

EFFECTS OF 4MAT INSTRUCTIONAL STRATEGY ON ACADEMIC ACHIEVEMENT, RETENTION AND MOTIVATION OF COLLEGES OF EDUCATION STUDENTS IN BUSINESS MATHEMATICS IN NORTH-WESTERN NIGERIA

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Abstract

The study determined the Effects of 4MAT instructional strategy academic achievement, retention and motivation of colleges of education students in business mathematics in in North-Western Nigeria. The study was guided by four purposes which were translated to four research questions and four null hypotheses. The study adopted Quasi experimental research design. The population of the study was 790 students that offered business mathematics in 2018/2019 academic session in the study area. The sample for the study was two intact classes of 373 students that randomly selected form the sampled schools. Two instruments namely; Business Mathematics Achievement Test and Motivation Scale which were both developed by the researchers were used for data collection. The instruments were validated and pilot tested on business education students from federal college of education Zaria, Kaduna state. The result of the pilot study was used to compute the reliability of the study. Test-retest method of establishing reliability was used. Pearson Product Moment Correlation formular was used to compute the reliability index of 0.86. The difficulty and discriminating index stood at 0.56 and 79% respectively. The reliability coefficient of motivational scale was 0.83 using Cronbach Alpha. Data collected were analyzed using mean score, standard deviation and mean difference to answer the research questions while t-test was used to analysed the null hypotheses at the 0.05 level of significance; all the analyses were carried out using Statistical Package for Social Science IBM version 23. The result indicated that 4MAT instructional strategy was found more effective than the conational instructional strategy used on the academic achievement, retention and motivation of colleges of education students in business mathematics. The study concluded that the use of 4MAT instructional strategy has helps in improving students learning in business mathematics in colleges of education. Based on the findings, the study recommended that colleges of education lecturers should use the 4MAT instructional strategy in teaching their student in business mathematics.

Key words: 4MAT, Achievement, Retention, Motivation Business Mathematics

Introduction

Business mathematics is one of the core courses taken by all business education students in colleges of education in Nigeria. It has one credit unit as stipulated by National Commission for Colleges of Education (NCCE) in Nigeria Certificate of Education minimum standard. The course content of the subject include checking accounts, price discounts, markups and markdown, payroll calculation, simple and compound interest, consumer and business credit and mortgages, annuities and revenue. Through the contents of business mathematics and understanding of the subject matter, students are expected to become acquainted and attain competencies in accounting courses, economics, element of finance and statistics. Adamu, Jibrin and Bashir (2013) stated that critical thinking skills and performance in mathematics are predictors of students' performance in accounting, element of finance and economics. It therefore means that a solid foundation in business mathematics skills will facilitate students understanding in related courses.

Despite the importance of Business Mathematics to business education students, the performance of students in the subject is not encouraging. Studies conducted by Adamu, Jibrin and Bashir (2013) revealed that students' performance in the subject had been relatively low over the years. The poor performance by students in this subject is not limited to only business education students alone as research findings have confirmed that even mathematics students who offer the course as elective perform poorly in tests and examinations. Report

from examination office from selected institutions under the study have conformed this claim. For instance, evidence from the examination offices in Federal College of Education, Zaria and Federal College of Education, Kano in the study area revealed that out of two hundred and twenty (220) students that sat for business mathematics examination in 2015/2016 academic session, 96 (43.64%) students passed, while 124(56.36%) students failed. Similarly, in 2016/2017 academic session, out of 243 students that sat for the examination, 101(41.56%) students passed the course while the remaining 142(58.44%) failed. The recent 2017/2018 examination indicated that out of 321 students that sat for the examination, 146 (42.37%) students passed while 185 (57.63%) students failed. This continuous decline in performance by students in this course is worrisome and poses a serious concern among stakeholders not only in business education but also in related disciplines in colleges of education.

In related studies by Usman and Memeh (2007), it has been found that the factors affecting students' academic achievement include interests, negative attitude, numerical anxiety and teacher-related factors. Similarly, Adamu and Jibrin (2017), found that the teacher is the most important factor that determines students' achievement. Specifically, their study indicated that the major problems prevailing against the academic performance of students is the teaching method. The study of Adamu and Kusa (2018) indicated that students' academic achievement in numerical subjects have closed association to the extent to which they are related by the instructional

strategy adopted. In their separate studies, Adamu and Jibrin (2017) and Adamu and Kusa (2018) both found out that the traditional teacher centered teaching method used in higher institutions in Nigeria hindered the academic attainment of students. The authors criticized the approach of gearing towards memorization and inappropriate to the needs of students.

