited empirical evidence exists on the combined effects of mobile learning and self-study package strategies on students' achievement and retention in Mathematics, particularly at the Colleges of Education level. This study therefore seeks to contribute to existing knowledge by examining the effects of mobile learning and self-study package strategies on achievement and retention in trigonometry among NCE I Mathematics students in Colleges of Education in North-Central Nigeria.

Statement of the Research Problem

Students' achievement in Mathematics in Colleges of Education in North-Central Nigeria has remained consistently low, particularly in trigonometry courses such as MAT 112. Analysis of students' performance in four selected Colleges of Education in North Central Nigeria showed consistently low achievement levels. The overall pass rate was 34.19% in 2020/2021, increased slightly to 35.92% in 2021/2022, but declined markedly to 21.57% in 2022/2023, indicating a worsening trend in student performance. Notably, Mathematics/Chemistry and Mathematics/Integrated Science recorded extremely low pass rates of 4.34% and 4.76%, respectively, in 2022/2023, highlighting significant challenges in students' mastery of trigonometric concepts (Source: Examination Offices of Four Selected Colleges of Education in North Central Nigeria, 2020–2024)

Several studies have attributed students' low achievement in Mathematics to ineffective teaching methods, especially the continued reliance on traditional teacher-centered instructional approaches (Maamin, 2020; Belbase, 2016). Such methods are largely non-interactive, render students passive learners, and often fail to stimulate interest or positive attitudes toward Mathematics (Iwuanyanwu, 2021).

Given the critical role of Colleges of Education in preparing competent teachers and meeting societal educational expectations, there is an urgent need to adopt innovative and learner-centered instructional strategies that can improve Mathematics achievement and transform students' perceptions of the subject (Feudel & Dietz, 2019). Furthermore, students' poor performance in Mathematics has been linked to inadequate self-study habits and insufficient practice, which limit conceptual understanding and retention Saha et al., (2024).

Mobile learning and self-study package strategies have shown strong potential for enhancing Mathematics learning by promoting learner autonomy, collaboration, motivation, and active engagement. While self-study packages enable students to construct knowledge independently at their own pace, mobile learning facilitates interaction, collaboration, and shared problem-solving among learners. Despite the growing relevance of these strategies, empirical evidence on their effects on Mathematics achievement and retention remains scarce, particularly within Colleges of Education in North-Central Nigeria. This gap in knowledge necessitates the present study, which seeks to investigate the effects of mobile learning and self-study package strategies on students' achievement and retention in Mathematics among Colleges of Education NCE I Mathematics students in North-Central Nigeria.

Purpose of the Study

The purpose of this study was to determine the effects of mobile learning and self-study package instructional strategies on students' achievement and retention in Mathematics among NCE I students in North-Central Nigeria. Specifically, the study sought to:

1. Determine the effects of mobile learning and self-study package on students' academic achievement in Mathematics.
2. Determine the effects of mobile learning and self-study package on students' retention in Mathematics.

Research Questions

The following research questions were raised to guide the study:

i. What is the difference in the mean achievement scores of NCE I Mathematics students' taught Mathematics using mobile learning and self-study package?
ii. What is the difference in the mean retention scores of NCE I Mathematics students' taught Mathematics using mobile learning and self-study package?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean achievements scores of NCE I students' taught Mathematics using mobile learning, self- study package and those taught using lecture method.

HO_2: There is no significant difference in the mean retention scores of NCE I Mathematics students' taught mathematics using mobile learning, self-study package and lecture method.

Methodology

The study adopted a pre-test post-test quasi-experimental research design. The population comprised all fifteen (15) public Colleges of Education in North-Central Nigeria, with a total population of 44,663 NCE I Mathematics students enrolled in Mathematics related courses. A multi-stage sampling technique was employed. Three Colleges of Education were randomly selected and assigned to three groups: Experimental Group I (Mobile Learning), Experimental Group II (Self-Study Package), and a Control Group (Conventional Lecture Method). Since random assignment of individual participants was not feasible, intact classes were used, resulting in a sample of 153 NCE I Mathematics students.

