British Journal of Education 13, (8), 13-24, 2025
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

# Effects of Brain Based Learning (BBL) On Students' Academic Achievement and Retention in Mathematics Word Problem in Akwa Ibom State-Nigeria

**Paul Moses Udofia**
Department of Mathematics, College of Education, Afaha Nsit
**Enyekeme Owouko Ibok**
Department of Mathematics, College of Education, Afaha Nsit

doi: https://doi.org/10.37745/bje.2013/vol13n81324 Published June 25, 2025

**Citation**: Udofia PM and Ibok EO (2025) Effects of Brain Based Learning (BBL) On Students' Academic Achievement and Retention in Mathematics Word Problem in Akwa Ibom State-Nigeria, *British Journal of Education,* 13, (8), 13-24

**Abstract:** *The study seeks to determine the effects of Brain Based Learning (BBL) on students' academic achievement and retention in mathematics word problem in Akwa Ibom State Nigeria. Three research questions were asked, and three corresponding null hypotheses were formulated to guide the study. The non-equivalent control group pre-test post-test quasi-experimental research design was adopted. The proportionate and stratified random sampling techniques were used to select a sample of two hundred (200) senior secondary one (SS 1) students drawn from intact classes from four (4) selected schools in Etinan Education Zone from the population of comprising of 3610 SS I students with 2400 male and 1210 female students as at 2024/2025 academic year. The instrument used for data collection was a researcher-developed Achievement Test on Brain Based Learning on Word Problem (ATBBLWP) a 30 items 4 options multiple choice test after determining its validity and reliability indices. Spilt half method was used to determine the reliability index of the instrument, which was 0.87. The null hypotheses were all tested at the .05 alpha level using the Analysis of Covariance (ANCOVA), statistical techniques. Findings revealed that Brain based instruction enhances students' academic achievement and retention in word problem than the conventional teaching method. Brain based instruction equally promotes gender equality in the classroom. The instruction favors male and female students equally in enhancing academic achievement in word problem. Brain based instruction also promotes rural and urban parity in classroom mathematics instruction and understanding. It favors both urban and rural students' locations equally in enhancing academic achievement in word problem. It was recommended, among other things, that teachers should adopt brain-based instruction to enhance students' mathematics academic achievement and retention, irrespective of students' gender.*

**Keywords:** Brain Based Learning (BBL), students' academic achievement, retention, mathematics word problem, Akwa Ibom, Nigeria

British Journal of Education 13, (8), 13-24, 2025
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

## INTRODUCTION

Mathematics is one of the subjects in the school's curriculum that demands logical reasoning and the full utilization of the brain. According to Okeke (2013), Mathematics is the logical language for expressing ideas of shapes, quantities, sizes, order, change and dynamism in systems and for the explanation of the complexities of modern society in the business, economic, academic, engineering and medical settings. Mathematics is a field of study that is studied by all students from elementary through to Senior High Schools and even the Universities (Jagals et. al.,2016 ; Asfar et al., 2022).

This is expedient since the contents embedded in Mathematics equips the mind of the learner with logical, cognitive and analytical reasoning ability suitable in solving real life problems. The competence and learning of Mathematics are necessary to address everyday life problems (Kong &Matore, 2021), as the application of mathematics is not only limited to Science, Technology, Engineering and Mathematics (STEM) education but it's impact and importance cut across other fields such as Humanities and social sciences. For a fact, it is pivotal to all human endeavors. This claim is supported by UNESCO (2012), that mathematics education that is relevant and of quality can develop critical and creative thinking, help learners to understand and participate in public policy discussions, encourage behavioural changes that can put the world on a more sustainable path and stimulate socio-economic development. Even with its vastness, Mathematics is a social construct that is open to change, progress and development (Uzoechi, et al.,2013)

Word Problem is an important topic in mathematics education at all educational levels, it is often found in the subject matter such as Social Arithmetic, Statistics, Algebra, Physics and Economics and it serves many purposes in Mathematics education (Carlos, et.al.,2023; Pongsakdi, et. al., 2020, Nwankwo, 2021). Word problems require students to read a language-based problem, identify necessary information to answer a prompt, and perform calculation(s) to develop a problem solution. (Powell et.al.,2019). It brings variation to the practising of basic Mathematical operations and prepare students to use Mathematical skills in everyday situations outside the classroom (Pongsakdi, et. al., 2020).