The criticism of the traditional lectures approach prompted scholars to investigate a more suitable method that will improve teaching and effective learning by students. For example, study conducted by Aktaş (2011) revealed that 4MAT create deepen insight regarding learning, gain essential insight on individual differences, strengthen understanding of successful communication and creates more successful learning environments in science and Technology subjects. In related studies conducted by Filiz (2012) and Joan (2012) it has been reported that the use of 4MAT teaching strategy enhances students' academic achievement in mathematics and other science subjects. Serap and Şengul (2013) argued that with 4MAT there was a general decrease in students' apathy, prejudice, anxiety, and stereotyping towards learning. Recent study by Rhonda, Wilkerson and White (2019) reported the effectiveness of 4MAT teaching strategy on academic achievement and motivation of tertiary students in mathematics and other science subjects in various overseas universities.

The 4MAT instructional strategy is based on learning styles and brain hemispheres. The instructional strategy was developed by McCarthy in 1985 as one of the well-known

systems of instructions that are applied in teaching. Nikolaou and Koutsouba (2012) defined 4MAT as an instructional strategy that operates with a cyclic learning environment using an 8-step lesson plan that is followed in a prescribed order. Simply, these steps include creating an experience, examine, image, define, try, extend, refine and integration.

There are several studies in literature which have found out that there is a significant rise in the level of retention when the students receive instruction in a classroom atmosphere according to learning styles, for instance in a study by Nikolaou and Koutsouba (2012) it was revealed that 4MAT encourages students' participation and provide them with the opportunity to explain, explore and discuss each other's perspectives, which led to greater understanding and mastery of the course. Uyangor, Sevinç and Mert (2012) reported that 4MAT instructional strategy has positive effect on student achievement and retention levels of students. Similarly, the study conducted by Yusuf (2018) disclosed the effectiveness of 4MAT on social studies students.

Purpose of the study

The general purpose of the study is to determine the effect of 4-MAT instructional approach on the academic achievement of students in business mathematics in colleges of education in the north-east Nigeria. Specifically, the study sought to determine:

1. The mean achievement score of business education students when

taught business mathematics using the 4MAT instructional approach

2. The mean retention score of business education students when taught business mathematics using the 4MAT approach
3. The effect of the 4MAT instructional approach on the mean gain of business education students in business mathematics
4. Determine the difference between the motivation level of students taught business mathematics using the 4MAT instructional strategy and those taught using the lecture method

Research Questions

In line with the specific purposes the following research questions were formulated

1. What is the effect of 4MAT instructional strategy on the mean academic achievement of students' business mathematics in colleges of education in North-western Nigeria?
2. What is the effect of 4MAT instructional strategy on mean gain of students' business mathematics in colleges of education in North-western Nigeria?
3. What is the effect of 4MAT instructional strategy on the mean

retention of students in business mathematics in colleges of education in North-western Nigeria?

4. What is the effect of 4MAT instructional strategy on students' motivation in business mathematics in colleges of education in North-western Nigeria?
5. What is the effect of 4MAT instructional strategy on students' motivation in business mathematics in colleges of education in North-western Nigeria?

Null Hypotheses

In line with the research questions, the following null hypotheses were formulated and tested at 0.05 alpha value.

H₀₁. There is significant difference between the posttest mean academic achievement of students taught business mathematics using 4MAT instructional strategy and those taught using lectures method in colleges of education in North-western Nigeria.

H₀₂ There is no significant difference between the pre-test and post-test mean achievement of students taught business mathematics using 4MAT instructional strategy in colleges of education in North-western Nigeria.

H₀₃ There is no significant difference between the mean retention of students taught business mathematics using 4MAT instructional strategy and those taught using lectures

method in colleges of education in North-western Nigeria.

H₀₄ There is no significant difference between the motivation level of business mathematics students taught business mathematics using 4MAT instructional strategy and those taught using lectures method in colleges of education in North-western Nigeria.