Data were collected using the Mathematics Achievement Test (MAT), a 40-item multiple choice instrument developed from selected trigonometry topics, including applications of SOHCAHTOA, trigonometric identities and trigonometric ratios. The instrument was validated by three Mathematics experts from the Federal College of Education, Zuba, and one senior lecturer in Mathematics Education from the Federal University of Education, Kontagora. A pilot study established the reliability of the instrument using the split-half method, yielding a Kuder–Richardson Formula 20 (KR-20) reliability coefficient of 0.79. Ethical approval was obtained from the relevant institutional research ethics committee, while permission and informed consent were secured from the participating institutions and students. Participants were assured of confidentiality, anonymity and their right to withdraw from the study at any stage without penalty.

The MAT was administered as a pre-test before the commencement of the three weeks intervention. Experimental Group I received instruction through Mobile Learning, Experimental Group II used the Self-Study Package, while the Control Group was taught using the conventional lecture method. Following the treatment, the MAT was re-administered as a post-test to assess achievement, and a reshuffled version of the instrument, designated as the Mathematics Retention Test (MRT), was administered two weeks later to measure retention. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at the 0.05 level of significance, controlling for pre-test differences among the groups. Significant effects were further examined using Sidak post-hoc pairwise comparisons. Prior to the analysis, the assumptions of ANCOVA were tested using the Shapiro–Wilk test for normality, Levene's test for homogeneity of variances, and the test of homogeneity of regression slopes. The results confirmed that all assumptions were satisfactorily met.

Results

Research Question One: What is the difference in the mean achievement scores of NCE I Mathematics students' taught Mathematics using mobile learning, self-study package and lecture method?

Table 1: Mean and Standard Deviation of Pre-test and Post-test Mean Scores of mobile learning, self-study package and Lecture Method

Group	N	Pre-test		Post-test		Mean gain
		$\bar{X}$	Std. Dev.	$\bar{X}$	Std. Dev.	
Mobile Learning	54	39.78	12.58	52.83	14.83	13.05
Self-Study	51	34.22	11.50	51.80	11.57	17.58
Lecture Method	48	32.56	13.68	44.13	15.92	11.57

Table1 presents the mean and standard deviation for pre-test and post-test scores across three instructional strategies: Mobile Learning, Self-Study, and Lecture. For the Mobile Learning group (N=54), students' mean scores improved from 39.78 (SD = 12.58) in the pre-test to 52.83 (SD = 14.83) in the post-test, with a mean difference of 13.05. In the Self-Study group (N=51), students' scores increased from a pre-test mean of 34.22 (SD = 11.50) to a post-test mean of 51.80 (SD = 11.57), resulting in a higher mean difference of 17.58. The Lecture group (N=48) showed an increase from a pre-test mean of 32.56 (SD = 13.68) to a post-test mean of 44.13 (SD = 15.92), with a mean difference of 11.57. These results indicate that the Self-study strategy yielded the highest improvement in mean scores, followed by Mobile Learning and then the Lecture method.

Research Question Two: What is the difference in the mean retention scores of NCE I Mathematics students' taught Mathematics using mobile learning, self-study package and Lecture Method?

Table 2: Mean and Standard Deviation of Post-test and Retention Mean Scores of NCE I Mathematics students' taught Mathematics using mobile learning, self-study package and Lecture Method

Group	N	Post-test		Retention-test		Mean gain
		$\bar{X}$	Std. Dev.	$\bar{X}$	Std. Dev.	
Mobile Learning	54	52.83	14.83	55.85	14.84	3.02
Self-Study	51	51.80	11.57	55.98	12.50	4.18
Lecture Method	48	44.13	15.93	51.33	16.09	7.20

Table 2 compares the mean and standard deviation scores of post-test and retention assessments for NCE I Mathematics students" who were taught using three different instructional strategies: Mobile Learning, Self-Study package, and the Lecture Method. The Mobile Learning group, consisting of 54 students, achieved a post-test mean score of 52.83 (SD = 14.83) and a retention mean score of 55.85 (SD = 14.84), with a mean difference of 3.02. The Self-Study Package group, with 51 students, performed slightly the same score in post-test mean of 51.80 (SD = 11.57) and slightly higher in retention mean of 55.98 (SD = 12.50), resulting in a mean difference of 4.18. Meanwhile, the Lecture Method group of 48 students had a post-test mean of 44.13 (SD = 15.93) and a retention mean of 51.33 (SD = 16.09), showing a mean difference of 7.20. The Self-Study Instructional Strategies group demonstrated the highest retention score, suggesting that this method may be more effective in enhancing and maintaining the knowledge of NCE I Mathematics students compared to Mobile learning and Lecture Method.

Hypothesis One: There is no significant difference in the mean achievements scores of NCE. I Mathematics students' taught Mathematics using Mobile Learning, Self- Study Package and those taught using Lecture Method.

Table 3a: Summary of the Analysis of Covariance (ANCOVA) of Post-test Achievement Scores of Mobile Learning, Self-Study Package and Lecture Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	25478.538[a]	3	8492.846	179.608	.000	.783
Intercept	3529.909	1	3529.909	74.651	.000	.334
Pretest	23231.275	1	23231.275	491.300	.000	.767
Groups	985.690	2	492.845	10.423	.000	.123
Error	7045.514	149	47.285			
Total	411333.000	153				
Corrected Total	32524.052	152				

a. R Squared = .783 (Adjusted R Squared = .779)

Table 3a: shows the ANCOVA comparison of Post-test Scores of Mobile Learning, Self-study Package and Lecture Method). An examination of Table 3a with F (2,149) = 10.423, p = 0.000, the result of the analysis indicates that this hypothesis is rejected on the basis that the main effect (treatment) was significant. The results revealed that Mobile Learning, Self-Study Package and Lecture Method) produced a significant effect on the achievement scores of students when covariate effect (pretest) was controlled. The result indicates that the treatment, using Mobile Learning, Self-Study Package and Lecture Method), accounted for the difference in the post-test achievement scores of the students. This implies that a statistically significant difference exists among the three groups of Mobile Learning, Self-Study Package and Lecture Method. Since it was established that there was a significant difference in the mean of combined Mobile Learning and Self-Study Package on Mathematics achievement of NCE I Mathematics students, Sidak test post-hoc analysis was done to identify the direction of the difference among the treatment groups as shown in Table 3a.

Table 3b: Sidak Post-hoc Analysis of Post-test Achievement Scores of Students in Mobile Learning, Self-Study Package and Mobile Learning.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]
Mobile Learning	Self-Sudy Package	-4.465*	1.365	.004
	Lecture Method	1.580	1.401	.597
Self-Study	Mobile Learning	4.465*	1.365	.004
	Lecture Method	6.046*	1.385	.000

Lecture Method	Mobile Learning	-1.580	1.401	.597
	Self-Study Package	-6.046*	1.385	.000

Based on estimated marginal means. *. The mean difference is significant at the 0 .05 level. b. Adjustment for multiple comparisons: Sidak.

The data in Table 3b indicates significant difference in the posttest mean scores of Self-Study Package and Lecture methods with p-value of 0.00. There was significant difference between Mobile Learning and Self-Study Package with p-value of 0.04. Also, there was significant difference between Lecture Method and Self-Study Package with p-value of 0.00. There was no significant difference between Mobile Learning and Lecture Method with p-value of 0.597. Significant difference was established between Self-Study Package and Lecture Method with p=value of 0.0. Finally, no significant difference between Lecture Method and Mobile Learning with p-value of 0.597.

Hypothesis 2 There is no significant difference in the mean retention scores of NCE I Mathematics students' taught mathematics using mobile learning, self-study package and lecture method.

Table 4a: ANCOVA Comparison of the Retention Mean Scores of the Mobile Learning, Self-Study Package and Lecture Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	21812.970[a]	3	7270.990	102.893	.000	.674
Intercept	7356.970	1	7356.970	104.109	.000	.411
Post-test	21121.262	1	21121.262	298.890	.000	.667
Groups	738.004	2	369.002	5.222	.006	.066
Error	10529.200	149	70.666			
Total	486409.000	153				
Corrected Total	32342.170	152				

a. R Squared = .674 (Adjusted R Squared = .668)

Table 4a shows the ANCOVA comparison of retention scores of Mobile Learning, Self-Study Package and Lecture Method. An examination of Table 4a with F (2,149) = 5.222, p = 0.006, the result of the analysis indicates that this hypothesis is rejected on the basis that the main effect (treatment) was significant. The results revealed that the Mobile Learning, Self-Study Package and Lecture Method produced a significant effect on the retention scores of students when covariate effect (posttest) was controlled. The result indicates that the treatment, using Mobile Learning, Self-Study Package and Lecture Method. accounted for the difference in the retention scores of the students. This implies that a statistically significant difference exists among the three groups of Mobile Learning, Self-Study Package and Lecture Method. Since it was established that There was significant difference in the mean retention of NCE I Mathematics students taught Mathematics using Mobile Learning, Self-Study Package and Lecture Method, Sidak test post-hoc

analysis was done to identify the direction of the difference among the treatment groups as shown in Table 4a.

Table 4b: Sidak Post-hoc Analysis of Retention-test Achievement Scores of Students in Experimental Group I, Experimental Group II and Control Group.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]
Mobile Learning	Self-Study Package	-5.368*	1.669	.005
	Lecture Method	-2.278	1.713	.460
Self-Study	Mobile Learning	5.368*	1.669	.005
	Lecture Method	3.090	1.693	.196
Lecture Method	Mobile Learning	2.278	1.713	.460
	Self-Study Package	-3.090	1.693	.196

Based on estimated marginal means: *. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Sidak.

The data in Table 4b indicates significant difference in the retention test mean scores of Mobile Learning and Self-Study Package with p-value of 0.005. There was no significant difference between Self-Study Package and Lecture Method with p-value of 0.196. Also, there was no significant difference between Self-Study Package and Lecture Method with p-value of 0.196. There was no significant difference between Mobile Learning and Lecture Method with p-value of 0.460. Significant difference was established between Self-Study Package and Mobile Learning with p=value of 0.005. Finally, no significant difference occurs between Lecture Method and Mobile Learning with p-value of 0.460.

Discussion and Findings

This study examined the effects of Mobile Learning (ML) and Self-Study Package (SSP) instructional strategies on NCE I students' achievement and retention in Mathematics in Colleges of Education in North-Central Nigeria. The findings revealed a significant difference in students' achievement scores among the three instructional groups, with the Self-Study Package demonstrating superior effectiveness over both Mobile Learning and the conventional Lecture Method. However, no significant difference was observed between Mobile Learning and the Lecture Method in terms of achievement. These results suggest that the structured, self-paced nature of SSP enhances conceptual understanding more effectively than traditional teacher-centred instruction.

The findings are consistent with Abdulmoneim (2018), who reported significant improvements in students' performance when Google educational applications were integrated into instruction compared to traditional methods. Similarly, studies by David (2017), Shaheen (2020), Qaisara et al. (2024), and Achor et al. (2024) affirm that innovative, student-centred and technology-supported instructional approaches significantly improve academic achievement by promoting deeper engagement and conceptual understanding.

With regard to retention, significant differences were also observed among the groups, with both experimental groups outperforming the Lecture Method. The Self-Study Package particularly demonstrated strong retention effects, likely due to its provision for repeated engagement with learning materials, thereby reinforcing mastery. These findings corroborate Jimoh et al. (2019), who found that Skype-based instruction significantly enhanced students' achievement and retention in mathematics, as well as Yousef et al. (2014), who emphasized that repeated exposure to digital learning resources strengthens long-term retention. Related studies (Achor et al., 2018; Ekineh et al., 2019; Woolpit, 2015) similarly conclude that individualized and technology-enhanced instructional approaches foster better long-term memory and retention than traditional lecture methods.

Overall, the findings demonstrate that the Self-Study Package is particularly effective in improving both achievement and retention in Mathematics, while Mobile Learning also contributes positively to retention outcomes.

Limitations of the Study

This study has some limitations that should be considered when interpreting the findings;

1. the study was conducted in Colleges of Education located within North-Central Nigeria; therefore, the findings may not be generalizable to students in other geopolitical zones or educational contexts,
2. the intervention was limited to selected trigonometry concepts in Mathematics, which may restrict the applicability of the findings to other Mathematics topics or subject areas,
3. the treatment period lasted only three weeks, which may not have been sufficient to capture the long-term effects of Mobile Learning and Self-Study Package interventions on students' achievement and retention and
4. Retention was assessed only for two weeks after the post-test; a longer retention interval might have provided a more comprehensive evaluation of sustained learning outcomes. Future studies should consider broader geographical coverage, longer intervention periods, extended retention assessments, and the inclusion of additional Mathematics topics to enhance the generalizability and robustness of the findings

Recommendations

1. Mathematics lecturers in Colleges of Education integrate Mobile Learning and Self-Study Package strategies into their instructional practices to enhance students' achievement and retention.
2. Curriculum planners incorporate structured self-paced and technology-supported learning resources into Mathematics programmes.
3. Further research be conducted to examine the long-term impact of these strategies across different mathematical topics and student demographics.

Implication

1. The study developed and validated instructional resources—Mobile Learning Lesson Plan, Self-Study Package Lesson Plan, Self-Study package, and a 40-item Mathematics Achievement Test (MAT)—to support effective Mathematics teaching and future research.
2. Mobile Learning and Self-Study instructional strategies significantly improved NCE I Mathematics students' achievement and retention in Mathematics, helping to reduce underachievement.
3. The findings established Mobile Learning and Self-Study strategies as effective alternatives to the conventional lecture method and contributed valuable insights to existing literature.

Conclusion

The study concludes that Mobile Learning and Self-Study Package instructional strategies significantly enhance NCE I Mathematics students' academic achievement and retention in Mathematics compared to the traditional Lecture Method. The Self-Study Package emerged as the most effective strategy. Integrating structured, self-paced, and technology-supported instructional approaches into Mathematics education can improve students' understanding and retention of complex concepts, particularly in areas such as trigonometry.

References

Abdulmoneim, H. (2018). The Effect of Using Some Google Educational Applications in Teaching Computer Curriculum on the Achievement of Students for the First Year in College of Education, University of Samarra. International Journal of Engineering & Technology, 7(3.19), 129-135

Achor, E. E., & Ajai, J. (2024). Status of Students' Attitude Towards Physics when Analogy, Problem-solving and Concept-mapping Strategies are Used in Teaching at Senior Secondary School Level. *Peter, Status of Students' Attitude Towards Physics when Analogy, Problem-solving and Concept-mapping Strategies are Used in Teaching at Senior Secondary School Level*.

Adigun, I. A. (2015) Gender Issues in Science Education. Journal of Research and Method in Education 5(6), 1-6.

Alsaadat, K. (2017). Mobile learning an alternative approach in higher education. *European Journal of Alternative Education Studies*. *2*(1), 111–119.

Babayo, A. S., Tumba, I., & Ezugu, L. C. (2023). Effect of Peer Tutoring and Play-Way Methods on Students' Academic Achievement and Retention in Telecommunications in Colleges of Education in North-East, Nigeria. *ATBU Journal of Science, Technology and Education*, *11*(1), 8-20.

Belbase, S. (2016). Construction of mathematical 'self' as an eigen behaviour. In R. K. Dhakal, B. P. Pant, K. D. Khadka, & A. Manandhar (Eds.), *Program and abstracts: First International Conference on Transformative Education Research and Sustainable Development* (pp. 145–146). Dhulikhel, Nepal: Kathmandu University School of Education.

Belbase, S. (2016). Reflective and reflexive beliefs of two pre-service secondary mathematics teachers. *European Journal of Educational and Social Sciences, 1*(1), 34-65.

Brew, M., Taylor, S., Lam, R., Havemann, L., & Nerantzi, C. (2023). Towards developing AI literacy: Three student provocations on AI in higher education. *Asian Journal of Distance Education, 18*(2), 1-11.

Chen, C., Elliot, A. J., & Sheldon, K. M. (2019). Psychological need support as a predictor of intrinsic and external motivation: The mediational role of achievement goals. *Educational Psychology, 39*(8), 1090-1113.

Chen, Q., & Yan, Z. (2016). Does multitasking with mobile phones affect learning? A review. *Computers in Human Behavior, 54*, 34–42.

Chen, X., Lin, M., Schärli, N., & Zhou, D. (2023). Teaching large language models to self-debug. *arXiv preprint arXiv:2304.05128*.

Das, K. (2021). Integrating e-learning & technology in mathematics education. *Journal of Information and Computational Science, 11*(1), 310-319.

David, S. A., Taleb, H., Scatolini, S. S., Al-Qallaf, A., Al-Shammari, H. S., & George, M. A. (2017). An exploration into student learning mobility in higher education among the Arabian Gulf Cooperation Council countries. *International Journal of Educational Development*, *55*, 41-48.

Ekineh, D. R., & Adolphus, T. (2019). Influence of Gender on Students' Performance in Biology when Taught Reproduction Using Collaborative Strategy in Secondary Schools in Rivers State. *Rivers State University Journal of Education*, *22*(1&2), 62-73.

Feudel, F., & Dietz, H. M. (2019). Teaching study skills in mathematics service courses—how to cope with students' refusal?. *Teaching Mathematics and its Applications: An International Journal of the IMA*, *38*(1), 20-42.

Hallak, G., Vázquez, M. M., Mengi, A., & Rosu, L. M. (2021, October). On the New Developments in ITU-T G. hn Standard: Use Cases, Requirements, and Solutions. In *2021 IEEE International Symposium on Power Line Communications and its Applications (ISPLC)* (pp. 49-54). IEEE.

Huang, R., Liu, D., Tlili, A., Knyazeva, S., Chang, T. W., Zhang, X., ... & Holotescu, C. (2020). Guidance on open educational practices during school closures: Utilizing OER under COVID-19 pandemic in line with UNESCO OER recommendation. *Beijing: Smart Learning Institute of Beijing Normal University*, 1-80.

Iwuanyanwu, P. N. (2021). Contemporary problems of teaching and learning in mathematics education. *Mathematics Teaching Research Journal*. City University of New York. Retrieved from http://www.hostos.cuny.edu/mtrj/

Iwuanyanwu, P. N. (2021). Contemporary problems of teaching and learning in mathematics education. *Mathematics Teaching Research Journal, 13*(2), 23-35.

Jimoh, M. A., Jimoh, F. O., & Santali, R. (2019). An Analysis Of Three Modes Of Mobile Instructional Package On Mathematics Students' Interest In Colleges Of Education, In North-Central Nigeria. *ADECT 2019 Proceedings*.

Le, T. N., Nguyen, T. V., Nie, Z., Tran, M. T., & Sugimoto, A. (2019). Anabranch network for camouflaged object segmentation. *Computer vision and image understanding*, *184*, 45-56.

Krauss, A. (2024). *Science of science: A multidisciplinary field studying science*. *Heliyon, 10*(17), Article e36066. https://doi.org/10.1016/j.heliyon.2024.e36066

Maamin, M. (2020). A systematic review of teacher factors and mathematics achievement. *Universal Journal of Educational Research*.

Mensah, I. K., Khan, M. K., & Pratt, C. B. (2025). The moderating influence of government support as the major environmental context on SMEs' adoption of social media systems—from the technology-organization-environment perspective. *Journal of the Knowledge Economy*, *16*(3), 12567-12594.

Mensah, I. K., Khan, M. K., & Mwakapesa, D. S. (2023). Factors determining the entrepreneurial intentions among Chinese university students: the moderating impact of student internship motivation. *Humanities and Social Sciences Communications*, *10*(1), 1-15.

Murray, B., Miles-Thomas, J., Park, A. J., Nguyen, V. B., Tung, A., Gillard, P., ... & Chermansky, C. J. (2023). Cost–effectiveness of overactive bladder treatments from a US commercial and payer perspective. *Journal of Comparative Effectiveness Research*, *12*(2), e220089.

Ndlovu, J. (2023). *Exploring the TVET College Lecturers' Perspectives on the Usage of Problem-Centred Teaching in Level 4 Calculus* (Master's thesis, University of South Africa (South Africa)).

Olatunde-Aiyedun, T. G., & Adams, S. O. (2022). Effects of blended learning models on students' academic achievement and retention in science education. *Education, Sustainability, and Society*, *5*(2), 74-80.

Olorode, J. J., & Jimoh, A. G. (2016). Effectiveness of guided discovery learning strategy and gender sensitivity on students' academic achievement in financial accounting in colleges of education. *International Journal of Academic Research in Education and Review*, *4*(6), 182-189.

Roul, M. R. (2020). Effect of self-study material on learning among senior secondary school students. *International education and research journal*, *6*(1), 48-49.

Qaisara A., Jamil, B., Khan, J. U. A., Asim, N., Shahana, N., & Khan, U. A. (2024). Perception of Faculty Towards Simulation Based Learning as A Method for Clinical Teaching. *Journal of Saidu Medical College Swat*, *14*(4), 389-392.

Saha, M., Islam, S., Akhi, A. A., and Saha, G. (2024). Factors affecting success and failure in higher education mathematics: Students' and teachers' perspectives. *Heliyon*, *10*(7) e29173.

Shaheen, N., Ahmad, N., & Shah, R. (2020). Quality university education through conducive classroom learning environment. *Research Journal of Social Sciences and Economics Review*, *1*(1), 76-84.

Suleiman, B., Sodangi, U., Nafi, M., Aliyu, K., & Tafa, T. O. (2023). *Effect of computer aided instruction strategy on secondary school students' achievement and retention in mathematics.*ResearchGate.https://www.researchgate.net/publication/371965968_effect_of_computer_aided_instruction_strategy_on_secondary_school_students'_achievement_and_retention_in_mathematics

Suman, C. (n.d.). Impact of mindset on academic achievement: A comprehensive review.

Sussan, C. H., & Sanja, K. (2015). In J.D Wright (Eds), International Encyclopedia of Social and Behavioural Encyclopedia of Social and Behavioural Sciences. Teen, Gender, and Self-Presentation in Social Media Indiana University, Bloomington.

Tang, T., Abuhmaid, A. M., Olaimat, M., Oudat, D. M., Aldhaeebi, M., & Bamanger, E. (2023). Efficiency of flipped classroom with online-based teaching under COVID-19. *Interactive Learning Environments, 31*(2), 1077-1088.

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, *8*(12).

Umar, A., Mu'azu, F., & Ibrahim, A. U. (2020). Analysis of principals' leadership styles and students' academic achievement in senior secondary schools in Gombe State. *ATBU Journal of Science, Technology and Education, 8*(1), 73-81.

UNESCO. (2014). *Model policy for inclusive ICTs in education for persons with disabilities*. Paris: UNESCO.

Yemi, T. M. (2018). Mastery Learning Approach (MLA): Its effects on the students' mathematics academic achievement. *European Journal of Alternative Education Studies*.

Yousef, A. M. F., Chatti, M. A., & Schroeder, U. (2014). Video-based learning: A critical analysis of the research published in 2003-2013 and future visions. In *eLmL 2014, The Sixth International Conference on Mobile, Hybrid, and On-line Learning* (pp. 112-119).