Mathematics achievement is often measured using standardized tests (Carlos et. al.,2023). Both in the internal and external standardized test administered to students on word problems, the academic performance has not been encouraging despite the importance of word problem to real life. According to Powell, et al., (2019), lower performance in word-problem solving may impact students' later Mathematics success in school, job opportunities, and salary later in life. The complexity of word problems may be influenced by students experiencing Mathematics difficulty, language comprehension challenges both general and Mathematics-specific, used within the word problems text (Fuchs et.al.,2018, Powell, et al., 2019 and Carlos, et. al.,2023). Lack or shortage of qualified, experienced and committed Mathematics teachers, ineffective teaching strategy for impacting knowledge of the concepts of word problem, conducive learning environment, lack of confidence by the students (Riskiningtyas & Wangid, 2019) and the teaching approach can also contribute to this incessant poor performance.

Most teachers of Mathematics have been using the conventional Teacher- centered approach for their lesson delivery in the class room (Ibok, Esuong, & Joseph, 2023). This strategy of teaching can be in the form of discussion, giving of project, lecture, demonstration and discovery, depending on the teacher. Considering the commonly used method by Mathematics teachers, Lecture method emphasizes only on

superficial learning instead of in depth knowledge of the facts (Asiyai, 2015) and this does not bring out the desired results because the learner undergoes passive learning. Since teaching and learning Mathematics must be child or student-centred and not teacher-centred (Zain et al., 2012) for learning to take place, it is then of great necessity to use the learner centered approach, rather than trying to improve on the teacher centered approaches. The researcher in this study wishes to examine the effect of Brain - based Learning (BBL) approach on Students academic achievement and retention in Mathematics Word problem.

Brain-based learning (BBL) approach originated from the study of neurology and cognitive science. According to (Nwankwo et. al.,2021), Brain based learning (BBL) refers to an advanced teaching strategies, lesson designs and school programmes that are based on the latest scientific research about how brain learns, including such factors as cognitive development; how students learn differently as they age, grow and mature socially, emotionally and cognitively. It is an instructional approach that addresses students' achievement and learning goals from the perspective of the human brain. It entails specialized learning procedures centred on how human memory, attention, motivation, and conceptual cognitive learning work. (Amjad et.al., 2022). This approach is used in a classroom setting that is brain friendly and non-threatening to maximize knowledge and reduce the use of the traditional approach, which merely encourages rote memorization (Noureen et al., 2017). It follows how the brain is biologically structured for learning (Solihat, 2017). Brain-based learning (BBL) approach is believed to be more learner-friendly and boosts learning due to its holistic approach to learning, with the goal of attaining maximum attention, understanding, meaning and memory adding that BBL approach emphasizes meaningful learning instead of memorization and that it does not easily learn things that are not logical or meaningful (Nwankwo et. al ,2021). Considering the benefits of Brain-based learning, it is needful for teachers of Mathematics to use this method in teaching Word problems in Akwa Ibom State.

**Statement of the Problem**

Mathematics is a pivotal field as far as Science, Technology and human development is concerned. Correct applications of the concepts in Mathematics is visible in modern inventions and the nation's development. However, the teaching approach used in teaching Mathematics in some secondary schools is teacher centered, making the students passive learners with little or no independent mental reasoning. In this approach the learner is presented with the choice of memorizing rather than understanding and retaining the lesson, leading to poor academic achievement of students in mathematics word problems. According to Nwankwo (2021), whatever is learned though memorization and rote learning are not stored in the long term memory and so are easily forgotten?