Methodology

Quasi experimental research design specifically, pretest-posttest nonequivalent was used for the study. [Quasi experimental design](#) involves selecting groups, upon which a variable is tested, without any random pre-selection processes. The researcher administered pre-test to determine the academic status of the two groups of students involved in the study. The choice of the design was based on the suggestion of Martyn (2006) who opined that pretest-posttest design is the preferred method to compare participant groups and measure the degree of change occurring as a result of treatment or interventions. The design was considered suitable because it allowed the researcher to determine the effect of independent variable on dependent variables.

The population of the study comprised all the 790 students offering business mathematics in the 2018/2019 academic session in the five (5) Federal colleges of education offering business education in North-East geopolitical region of Nigeria.

Two intact classes of 353 students from two institutions were randomly selected and used for the study. The schools selected were Federal College of Education (Technical)

Bichi with 175 students and Federal College of Education Kano 178 students. Students from Federal College of Education (Technical) Bichi constituted the experimental group while Federal College of Education Kano constituted the control group.

Two instruments were used to elicit data for the study. The first instrument was motivation scale adapted from Andressa, Mavrikaki, and Dermizaki (2015). The second instrument was Business Mathematics Achievement Test (BMAT). The BMAT is divided into Pre-Diagnostic Achievement Test (PDAT) otherwise call pre-test and Post Treatment Achievement Test (PTAT) otherwise call posttest. The PDAT was used to determine the entry level of students involved in the study while the PTAT was used to determine the effectiveness of 4MAT instructional strategy on students' achievements. To collect retention, mean scores of students, the PTAT was reshuffled and re-administered at an interval of two weeks. The PDAT and PTAT which contain 30 multiple choice questions each was adapted from 2014 to 2018 past examination.

To determine the face and content validity of the instruments, consultations were made with two experts in business education and 2 experts in educational psychology from Ahmadu Bello University, Zaria. The corrections and suggestions in area of appropriateness, spellings, grammar and clarity were incorporated into the final copy. The validated instrument was pilot tested in College of Education, Zuba using an intact class of 98 students. The result of the achievement test was used to determine the

reliability of achievement test using test-retest. Also determine were the difficulty and discriminating indices of the instrument. The instrument gave reliability coefficient of 0.86. The instrument was found to satisfactory for the study as suggested by George and Mallery (2003) who opined that a minimum reliability coefficient of .70 is acceptable for experimental study. The difficulty and discriminating index of the instrument stood at 0.56 and 79% respectively. According to the Anowar and Rohani (2013), the Ideal Difficulty of Four-response multiple-choice should be at least 74%. Similarly, Ebel and Frisbie (1986) opined that rule of thumb for determining the quality of the items, in terms of the discrimination index. The author suggested that a discriminating score of >0.39 should be retained. Based on these arguments, the instrument was found satisfactory for the study.

The researcher subjected the motivational scale to Cronbach's alpha reliability test. The instrument gave a reliability coefficient of 0.83. The instrument was also found suitable for the study as suggested by Adamu, Shago and Kusa (2019) who maintained that, for a survey instrument, a reliability opined coefficient of at least 0.70 should be consider reliable for study.

In the first stage of data collection, the researcher employed the service of research assistants used in the study. To avoid the students from behaving in any manner that can affect the outcome of the study, the regular business mathematics lecturer in the schools were used for the study. The research assistant in the experimental group was subjected to intensive training for two

days. The training involved detailed explanations on the teaching approach and how to apply it in the classroom situation. At the end of the training, microteaching was organized to ensure that the research assistants mastered the strategy. The stage was immediately followed by administration of a pretest instrument to the two groups of the students. The instrument enabled researcher to established equivalence of the participants in the study prior to the treatment.

In the second state of the data collection, the two groups of students (experimental and control) were taught Amortization, Annuities and Sinking Funds for period of three weeks guided by their drawn lesson plans. At the end of the exercise, post-test and motivation questionnaire were administered. Two weeks after the post-test, the instrument was reshuffled and administered to determine the retention ability of the students. The scripts of pre-test, post-test and retention achievement test were mark by the researcher personally guided by drawn marking schemes. . The entire exercise lasted for 6 weeks.

Data collected were analysed in two stages. In the first stage, mean score, mean difference and standard deviation were used to answer the research questions. In answering the research questions, the researcher used Kusa (2018) as a decision making benchmark. The research questions on students' motivation was determined using a mean score. The decision making benchmark is as seen in Table 1 and 2 respectively.

Table 1: Bench mark for decision making

S/no	Mean range	Remark	Abbreviation
1.	0.1 to 4.49	Slight difference	SD
2.	4.50 – 7.99	Moderate difference	MD
3.	8.00 – 9.99	Large difference	LD
4.	10 and above	Very Large difference	VLD

Table 2: Benchmark for motivation decision making

S/no	Mean range	Decision	Abbreviation
1.	1.00 - 1.49	Partially Motivated	PM
2.	1.50 – 2.49	Moderately Motivated	MM
3.	2.50 – 3.49	Highly Motivated	HM
4.	3.50 – 4.00	Very Highly Motivated	VHM

Similarly, the null hypotheses were analysed using t-test statistics specifically the paired and independent samples t-test was used for the analyses at 0.05 level of significance. In the analysis of the hypotheses, if the p-value is equal or less than the alpha value of 0.05 ($P \leq \alpha$) the null hypothesis was rejected and if the p-value is greater than the alpha value of 0.05 ($P > \alpha$) the null hypothesis was retained.

Results

Research Question One: What is the difference between the posttest mean scores of students taught business mathematics using the 4-MAT instructional strategy and

the lecture method in colleges of education in North-western Nigeria?

A descriptive statistic was used to determine the effect of 4MAT instructional strategy on the achievement of students in business mathematics by comparing the post-test mean scores of experimental and control groups. The result is presented in Table 3 and it indicates that the mean difference between the post-test mean achievement scores of experimental group and control group is 12.66 . This therefore, shows that, students taught using 4-MAT instructional strategy performed better.

Table 3: Mean Difference in post-test mean academic achievement scores of experimental and control group

Group	N	Mean	SD	Mean difference	Remarks
4-MAT	178	44.8	13.68	12.66	
Lectures	175	32.14	10.23		

Research Question Two: What is the mean gain difference between the pretest and

posttest mean scores of business education students taught business mathematics using

4MAT instructional strategy in Federal Colleges of Education in North-western Nigeria?

Table presents the descriptive statistics of mean gain scores of the experimental and control group students. The result in Table 3 shows that the difference exists in the mean gain scores of students exposed to 4MAT

instructional strategy (16.66) and those exposed to lectures method (4.16). The result indicates that, the students of 4MAT instructional strategy had a better mean gain compare to their counterparts in lecture method. The result indicated that the mean gain was very large.

Table 4: Difference in the pretest and posttest (mean gain) scores of experimental and control group

Group	N	Mean	Mean Gain	Remark
Pretest	178	28.14	16.66	VLD
Posttest	178	44.80		

The result presented in table 4 reveals that there is a mean difference of 16.66 between the pretest and the posttest mean score of business education students in business mathematics achievement test. The posttest mean score is relatively higher than the pretest mean score

Research Question Three: What is the effect of 4MAT instructional strategy on the mean retention of students in business mathematics in colleges of education in North-western Nigeria?

A descriptive statistics used to answer research question four in Table 5 reveals that there was very large difference in the retention scores of experimental group students (M = 43.80, SD = 13.34) and control group students (M = 29.21, SD = 9.31). The mean difference of 14.59 was in favour of students in experimental group. It is therefore concluded that, the students of 4MAT instructional strategy has better retention than their counterpart in lectures method.

Table 5: Mean difference in the retention scores of experimental and control groups

Group	N	Mean	Mean difference
4MAT	178	43.8	13.34
Lecture 175		29.1	9.31

Research Question Four: What is the effect of 4MAT instructional strategy on students' motivation in business mathematics in colleges of education in North-western Nigeria?

The result in Table 6 used to answer research question 5 discloses that there was a difference in

the motivation scores of experimental group students (M = 3.05, SD = .69) and control group students (M = 2.21, SD = .75). The result indicated that students in experimental group were highly motivated while those in control group were moderately motivated.

Table 6: Mean Difference of motivation scores of experimental and control group

Groups	N	Mean	SD	Mean difference	Remarks
4MAT	175	3.05	0.69	0.84	HM
Lecture 178		2.21	0.75		

Null Hypothesis One

H₀₁ There is no significant difference between the posttest mean academic achievement of students taught business mathematics using 4MAT instructional strategy and those taught using lectures method in colleges of education in North-western Nigeria.

The outcome of the independent-samples t-test in Table 7 indicates that there is existence of a statistically significant

difference between the posttest mean achievement score of 4MAT instructional strategy students (M = 44.80, SD = 13.68) and lectures students (M = 32.14, SD = 10.23), $t(351) = 9.86, p = .000$. Hypothesis 1 is, therefore, rejected. This finding suggested that 4MAT instructional strategy has a significant effect on academic achievement of colleges of education students in business mathematics.

Table 7: Independent samples t-test for posttest scores of experimental and control groups

Variable	Groups	N	Mean	SD	Sig.	T	Sig. (2-tailed)	Dec.
Posttest	4MAT	178	44.80	13.68	.002	9.86	.000	HO ₂ (Rejected)
	Lectures	175	32.14	10.23				

Null Hypothesis Two

H₀₂ There is no significant difference between the pre-test and post-test mean achievement of students taught business mathematics using 4MAT instructional strategy in colleges of education in North-western Nigeria.

The result of paired-samples t-test in table 8 revealed that there is existence of a statistically significant difference between the pretest and posttest mean achievement

score of 4MAT instructional strategy students (M = 28.14, SD = 9.68) while the post-test stood at (M = 44.80, SD = 13.68). The t-value stood at 41.82 and $p = .000$. This analysis therefore indicated that the posttest mean achievement score of students exposed to 4MAT instructional strategy significantly higher than their pre-test mean achievement scores. The result therefore rejected the hypothesis.

Table 8: Paired samples t-test for posttest scores of experimental and control group

Variable	N	Mean	SD	Df	t	Sig. (2-tailed)	Dec.
Pretest	175	28.14	9.68	348	41.82	.000	HO ₃ (Rejected)
Posttest	175	44.80	13.68				

Null Hypothesis Three

H₀₃ There is no significant difference between the mean retention of students taught business mathematics using 4MAT instructional strategy and those taught using lectures method in colleges of education in North-western Nigeria.

The statistical evidence presented in the independent-samples t-test in table 8

indicates that there is a statistically significant difference in the mean retention of students taught business mathematics using 4MAT instructional strategy (M = 43.80, SD = 13.34) and those taught using lectures method (M = 29.21, SD = 9.31), $t(351) = 11.94, p = .000$. Hypothesis 3 is, therefore, rejected. This finding suggested that the retention ability of students exposed to 4MAT instructional strategy is

significantly better than that of their counterparts in lectures method.

Table 9: Independent samples t-test of mean retention of experimental and control group

Variable	Groups	N	Mean	SD	Sig.	t	Sig. (2-tailed)	Dec.
Retention	4MAT	178	43.80	13.34	.000	11.94	.000	HO ₄ (Rejected)
	Lectures	175	29.21	9.31				

H₀₄ There is no significant difference between the motivation level of business mathematics students taught business mathematics using 4MAT instructional strategy and those taught using lectures method in colleges of education in North-western Nigeria.

The result of independent-samples t-test in Table 8 shows that there is a statistically significant

difference in the motivation scores of students taught business mathematics using 4MAT instructional strategy (M = 3.05, SD = .69) and those taught using lectures method (M = 2.21, SD = .75), $t(351) = 10.94$, $p = .000$. Hypothesis 5 is, therefore, rejected. This finding suggested that the motivation of students' in 4MAT instructional strategy is significantly higher than that of their counterparts in lecture method.

Table 8: Independent samples t-test on mean motivation of experimental and control group

Variable	Groups	N	Mean	SD	Sig.	t	Sig. (2-tailed)	Dec.
	4MAT	178	3.05	.69	.020	10.94	.000	HO ₅ (Rejected)
	Lectures	175	2.21	.75				

Discussion of the Findings

The finding of research question two and test of corresponding null hypothesis two revealed that students taught business mathematics using 4MAT instructional strategy performed significantly better than those taught using lectures method. The outcome of the study agreed with the study conducted by Uyangor, Sevinç and Mert(2012) which shows that 4MAT learning method can be used as an effective method to improve the academic achievement of students. Review of the relevant literature studies show that the 4MAT learning method has positive effects on the academic achievement of the students (Göksel&Aydıntan, 2012; Ardiç, 2013; Ergin and Sarı, 2012). The result agreed with the submission of Uyangor and Sevinc

(2012) who reported that 4MAT model has positive impact on academic attainment and attitudes of students towards mathematics of seventh year grade students at public schools

The outcome of research question two and test of null hypothesis two compared the pretest and post-test mean scores of experimental group was compared to determine the mean gain, the study indicated that the 4MAT instruction had a didactic effect on the mean gain of students in experimental group. The outcome of the study is similar with that of Uyangor and Sevinc (2012) who applied an experimental model on a control group with a pre-test and post-test. The results revealed more efficient of 4MAT method than the traditional method on mean gain. The 4MAT has positive effect on the mean gain

of students in mathematics. The outcome of the study is in line with the earlier report of Sedat (2015) who reported that the pre-test mean achievement of students exposed to 4MAT was lower than their post-test.

The finding of research question three and test of null hypothesis three shows that students of 4MAT instructional strategy have better retention than their counterparts in lectures method. The outcome of the study is in line with earlier submission of scholars who opined that the 4MAT learning styles have an effect on retention ability of students (Yusuf, 2018). The study of Sedat (2015) revealed the learning environment designed based on 4MAT learning styles has a large effect on students' attitude toward course and learning retention. Similarly, study conducted by Ergin and Sari (2012) reported that 4MAT model resulted in enhance of academic achievement and more long-life learning.

The finding of research question four and the corresponding null hypothesis indicated that, the motivation of students taught business mathematics using 4MAT instructional strategy was significantly higher than that of their counterparts taught using lectures method. The result of the study is agreed with the study that of Sedat (2015) which revealed that the average student receiving instruction using 4MAT learning styles scored higher on attitude test than 84.1% of students receiving no instruction, respectively. The result also agreed with that of Yusuf (2018) who reported that 4MAT instructional strategy has positive impact on students motivation. Similarly, the study conducted by Ergin and Sari (2012) reported that 4MAT model

resulted in positive attitudes, enhancing of academic achievement and more long-life learning. The work on effects of the 4MAT learning model on seventh Grade students' academic achievement and motivation on the Particulate Nature of Matter revealed the effectiveness of 4MAT model rather in terms of enhancement of achievement and motivation (Aktasa and Bilgin, 2015).

Conclusion

The summary of the study revealed that the low performance and motivation of students in business mathematics is as a result of the lectures method adopted. It was revealed that the used of 4MAT instructional strategy helps to improve the academic achievement and motivation in business mathematics students. It was therefore concluded that the application of 4MAT instructional strategy will help to address the problem of business mathematics students' academic achievement and improve their level of motivation in the subject. It will also help to reduce the rate of carry over among students, improve their grades and facilitate their graduations that is associated with carry over in business mathematics. Based on this, the study recommended that business mathematics lecturers should adopt 4MAT instructional strategy in teaching their students in colleges of education in North-west, Nigeria. In addition, school management should provide enabling

environment for teachers to use 4MAT instructional strategy for teaching business mathematics in colleges of education in north-west, Nigeria.

Recommendations

Recommendations based on the findings were made as follows

1. The use 4MAT instructional approach should adopted by business mathematics lecturers in colleges of education to enhance students' performance in the subject
2. Lecturers in other subject areas should be given the necessary orientation on how to use the 4MAT instructional strategy because of its potential in motivating and retaining learned task among students

References

- Adamu, I. And Kusa, G. W. (2018). Effect of Peer-Tutoring Learning Teaching Method on Academic Performance of Financial Accounting Students in Federal Unity Colleges, in North-Eastern Nigeria, *Journal of Advanced Research in Social Sciences*, 1 (1):7-15, From <https://www.google.com/search?client=firefox-b-d&q=adamugadabs%40>
- Adamu, I. and Jibril, A. H. (2017). Effects of Flipped and Conventional Teaching Approaches on Performance and Retention Ability of Students in Advance Financial Accounting in Abubakar Tafawa Balewa University Bauchi, Nigeria. *Journal of Philology,*

Malaysia. 31(1)12-20

- Adamu, I., Jibril, A.H. and Bashir. A. U. (2013). Effects of Jigsaw and Lecture Based Techniques on Class Attendance, Participation and Proficiency of Undergraduate Students in Business Mathematics in Nigeria. *Technical and Vocational Education Journal. A Publication by Department of Vocational and Technical Education*, 5(1), 26-34
- