Impact of self-evaluation strategy on mathematical achievement: An empirical study among undergraduate mathematics education students

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Abstract

Background: Given Nigerian students' poor achievement in mathematics performance over the years, researchers are exploring how a self-evaluation learning strategy can improve this situation. This strategy empowers students to assess their own understanding of learning materials in the subject, apply concepts effectively, and accurately complete tasks.

Aim: The authors examined the impact of self-evaluation strategy on mathematical achievement among undergraduate mathematics education students in Nigeria.

Method: The researchers adopted a quantitative approach with Correlational survey research design using (N = 357) 3rd year undergraduate mathematics students at a public University in Nigeria. Data was collected using two researcher-developed instruments: Students' Self-evaluation Learning Strategy Questionnaire (SSLSQ) and Students Mathematics Academic Achievement Proforma (SMAAP). The internal consistency reliability index obtained using Cronbach Alpha was 0.77. Data collected were analyzed using simple linear regression analyses through SPSS version 26.0 as well as regression analysis through Process model 1 procedure IBM SPSS version 4.00.

Result: Findings from the study revealed that self-evaluation learning strategy positively impacted students' achievement in Mathematics. Specifically, 22% of the variation in students' achievement in Mathematics is attributed to self-evaluation learning. The study also revealed a significant difference in the mean achievement score of mathematics students taught in public universities who used self-evaluation compared to those who did not.

Conclusion: Students should be encouraged by Mathematics teachers to adopt Self-evaluation strategy when assessing their learning outcomes to enhance their learning of the subject.

INTRODUCTION

Poor academic performance in Mathematics has garnered global attention. In Nigeria, Mathematics has been made a compulsory subject at all educational levels starting from class one. Despite the relevance of Mathematics due to its importance in the development of a country both on national, educational, social and individual level, the records of students' academic achievement in Mathematics over the years is still unsatisfactory

(Ejembi et al., 2024). Moyosore as cited in Ejembi et al. (2024) associates the unsatisfactory students' academic achievement in Mathematics to factors such as attitudes, interest, instructional strategy, classroom environment, and nature of assessment employed in the classroom. Despite ongoing efforts by education stakeholders and researchers to enhance the teaching and learning of Mathematics for better outcomes, students' academic achievements in the subject over the years have remained unsatisfactory (Chand et al., 2021; Mazana et al., 2020)). The unsatisfactory state of students' achievement in Mathematics no doubt has negative implication on the growth and development of any country like Nigeria due to the enormous importance and wide application of the knowledge from the subject. The issue of these inconsistent and unsatisfactory students' achievement in Mathematics is also evident in the West African Examination Council (WAEC) Chief Examiner's report of 2020, 2021, 2022, and 2023. Considering the importance of mathematics for both individuals and society, it is essential to enhance the teaching and learning of this subject to ensure high academic achievement (Sitopu et al., 2024).

Academic achievement is a prominent topic in educational research. Literally, achievement refers to something that has been accomplished. It encompasses all learning demonstrated by each student, including knowledge, skills, abilities, and the cognitive, affective, and psychomotor domains (Kpolovie et al., 2014). Achievement reflects performance outcomes, indicating the extent to which someone has met specific objectives within an instructional setting, such as a school, college, or university (Steinmayr et al., 2015). In this study, academic achievement is viewed as a quantitative measure of mathematics learning outcomes, expressed in the form of scores. It indicates the level of intellectual education of an individual, a group of people, or an entire nation. Achievement is generally assessed through examinations.

The ongoing trend in students' achievement in Mathematics remains a puzzle for researchers. A study by Owan (2020) analyzed students' achievement at credit level in Mathematics in May/June WASSCE from 2009 to 2018 and discovered that students' achievement at credit level was below average (50%). This implies that the percentage of students who obtain at least credit pass in Mathematics is below 50%. They recommended that strengthening teachers' abilities to effectively teach these subjects would be a key step towards improvement. This weakness in Mathematics is not limited to Africa alone as over 20 percent of European students and 26 percent of American students fail to attain the minimum skill levels in reading, Mathematics, and science, largely due to poor Mathematics results at the basic levels. Studies in Nigeria reveal that senior secondary school students are struggling to learn and retain (remember) mathematics concepts they had learned (Ajayi & Ogbeba, 2017; Kurumeh et al., 2012). The senior secondary school certificate examinations conducted by WAEC and NECO have reported fluctuating and unsatisfactory performance in Mathematics (Agwagah & Utibe, 2015; Zalmon & Wonu, 2017). Similarly, scholars have noted a consistent decline in students' Mathematics achievement in both internal and external examinations (Iji et al., 2015; Amadi et al., 2021).

Several factors have been identified as contributing to students' consistently poor academic achievement in mathematics. These include the teaching and assessment methods used (Ohwoavworhua & Oguguo, 2023; Olulonye, 2010) and the lack of adequate or suitable learning materials (Obi, 2014; Yara & Otiemo, 2010); negative attitudes or low interest toward the subject (Uhumuavbi & Umoren, 2005); and the inability to retain learned information (Kurumeh et al., 2012). Eze (2011) identified additional influences on students' mathematics achievement, such as inadequate instructional materials, unqualified teachers, and poor school environments. Teacher-related variables, including teaching strategies, have also been shown to enhance students' mathematics achievement (Emaikwu, 2012). Other influencing factors include students' family background, self-confidence, and the quality of school resources available for teaching the subject (Glewwe et al., 2011; Tariq et al., 2013). Sitko (2013) links low achievement in mathematics to the nature of teacher-student relationships, disciplinary practices, and homework assignments. Moreover, student characteristics are considered the most significant predictors of variation in academic achievement (Spinath, 2012). Given the above factors that may hinder mathematics achievement, this study examines the impact of self-evaluation learning strategies on students' academic achievement in mathematics.

Self-evaluation has been extensively researched in recent years, though there is still no consensus on its definition and scope (Brown & Harris, 2014; Andrade, 2019). Student self-evaluation refers to students' perceptions of the quality of their work and academic skills (Fletcher, 2020). Empirical studies emphasize the importance of self-evaluation in learning. Zapitis (2011) suggests that self-evaluation training improves writing skills and focus among 5th and 6th graders by helping them establish clear guidelines and concentrate on critical writing criteria and processes. Fauzi and Widjajanti (2018) affirm that students who adopt self-evaluation learning strategies are more aware of their understanding, strengths, weaknesses, and performance compared to those who do not. Therefore, a high level of self-evaluation can promote academic achievement and vice versa.

Although numerous studies emphasize the role of self-evaluation in enhancing academic performance across various subjects, most of this research has been conducted within general or secondary education contexts. Previous studies, such as those by Evans et al. (2024), Kania & Juandi (2023), Karaman (2021), Karatas & Arpaci (2021), Lourenço & Paiva (2024), Ningsih et al. (2021), and Wiriani (2021), indicate that self-evaluation strategies can positively impact students' learning outcomes, particularly by enhancing self-awareness and metacognitive skills. However, these studies tend to overlook the specific context of undergraduate mathematics education, especially for students in mathematics teacher education programs. Additionally, while some research has examined self-evaluation within broader educational frameworks, there is limited exploration of its impact on mathematics achievement in higher education settings in Nigeria, where unique educational challenges such as limited teaching resources and varying levels of student preparedness may affect outcomes (Okigbo & Onoshakpokaiye, 2023; Okoloeze, 2015; Oppong-Gyebi et al., 2023; Ouda et al., 2021). Therefore, further

research is needed to examine how self-evaluation strategies specifically influence mathematics achievement among teacher education students in Nigeria, providing insights into potential interventions to improve academic success in this field.

Given that previous studies largely highlight the positive impact of self-evaluation on learning outcomes through enhanced self-awareness and metacognitive skills, this research gains particular relevance within Bandura's social cognitive theory framework. This theory views learning as a continuous interaction between personal, behavioral, and environmental factors. In the context of mathematics education for prospective teachers in Nigeria, self-evaluation strategies can activate this interaction, enabling students to address educational challenges such as limited resources and varying levels of academic preparedness. Thus, self-evaluation can function not only as an assessment tool but also as a learning strategy with the potential to enhance academic achievement by strengthening personal factors and shaping the learning environment.

While self-evaluation serves as a learning strategy in which students assess their own learning progress (Omare, 2020), research has yet to fully explore how it affects the mathematics achievement of students specifically training to become mathematics teachers. Simply put, students can use self-evaluation to gauge how well they understand mathematical concepts, but it remains unclear how this approach impacts their mathematical skills as they prepare to teach this subject in the future. Therefore, such research is needed to determine the predictive power of self-evaluation on the academic achievement of undergraduate mathematics education students.

METHODS

Design:

The study adopts a quantitative research methodology with a correlational framework involving undergraduate mathematics education students. This design aims to determine the relationship between two or more variables and also indicates the direction and strength of the relationship (Nworgu, 2015). Since this study aimed to ascertain the extent to which students' academic achievement in Mathematics could be linked to their self-evaluation learning strategy, which served as the independent variable, this design was deemed suitable.

Participants:

The subjects for this study comprised ($N = 357$) 3rd year undergraduate mathematics education students in Nigerian University. The participants are 300 level mathematics education degree students. This sample size is based on Cohen's et al. (2018) criteria for choosing a sample size from a population that ranges from 5,000 - 6,999 at 95% confidence level. The participants were drawn using multistage sampling procedure involving simple random sampling and purposive sampling using two Faculties at Imo State University [Faculty of Education (Mathematics Education Unit) & Faculty of Physical Sciences (Pure Mathematics)].

Data Collection:

Two instruments developed by the researcher were utilized for data collection in this study: the Students' Self-Evaluation Learning Strategy Questionnaire (SSLSQ) and the Students' Mathematics Academic Achievement Proforma (SMAAP). The SSLSQ comprises items designed to gather information on students' self-evaluation strategies. Participants indicated their level of agreement or disagreement with each item using a modified four-point Likert-type scale, with response options including Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), assigned numerical values of 4, 3, 2, and 1 respectively. The Students' Mathematics Academic Achievement Proforma (SMAAP) is used to obtain the students' achievement scores in Mathematics from the sampled school. The proforma have three (3) columns: serial number, students' identification number, and the column for the most recent terminal score of the students in Mathematics.

Validity and Reliability of the Instrument:

Experts conducted a face validation of the instruments to ensure the suitability of items, clarity of language, structure, and appropriateness for the study, and to provide suggestions for enhancing the instruments. The reliability of the SSLSQ was assessed by administering the final version of the instrument to thirty (30) randomly selected undergraduate mathematics education students from a university not included in the study sample. The internal consistency of the instrument was evaluated using the Cronbach Alpha method with Statistical Package for Social Sciences version 26 (SPSS 26.0). The Cronbach Alpha method was employed because it applies to instruments that involve polytomous scoring. The reliability estimates obtained for the SSLSQ was 0.77. The reliability index is high in line with Cohen et al. (2018) who recommended that a correlation coefficient (r) of .70 and above should be considered high. Hence, the instrument was considered good for the study.

Data Analysis:

Data collected were analyzed using simple linear regression analyses through SPSS version 26.0 as well as regression analysis through Process model 1 procedure IBM SPSS version 4.00 by Hayes (2018). The correlation coefficients (R) and coefficient of determination (R^2) obtained from simple linear regression analysis was used to answer the research question. This is because they involve bivariate relationship. This is because they involve the linear relationship between more than one predictor variables and the criterion variable. The null hypothesis was tested using regression ANOVA at 0.05 level of significance.

RESULTS AND DISCUSSION

Result

The findings presented on Table 1 depict the regression analysis examining the extent to which students' academic achievement in Mathematics can be linked to their self-evaluation strategy. The analysis revealed that when students' self-evaluation strategy scores were compared with their Mathematics academic achievement scores, a

correlation coefficient (R) of 0.47 was observed, along with an associated coefficient of determination (R^2) of 0.22. This coefficient of determination (R^2) of 0.22 indicates that 22% of the variance in students' academic achievement in Mathematics can be accounted for by their self-evaluation learning strategy.

Table 1. Regression Regression Analysis of Variation in Students' Mathematics Achievement Attributable to Self-Evaluation Strategy

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
					Change Statistics				
1	.470ª	.221	.219	6.805	.221	112.883	1	355	.000

a. Predictors: (Constant), Self-Evaluation Strategy; R = Correlation coefficient

The findings in Table 2 also demonstrate that the variance in academic achievement among undergraduate mathematics education students, attributed to self-evaluation strategy, is statistically significant (F (1, 356) = 100.687, p = .000). This significance arises from the associated probability value of .000, which is lower than the 0.05 level of significance at which the hypothesis was tested. Indicating a statistically significant variation in students' academic achievement in Mathematics attributable to self-evaluation learning strategy.

Table 2. ANOVA Test of Significance for Variation in Students' Mathematics Achievement Attributable to Self-Evaluation Strategy

Model		Sum of Squares	df	Mean Square	F	Sig.	Dec.
	Regression	5227.545	1	5227.545	100.687	0.000	S
1	Residual	18431.165	355	51.919			
	Total	23658.710	356				

The research findings indicate that self-evaluation strategies play a significant role in supporting students' academic achievement in mathematics. This strategy helps students become more aware of their understanding of the material and gives them the opportunity to independently evaluate their progress. By relying on self-evaluation, students can be more proactive in identifying weaknesses and optimizing their learning process, ultimately having a positive impact on academic outcomes. These findings suggest that students who use this strategy tend to have better academic achievement compared to those who do not employ self-evaluation strategies.

Furthermore, the statistical significance of the relationship between self-evaluation strategies and academic achievement indicates that its effect is not merely coincidental. This reinforces the importance of self-evaluation as an effective strategy in the mathematics learning process, particularly at the higher education level. The application of this strategy can be beneficial for educators in helping students develop learning independence and achieve better academic performance. Thus, self-evaluation has the potential to be a powerful tool in enhancing the quality of mathematics education.

Discussion

This study found that the use of self-evaluation learning strategies effectively enhances academic achievement among undergraduate mathematics education students. This strategy shows a significant impact on students' academic performance in Mathematics within the undergraduate teacher education program. These results indicate that self-evaluation plays a crucial role in building students' awareness of their learning progress. By engaging in regular self-evaluation, students become more aware of their understanding and have the opportunity to address identified weaknesses. This significant relationship suggests that self-evaluation learning strategies can directly contribute to improving students' academic outcomes.

Additionally, this study demonstrates a statistically significant association between students' academic achievement in Mathematics and the implementation of self-evaluation learning strategies. This finding aligns with the research of Martinez et al. (2020), which investigated the effectiveness of e-self-evaluation in enhancing the learning process at the university level. Their study revealed improved student performance and higher satisfaction as a result of using e-self-evaluation. These results affirm that self-evaluation, whether directly or through technology, can foster deep student engagement in their learning.

These findings are also consistent with the research by Omare (2020), which focused on the impact of self-evaluation learning strategies on English performance among general secondary school students in Kenya. The results of that study showed a significant positive effect on students' academic performance, indicating that self-evaluation strategies can enhance academic achievement across various educational contexts. Thus, self-evaluation strategies are not only relevant in mathematics but can also be applied to other subjects, extending their benefits to education as a whole.

However, the results of this study differ from the findings of Olodo (2020), who found that student self-evaluation was ineffective in improving mathematics performance in Kenya. This discrepancy may reflect variations in the implementation or acceptance of self-evaluation strategies across different educational settings and cultural contexts. Olodo suggests that self-evaluation strategies may not universally yield positive outcomes, and it is essential to consider the specific context of the educational environment when applying them. This indicates that factors such as student readiness and resource availability can influence the success of this strategy. These findings are also consistent with Karaman's (2021) research, which showed that self-evaluation interventions had minimal impact on overall academic performance.

Self-evaluation strategies as observed in this study, likely stems from a structured approach to regularly assessing and reflecting on task performance. This process includes reviewing and adjusting personal goals to evaluate their achievement, as well as re-evaluating learning outcomes to ensure that set objectives have been met. The strategy also involves critically evaluating problem-solving approaches in Mathematics and assessing the effectiveness of these approaches in reaching learning goals. Together, these factors contribute to the significant variation in students' academic achievement in Mathematics associated with the use of self-evaluation learning strategies.

Implication

The results of the study have educational implications. Given that the self-evaluation learning strategy accounts for a significant variation in students' academic achievement in mathematics, this has far-reaching effects on the teaching and learning of the subject. Teachers, who are tasked with guiding students in school, should expose and encourage students to adopt this strategy to improve their performance in mathematics. The findings also have implications for students, as the strategy requires a high level of student commitment. Therefore, if students are to excel in mathematics, they need to actively employ or adopt the self-evaluation learning strategy when studying, to enhance their academic achievement in the subject

Limitations and Suggestions for Further Research

Due to individual differences, some of the respondents could have faked their responses to the items on the instruments. This could have affected the result of this study. Multivariate approach could also be employed in studying self-evaluation learning strategy alongside with other psychological variables in relation to students' academic achievement in Mathematics, where all the variables will be analyzed simultaneously.

CONCLUSIONS

The research findings indicate that the self-evaluation learning strategy plays a significant role in explaining variations in the academic achievement of undergraduate mathematics education students in mathematics. Essentially, this strategy makes a substantial contribution to students' academic success in the subject. Based on these study outcomes, it can be concluded that integrating self-evaluation learning strategies is crucial for improving students' academic achievement in Mathematics. Therefore, undergraduate mathematics education students should actively incorporate and utilize self-evaluation strategies in their learning processes to enhance their learning capabilities and overall academic performance in Mathematics.

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AUTHOR CONTRIBUTION STATEMENTS

BCOC : Conceptualization, data curation, methodology, project administration, visualization, original draft writing, and review.

COU : Formal analysis, resource management, validation, visualization, editing, and review.

LO : Methodology, project administration, , formal analysis, and editing.

REFERENCES

Agwagah, U. N. V. & Utibe, U. V. (2015). A decade of candidates' performance in NECO-SSCE Mathematics in Nigeria. *Journal of Education and Practice, 6*(25), 25 - 30.

Ajayi, O. V. & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Education and Science (IJRES), 1*(1), 45- 50. https://doi.org/10.12691/education-5-8-1

Aji, C.A & Khan, M.J. (2019) The impact of active learning on students' academic performance. *Open Journal of Social Sciences*, **7**, 204-211. https://doi.org/10.4236/jss.2019.73017.

Amadi, S. N., Adedapo, I. Y. & Sunday, O. G. B. U. (2021). Effect of chess board game approach on students' achievement in mathematics in Enugu Education Zone of Enugu State. *International journal of Education Research Review, 1*(1).

Andrade, H. L. (2019). A critical review of research on student self-assessment. *Frontiers in Education*, 4(87). https://doi.org/10.3389/feduc.2019.00087

Brown, G.T. & Harris, L.R. (2014). The Future of Self-Assessment in Classroom Practice: Reframing Self-Assessment as a Core Competency. *Front. Learn. Res., 2,* 22–30. https://doi.org/10.14786/flr.v2i1.24

Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education (8th ed.). London: Routledge. https://doi.org/10.4324/9781315456539

Chand, S., Chaudhary, K., Prasad, A., & Chand, V. (2021). Perceived causes of students' poor performance in mathematics: A case study at Ba and Tavua secondary schools. *Frontiers in applied mathematics and statistics*, *7*, 614408.

Emaikwu, S. O. (2012). Assessing the relative effectiveness of three teaching methods in the measurement of student' achievement in mathematics. *Journal of Emerging Trends in Educational Research and Policy Studies, 3*(4), 479-486.

European Commission (2013c). Thematic Working Group on Mathematics, science and technology. *Addressing low achievement in Mathematics and science. Brussels.*

Evans, C., Kay, W., Amici-Dargan, S., González, R. D. M., Donert, K., & Rutherford, S. (2024). Developing a scale to explore self-regulatory approaches to assessment and feedback with academics in higher education. *Frontiers in Psychology*, 15. https://doi.org/10.3389/fpsyg.2024.1357939

Eze, J. E. (2011). A practical approach to effective teaching and learning of Mathematics in Nomadic schools. *Abacus the Journal of Mathematical Association of Nigeria*, *36*(1),129-138

Fauzi, A. & Widjajanti, D. B. (2018). Self-regulated learning: The effect on student's mathematics achievement. *Journal of Physics: Conf. Series,* 1097. https://doi.org/10.1088/1742-6596/1097/1/012139

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive – developmental inquiry. *American Psychologist, 34*(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Fletcher, D.R. (2020). Introduction to the Special Edition. *Social Policy and Administration, An International Journal of Policy and Research,* 54(2), 185-190. https://doi.org/10.1111/spol.12569

Hayes, A. F. (2018). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach (Methodology in the Social Sciences) (2nd ed.). New York, NY: The Guilford Press.

Higham, N. J. (2020). *Handbook of writing for the mathematical sciences.* Society for industrial and allied mathematics. https://doi.org/10.1137/1.9781611976106

Iji, C. O., Emiakwu, S. O., & Utubaku, R. U. (2015). Effect of problem-based learning on senior secondary school students' achievement in trigonometry in northern educational of Cross River State, Nigeria. *IOSR journal of mathematics, 11*(1), 16-21. https://doi.org/10.9790/5728-11151625

Kania, N., & Juandi, D. (2023). Does self-concept affect mathematics learning achievement? *Journal of Education and Learning (EduLearn)*, *17*(3), 455–461. https://doi.org/10.11591/edulearn.v17i3.20554

Karaman, P. (2021). The impact of self-assessment on academic performance: A meta-analysis study. *International Journal of Research in Education and Science, 7*(4), 1151-1166. https://doi.org/10.46328/ijres.2344

Karatas, K., & Arpaci, I. (2021). The role of self-directed learning, metacognition, and 21st century skills predicting the readiness for online learning. *Contemporary Educational Technology*, *13*(3), ep300. https://doi.org/10.30935/cedtech/10786

Kallweit. I & Melle. I. (2013). *Effects of self-evaluation on students' achievements in chemistry education.* TU Dortmund University, Germany.

Kpolovie, P. J., Joe, A. I. & Okoto, T. (2014). Academic achievement prediction: Role of interest in learning and attitude towards school. *International Journal of Humanities, Social Science and Education, 1*(11), 73-100.

Kurumeh, M. S., Onah, F. O. & Mohammed, A. S. (2012). Improving students' retention in junior secondary school statistics using the ethno-mathematics teaching approach in Obi and Oju local government areas of Benue State, Nigeria. *Greener Journal of Educational Research, 2*(3), 54 – 62. https://doi.org/10.15580/GJER.2012.3.10051286

Lourenço, A. A., & Paiva, M. O. (2024). Academic performance of excellence: The impact of self-regulated learning and academic time management planning. *Knowledge*, *4*(2), Article 2. https://doi.org/10.3390/knowledge4020016

Martínez, V., Mon, M. A., Álvarez, M., Fueyo, E., & Dobarro, A. (2020). E-self-assessment as a strategy to improve the learning process at university. *Education Research International*. https://doi.org/10.1155/2020/3454783

Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2020). Assessing students' performance in mathematics in Tanzania: the teacher's perspective. *International Electronic Journal of Mathematics Education*, *15*(3), em0589.

Ningsih, M. F., Sarjana, K., Azmi, S., & Baidowi, B. (2021). Pengaruh kemandirian belajar terhadap hasil belajar matematika siswa kelas VIII SMP. *Griya Journal of Mathematics Education and Application*, *1*(1), 11–18. https://doi.org/10.29303/griya.v1i1.9

Nzeadibe, A.C., Egara, F.O., Inweregbuh, O. & Osakwe, I.J. (2019). Effect of two meta-cognitive strategies on students' achievement in mathematics. *J-CUDIMAC, 7*(1), 43-57. https://cudimac.unn.edu.ng/volume-7/

Ejembi O.S, Oguguo B.C.E, Ezeanya C.O, Okpe K.E, Okwara V.C, Adie I.I, Ayek B. B, Okpara L.I & Ojobo B.N. (2024). Relative effectiveness of formative assessment techniques on students' academic achievement in mathematics classroom teaching and learning. *Mathematics Research Teaching Journal (MRTJ), 15*(6), 171-193

Obi, C. N. (2014). Effect of origami on students' achievement, interest and retention in geometry. *Unpublished Doctoral Dissertation, University of Nigeria Nsukka.*

Ohwoavworhua, L & Oguguo C.E. (2023). The effectiveness of metacognition on academic achievement among the nigerian university students. *AJSTME, 9*(6), 493-499. https://ajstme.com.ng

Okafor, O. S. (2020). Interest as predictor of academic achievement of secondary school students in physics. *British Journal of Education, Learning and Development Psychology, 3*(3), 1-9.

Okigbo, E. C., & Onoshakpokaiye, O. E. (2023). Relationship between academic self-concept and academic performance in mathematics of secondary school students in Delta State, Nigeria. *Indonesian Journal of Mathematics Education*, *6*(2). https://doi.org/10.31002/ijome.v6i2.991

Okoloeze, M. (2015). *Trends In Educational Evaluations in Nigeria: Issues And Challenges*.

Olodo, Z. O. (2020). *Effect of student self-assessment on academic performance.* (published M.Ed thesis), University of Nairobi, Kenya.

Olunloye, O. (2010). *Mass failure in Mathematics: A national disaster.* Tribune of 07/02/2010. Retrieved from http/www.tribune.com.ng on 08/05/2022

Omare, J. M. (2020). Effect of self-evaluation learning strategy on academic performance in english language among students in public secondary schools in Kenya." *American Journal of Educational Research*, *8*(11), 822-827. https://doi.org/10.12691/education-8- 11-2.

Onoshakpokaiye, E. O. (2015). Relationship of study habits with Mathematics achievement. *Journal of Education and Practice, 6* (10), 168 – 170. https://files.eric.ed.gov/fulltext/EJ1081665.pdf

Oppong-Gyebi, E., Dissou, Y. A., Brantuo, W. A., Maanu, V., Boateng, F. O., & Adu-Obeng, B. (2023). Improving STEM mathematics achievement through self-efficacy, student perception, and mathematics connection: The mediating role of student interest. *Journal of Pedagogical Research*, 4. https://doi.org/10.33902/JPR.202321085

Ouda, J. B., Runhare, T., Mudzielwana, N. P., Cassim, H., & Mulovhedzi, S. A. (2021). An examination of the correlation between South African grade 12 students' mathematics self-concept and their academic achievement. *International Journal of Learning, Teaching and Educational Research*, *20*(12). https://doi.org/10.26803/ijlter.20.12.8

Owan, V. J. (2020). Effect of gender, test anxiety and test items scrambling on students' performance in mathematics: A quasi- experimental study. *World Journal of*

Vocational Education and Training, 2(2), 56-75. https://doi.org/10.18488/journal.119.2020.22.56.75

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*, 111-139. https://doi.org/10.1007/s11165-005-3917-8

Singh, P. (2016). Study of acedemic achievement in mathematics in relation with study-habits and home-environment. *International Journal of Innovative Science, Engineering & Technology, 3*(1). https://ijiset.com/vol3/v3s1/IJISET_V3_I1_16.pdf

Sitko, N. J. (2013). Designing a qualitative research project: Conceptual framework and research questions. *Indaba Agricultural Policy Research Institute (IAPRI)*.

Sitopu, J. W., Khairani, M., Roza, M., Judijanto, L., & Aslan, A. (2024). The importance of integrating mathematical literacy in the primary education curriculum: A literature review. *International Journal of Teaching and Learning*, *2*(1), 121-134.

Spinath, B. (2012). *Academic Achievement.* Heidelberg University, Heidelberg, Germany. https://doi.org/10.1016/B978-0-12-375000-6.00001-X

Steinmayr, R., Meibner, A., Weidinger, A. F. & Wirthwein, L. (2015). *Academic achievement*. https://doi.org/10.1093/obo/9780199756810-0108

Tariq, V. N., Qualter, P., Roberts, S., Appleby, Y., & Barnes, L. (2013). Mathematical literacy in undergraduates: Role of gender, emotional intelligence and emotional self-efficacy. *International Journal of Mathematical Education in Science & Technology, 44*(8), 1143–1159. https://doi.org/10.1080/0020739X.2013.770087

Uhumuavbi, P. O. & Umoren, G. E. (2005). Relationship between interests in Mathematics and achievement of students: A case study of Auchi Polytechnic. *Nigerian Journal of Professional Teachers. An International Journal of TRCN*, *1*(1), 71-76.

Umaru, Y.,Ngwoze, D.U.& Eze, U.N. (2015). Moderating role of instruction in metacognitive skills on mathematics qehunt of low achievement of students in senior secondary school. *Umya Journal of adventures research, 1*(1), 14-22.

Wiriani, W. T. (2021). Pengaruh kemandirian belajar terhadap hasil belajar siswa pada pembelajaran online. *Jurnal Ilmiah Matematika Realistik*, *2*(1), 57–63. https://doi.org/10.33365/ji-mr.v2i1.436

Yara, P. O. & Otieno, K. O. (2010). Teaching/learning resources and academic performance in Mathematics in secondary schools in Bondo District of Kenyan. *Asian Social Science, 6(*12), 26 -35. https://doi.org/10.5539/ass.v6n12p126

Zapitis, M. (2011). *The effects of self-evaluation training on writing of students in grades 5 & 6. (*Master's Thesis), University of Toronto. Ontario.