Since the traditional approaches have not enhanced students' academic achievement in Mathematics, adopting one of the innovative and learner-centered teaching approach as an alternative to check whether it can enhance the Students' Academic Achievement and retention in Mathematics Word problems is needful. The study seeks to investigate the effects of Students Academic Achievement and retention in Mathematics Word problem via Brain based learning (BBL) approach.

**Purpose of the Study**

The aim of the study is to determine the effects of Brain Based Learning (BBL) on Students Academic Achievement and retention in Mathematics Word problems in Akwa Ibom State.

**Research Hypotheses**

1. There is no significant difference on academic achievement and retention of students in Mathematics Word problems when compared with those taught using conventional teacher centered approach.
2. There will be no significant difference on male and female students' academic achievement and retention in Mathematics Word problem.
3. There will be no significant difference on urban and rural students' academic achievement and retention in Mathematics Word problems.

**Concept of Word Problem in Mathematics**

Word problem is an essential topic in Mathematics. It is linguistically framed mathematical problems (Verschaffel, et al., 2020) practiced at all levels of education with vast application to humanity. By studying Word problems, students get introduced to mathematics in their everyday life via the application of the knowledge gained in the classroom to solving real life problems (Bullock ,2015). According to Taley (2022), Word problems may be categorized as routine or non-routine tasks. Routine problems are tasks whose solutions are deduced from applying general mathematics concepts inferred from the problem situation. They are tasks that can be solved by duplicating previously taught procedures step-by-step (Esuong, & Edoho, 2018). Non-routine problems, on the other hand, are those tasks that do not expressly propose a predictable, well-rehearsed route or solution pathway.

Despite the perceived importance of word problems, (Taley,2022 and Pearce et al., 2013) opines that students' dislike for word problems were premised instructional related factors and student-related factors. They went further to explain that Instructional-related factors included the teaching approach, the complexity in the instructional language and the language used in framing the tasks. Student-related factors also included the mental and emotional predisposition of students toward word problems and students' weakness in the language used in formulating Word problem as a medium of instruction (Esuong, Owan, Edoho, and Eni, 2023). Their findings showed students' weakness in comprehending word problems as a medium of instruction created deficiencies in students' ability to make meaning, as confirmed elsewhere.

**Brain Based Learning Approach**

In 1999 Caine et. al., (1999) developed 12 principles that apply what we know about the function of the brain as it regards teaching and learning. The principles are:

1. The brain is a parallel processor
2. Learning engages the whole physiology.
3 The search for meaning is innate.
4. The search for meaning comes through patterning
5. Emotions are critical to patterning
6. The brain processes wholes and parts simultaneously
7. Learning involves both focused attention and peripheral perception.
8. Learning involves both conscious and unconscious processes.
9. Humans have two memories namely spatial and rote.
10. Understanding is best when facts are embedded in natural, spatial memory
11. Learning is enhanced by challenge and inhibited by threat
12. Each brain is unique.

The Brain Based Learner approach of teaching has been identified as one of the critical teaching approaches to be investigated in the twenty-first century (Amjad et al.,2022). The Structure and function of the brain helps to develop the ability of learning process (Arun and Singaravelu, 2018) and there is no learning without the brain. Brain Based Learning is all about how our brain learn. (Amjad et al.,2022). It is learner-centered and teacher-facilitated method that employs learners' cognitive endowments (Gladys et.al.,2018), aligning with the workings of the brain and designed naturally to learn (Mekarina and Ningsih, 2017). According to Koşar & Bedir in 2018, Brain based learning is the process of adapting instruction to the learner-centred teaching processes of the human brain. This approach of learning is different from traditional methods of teaching and according to Arun and Singaravelu (2018), Brain based learning emphasizes meaningful learning in the place of rote learning, they further added that it is also a developed activity based learning and learner centric approach. Asides boosting the learners academic achievement and retention, Brain Based approach also foster cooperation, teamwork, and dedication (Duncan, 2020) with a lasting behaviour change resulting from building a knowledge based on practice and experience (Koşar & Bedir,2018).

**Empirical Framework**

Bilal (2010) conducted a study to investigate the effects of Brain-based learning (BBL) on the academic achievement of students with different learning styles. The study group consists of students from the department of Social Sciences Teacher Education in the Faculty of Education at Mugla University (N=68). The study was carried out by the researcher among third-year students of the Education Faculty of Mugla University in the 2006-2007 academic year. While forming the sample, attention was paid to the need for students in the groups to be from the same departments, and with similar university entrance exam (ÖSS) scores. Through the pre-test, academic achievement scores of the students were equalized. Then, the students were randomly assigned to the control and experimental groups. Out of the 34 experimental group students, 18 (52.9%) are females and 16 (47.1%) are males, and out of the 34 control group students, 15 (44.1%) are females and 19 (55.9%) are males. The age range is 20-22 years in both groups. The socio-economic and cultural conditions of the participants are similar. Participation was on a voluntary basis, and the research was conducted during a course on the subject of measurement and evaluation. Participants were informed of their learning style preferences at the end of the study.

In the study, a pre-test-post-test experimental design was used. Data were collected by using academic achievement tests and the Kolb's Experiential Learning Style questionnaire. The findings of the study revealed that the BBL approach used in the experimental group was more effective in increasing student achievement than the traditional approach used in the control group. However, no significant difference was observed among the achievement levels of the experimental group students with different learning styles. Findings of the studies showed that learning styles-based teaching increases students' achievement but this increases does not vary depending on learning styles associating with individual diseases. Also, Aaron A. *et,al* (2023)conducted a study that explores the effectiveness of brain-based learning (BBL) as a pedagogical approach to address the challenges of poor conceptual understanding, which may have worsened due to the COVID-19 pandemic aftermath. In this meta-analysis, 14 studies qualified using the Publish or Perish software and the Preferred Reporting Items for Systematic Reviews and Meta-analyses. Statistical analysis conducted using Comprehensive Meta-Analysis (CMA) Version 4 software by Biostat, Inc. Based on the results, the overall effect size (ES = 3.135) indicates that the use and integration of BBL principles and strategies have a significantly large and positive effect on student conceptual understanding. The moderator analysis revealed a significant difference between individual studies ($p < .001$); however, the overall results for academic level ($p > .05$) and discipline ($p > .05$) revealed no

significant differences. Hence, each study included in this analysis may differ from one another due to the differences in various BBL strategies implemented; however, when grouped, they shared common effect sizes. With these findings, the researchers advocate the use of BBL principles and strategies to improve students' conceptual understanding at various levels in basic education, be it in English and STEM. Moreover, empirical studies focusing on a particular BBL variable, such as health and nutrition, are recommended for in-depth analysis and discussion.

## METHODOLOGY

The pretest-posttest quasi-experimental design was used for this study. This design make used of pretest and posttest in order to ascertain the effect of treatment together with the moderator variables. The population of this study comprise of 3610 SS I students comprising of 2400 male and 1210 female students as at 2024/2025 academic year, (Akwa lbom State Universal Basic Education Board — AKSUBEB) in the thirty (30) public secondary schools of the three (3) local government area (Etinan, Nsit Ibom and Nsit Ubium) making up etinan education zone.

The proportionate and stratified random sampling techniques were used to select a sample of two hundred (200) senior secondary one (SS 1) students drawn from intact classes from the four (4) selected schools in Etinan Education Zone. The samples were 82 males and 118 female students. In term of groups; 98 were assign to experimental group and 102 for control group.

The instrument for data collection is a researcher-developed instrument titles: Achievement Test on Brain Based Learning on Word Problem (ATBBLWP) a 30 items 4 option multiple choice test used for data collection after determining its validity and reliability indices validity involved face and content validity determination and item analysis. Spilt half method was used to determine the reliability index of the instrument, which was 0.87. The students were given code numbers to use in their scripts instead of their name. These code numbers were maintain in the pretest and posttest exercises. The instrument was expected to measure the students, pretest and posttest achievement in the experimental and control groups.

**Table 1: Split-half reliability estimates of the research instrument (N 30)**

| Instrument | No of item | Type | Mean ($\bar{x}$) | Standard derivation (SD) | Split-half correlate (rxy) | Reliability estimate (rtt) |
|---|---|---|---|---|---|---|
| | 15 | Odd | 121.37 | 1.40 | .82 | .87 |
| | 15 | Even | 130.55 | 26.54 | | |

**Treatment**

(i) Permission was obtained from the authorities of the selected schools.

(ii) Interaction between the researcher and the mathematics teachers who taught the students on the concept of Brain Based Learning on Word Problem.

(iii) Administration of pre-test: The ATBBLWP was administered to the entire groups by the researcher assisted by the mathematics teachers. The scripts were collected immediately after the test completion for marking.

(iv) Treatment: The active classroom teaching commenced two days after the pretest administrations. The teaching exercises were done by the mathematics teachers of each school. The instructional packages

of the study consisted of the lesson notes for experimental group using Brain Based Learning on Word Problem.

(v) Administration of Post-test: After the active classroom teaching exercise, the ATBBLWP was reshuffled and administered as posttest four days after the conclusion of treatment exercise. The test scripts were collected for marking and analysis.

For each correct option to items in ATBBLWP was scored 5 marks and incorrect answer was scored zero (0). For gender Male were scored – 1 and Female –2. The null hypotheses (1 - 4) stated, were tested using Analysis of Covariance (ANCOVA) at p-value = 0.05. This method of data analysis helps to eliminate differences between groups.

## RESULTS/DISCUSSION OF FINDINGS

### Hypothesis One

There is no significant difference in the mean academic achievement of students taught mathematics word problem using brain-based instruction and those taught with conventional method. One-way Analysis of Covariance (ANCOVA) was applied in testing this hypothesis with teaching method as factor (independent variable) and posttest achievement scores as dependent variable while pre-test achievement scores represented the covariate. The results obtained are presented in Table 1.

In Table 1, after adjusting for the effect of covariate, the results still showed that the effect of teaching method was significant (F = 400.706; P = .000). The effects of the corrected model, intercept and mean pre-test score were equally significant after adjustment (F = 468.048, 30.019, 512.379; P = .000). On the basis of this outcome, the null hypothesis was rejected. This means the difference between the mean mathematics achievement scores (20.00) of students exposed to brain-based instruction and that of those taught with the conventional method is statistically significant.

**TABLE 1**
**One-way ANCOVA of Students' Achievement Scores by Teaching Method**

| Source of Variation | Sum of squares | Df | Mean Square | F-value | P-value |
|---|---|---|---|---|---|
| Corrected model | 33118.224 | 2 | 16559.112 | 468.048* | .000 |
| Intercept | 1062.049 | 1 | 1062.049 | 30.019* | .000 |
| Pre-test | 18127.482 | 1 | 18127.482 | 512.379* | .000 |
| Method | 14176.600 | 1 | 14176.600 | 400.706* | .000 |
| Error | 4917.691 | 139 | 35.379 | | |
| Total | 398658.000 | 142 | | | |
| Corrected Total | 38035.915 | 141 | | | |

*Significant at .05 level, P < .05

**Hypothesis Two**

There is no significant difference in the mean mathematics achievement scores of male and female students taught word problems using brain-based instruction. To test this hypothesis, one-way Analysis of Covariance (ANCOVA) was applied with students' gender as independent variable and post-test scores in word problems as dependent variable while pre-test scores represented the covariate. The results obtained were presented in Table 2.

In Table 2, after adjusting the post-treatment scores for the effect of covariate, the F-ratio test indicated significant results, except for gender (F = .004; P = .947) as the respective P-values associated with computed F-values (87.754, 68.603 and 174.071) were less than .05. On the basis of this outcome, the null hypothesis was retained. This means that, there is no significant difference in the mean mathematics achievement scores of male and female students taught word problem using brain-based instruction.

**TABLE 2**

**One-way ANCOVA of Mathematics Aciehevement Scores of Treatment Group by Gender**

| Source of Variation | Sum of squares | df | Mean Square | F-value | P-value |
|---|---|---|---|---|---|
| Corrected model | 8675.217 | 2 | 4337.608 | 87.754 | .000 |
| Intercept | 3390.983 | 1 | 3390.983 | 68.603 | .000 |
| Pretest | 8604.201 | 1 | 8604.201 | 174.071 | .000 |
| Gender | .216 | 1 | .216 | .004 | .947 |
| Error | 3460.043 | 70 | 49.429 | | |
| Total | 278306.000 | 73 | | | |
| Corrected Total | 12135.260 | 72 | | | |

**Hypothesis Three**

There is no significant difference in the mean mathematics achievement scores of rural and urban students taught word problems using brain-based instruction. To test this hypothesis, one-way Analysis of Covariance (ANCOVA) was applied with location as independent variable and post-test scores in word problems as dependent variable while pre-test scores represented the covariate. The results obtained were presented in Table 3.

In Table 3, after adjusting the post-treatment scores for the effect of covariate, the F-ratio test indicated significant results, except for gender (F = .004; P = .947) as the respective P-values associated with computed F-values (87.754, 68.603 and 174.071) were less than .05. On the basis of this outcome, the null hypothesis was retained. This means that, there is no significant difference in the mean mathematics achievement scores of urban and rural students taught word problem using brain-based instruction.

**TABLE 3**
**One-way ANCOVA of Mathematics Achievement Scores of Treatment Group by Location**

| Source of Variation | Sum of squares | df | Mean Square | F-value | P-value |
|---|---|---|---|---|---|
| Corrected model | 8675.217 | 2 | 4337.608 | 87.754 | .000 |
| Intercept | 3390.983 | 1 | 3390.983 | 68.603 | .000 |
| Pre-test | 8604.201 | 1 | 8604.201 | 174.071 | .000 |
| Location | .216 | 1 | .216 | .004 | .947 |
| Error | 3460.043 | 70 | 49.429 | | |
| Total | 278306.000 | 73 | | | |
| Corrected Total | 12135.260 | 72 | | | |

## DISCUSSION OF FINDINGS

There is no significant difference in the mean academic achievement of students taught mathematics word problem using brain-based instruction and those taught with conventional method. On the basis of the outcome, the null hypothesis was rejected. This means the difference between the mean mathematics achievement scores of students exposed to brain-based instruction and that of those taught with the conventional method is statistically significant.

The result is in line with the findings of Bilal (2010) who conducted a study to investigate the effects of Brain-based learning (BBL) on the academic achievement of students with different learning styles. The findings of the study revealed that the BBL approach used in the experimental group was more effective in increasing student achievement than the traditional approach used in the control group. However, no significant difference was observed among the achievement levels of the experimental group students with different learning styles. Findings of the studies showed that learning styles-based teaching increases students' achievement but this increases does not vary depending on learning styles associating with individual diseases.

Also, the findings aligned with Aaron A. *et,al* (2023) in his study that explores the effectiveness of brain-based learning (BBL) as a pedagogical approach to address the challenges of poor conceptual understanding, which may have worsened due to the COVID-19 pandemic aftermath. The findings of the research advocated the use of BBL principles and strategies to improve students' conceptual understanding at various levels in basic education, be it in English and STEM. Moreover, empirical studies focusing on a particular BBL variable, such as health and nutrition.

## CONCLUSION

Based on the findings of this study, the following conclusions were drawn:

1. Brain based instruction enhances students' academic achievement and retention in word problem than the conventional teaching method.
2. Brain based instruction promotes gender equality in the classroom. It favours male and female students equally in enhancing academic achievement in word problem
3. Brain based instruction also promotes rural and urban parity in classroom mathematics instruction and understanding. It favours both urban and rural students locations equally in enhancing academic achievement in word problem.

**Recommendations**

Based on the findings of this study, the following recommendations were considered relevant for improvement in mathematics education.

1. Brain based instruction should be adopted by schools to enhance students' mathematics academic achievement and retention; irrespective of students' gender.
2. Government should make policy for effective implementation of brain based instruction in schools in the country and ensure their effective use.
3. Government, professional bodies and non-governmental organizations should use all necessary machineries to organize in-service training programs for teachers on the importance and effective use of brain-based instruction. This could make them more effective in the classroom and the desired students' mathematics outcome could be achieved.
4. Curriculum experts and textbook authors should be encouraged by government and other stakeholders in the education sub-sector to incorporate brain based instruction as innovative and efficacious method in curriculum and textbooks. This could draw mathematics closer to the learners.

**REFERENCES**

Aaron A. F., Jhonner D. R., Frances G. J. & Nestor L. L. (2023. Effectiveness of Brain-Based Learning Toward Improving Students' Conceptual Understanding: A Meta-Analysis: *International Journal of instruction, 17* (1) 361-380

Amjad, A. I, Habib, M & Saeed, M (2022). Effect of Brain-Based learning on students' Mathematics performance at Elementary Level Pakistan.*Journal of Social Research* ISSN2710-3129 (P) 2710-3137 (O) Vol. 4, No. 3, September 2022, pp. 38-51.

Arun, A and Singaravelu, G.(2018).Brain-Based Learning: A Tool for Meaningful learning in the Classroom. *International Journal of Research.* ISSN NO: 2236-6124.Volume 7, Issue IX, page (766-770)

Asfar, N. U., Permana, D., Fauzan, A., & Yarman, Y. (2022). Improving students' mathematical critical thinking ability with learning modules using brain-based learning models. Numerical: *Journal MatematikadanPendidikanMatematika* 6(1), 91-100

Asiyai, R. I. (2015). Enhancing Chemistry Teaching in Secondary Schools through concept Mapping Instructional Strategy. In Nzewi, U. (Ed) Proceedings of the 46th Annual Conference of Science Teachers Association of Nigeria Ibadan Nigeria: Heinemann Educational Books.

Bilal D. (2010) The Effects of Brain-Based Learning on the Academic Achievement of Students with Different Learning Styles: Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice 10 (4) • Autumn 2010 • 2077-2103

Bullock, G. P. (2015). Algebra in words presents: Word problems decoded (1st ed.). SAGE Publications Inc.

Caine, G. & Caine, R.& Crowell, S. (1999).Mindshifts: A brain-based process for restructuring schools and renewing education, 2nd edition, Tucson, AZ: Zephyr. Press, ISBN 1569760918

Carlos, S, González-Calero,J.A & Arnau, David (2023): Effect of algebraic language and problem text wording on problem model accuracy when solving age word problems. Educational Studies in Mathematics 114:109–127 https://doi.org/10.1y007/s10649-023-10236-1 3.

Esuong, U. U. & Edoho E. A. (2018). Correlates of attitude of students and academic performance of senior secondary school students towards mathematics. *International Journal of Contemporary Social Science Education. (IJCSSE)1*(1) 108-110.

Esuong, U. U., Owan, V. J., Edoho, E. A. and Eni, B. E. (2023). Mathematics symbol instruction and senior secondary students achievement in word problems: A quasi- experimental study. *Pedagogical Research 8(1),* em0142 https://doi.org/10.29333/pr/12595

Duncan, K. J. (2020). Examining the effects of immersive game-based learning on student engagement and the development of collaboration, communication, creativity and critical thinking. TechTrends, 64(3), 514-524. https://doi.org/10.1007/s11528-020-00500-9.

Fuchs, L. S., Gilbert, J. K., Fuchs, D., Seethaler, P.M., & Martin, B. N.(2018).Text comprehension and oral language as predictors of word-problem solving: Insights into word-problem solving as a form of text comprehension. Scientific Studies of Reading, 22, 152–166. https://doi.org/10.1080/10888438.2017.1398259.

Gladys, J.U., Stella, D.G., & Omobolanle, G.B. (2018). Effect of brain-based learning model on colleges of education students' retention and attitude in "current electricity" in Taraba state, Nigeria.*Journal of Education, Society and Behavioural Science*, 25(2): 1-15.

Ibok, E. O., Esuong, U. U. & Joseph, V. A. (2023). The use of ICT in mathematics classroom: Implications for National Mathematics contents development for basic Education in Nigeria. *Prestige Journal of counselling psychology*, 6 (1), 183-191.

Jagals D. & VanDer W. M. (2016) Enabling metacognitive skills for mathematics problem solving: A collective case study of metacognitive reflection and awareness.*African Journal of Research in Mathematics, Science and Technology Education* 20(2) p154-64.

Kong, S. F., & Matore, M. M. E. E. (2021). Can a science, technology, engineering, and mathematics (STEM) approach enhance students' mathematics performance? Sustainability, 14(1), 379. https://doi.org/10.3390/su14010379

Koşar, G., & Bedir, H. (2018). Improving knowledge retention via establishing brain-based learning environment. European journal of education studies. *European Journal of Education Studies*, 4(9), 208-218.

Mekarina, M., & Ningsih, Y.P. (2017). The effects of brain-based learning approach on motivation and students achievement in mathematics learning. *Journal of Physics*: Conf. Series 895:1-7. doi:10.1088/1742-6596/895/1/01205

Noureen, G., Awan, R. N., & Fatima, H. (2017). Effect of brain-based learning on academic achievement of vii graders in mathematics. *Journal of elementary education*, 27(2), 85-97.

Nwankwo, M. C & Anulika, E. J.(2021): Fostering Secondary School Students' Achievement in Physics using brain-based Instructional Strategy. *Unizik Journal of Educational Research and Policy Studies*,Vol.4. p(136-157)

Okeke, N. F, Umeh, U. B & Menkiti, C.C (2013). Effect of students' involvement in Mathematics Test Construction on Thier achievement: implication for curriculum innovation in attaining MDGs. Proceedings of 54th Annual Conference STAN page 351-356.

Pearce, D. L., Bruun, F., Skinner, K., & Lopez-Mohler, C. (2013). What teachers say about student difficulties solving mathematical word problems in grades 2-5. International Electronic Journal of Mathematics Education, 1, 3–19.

Pongsakdi, N., Kajamies, A., Veermans, K., Lertola, K., Vauras, M., & Lehtinen, E.(2020): What makes mathematical word problem solving challenging? Exploring the roles of word problem characteristics, text comprehension and arithmetic skills.ZDM 52:33–44. https://doi.org/10.1007/s11858-019-01118-9.

Powell, S.R., Stevens, E. A., & Berry, K. A.(2019). Effects of a Word-Problem Intervention on Word-Problem Language Features for Third-Grade Students with Mathematics Difficulty. https://doi.org/10.18666/LDMJ-2019-V24-I2-9835

Riskiningtyas, L., & Wangid, M. N. (2019). Students' self-efficacy of mathematics through brainbased learning. *Journal of physics*: Conference Series, 1157(4). https://doi.org/10.1088/1742-6596/1157/4/042067

Solihat, A., Panjaitan, R. L., & Djuanda, D. (2017). Penerapan model pembelajaran brain based learning. *Journal Pena Ilmiah*, 2(1), 451-460.

Taley, B.I. (2022). Teacher and student views of mathematics word problem-solving task at senior high school level. FNAS. *Journal of Mathematics and Science Education*, 3(2), 39-49.

Uzoechi, B. C; Ubah, Adaobi I & Kurumeh M.S (2013): Computer Aided Instruction: An Essential tool for Effective Teaching and learning of Mathematics in Secondary School. Proceedings of 56th Annual Conference STAN page 363-368.

UNESCO (2012). Challenges in Basic Mathematics Education http://unesdoc.unesco.org/images/0019/001917/191776e.

Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in mathematics education: A survey. ZDM - Mathematics Education, 52(1), 1–16. https://doi.org/https://doi.org/10.1007/s11858-020-01130-4.

Zain, S. F. H. S., Rasidi, F. E. M., & Abidin, I. I. Z. (2012). Student-Centred Learning In Mathematics Constructivism In The Classroom. *Journal of International Education Research* (JIER), 8(4), 319–328. https://doi.org/10.19030/jier.v8i4.7277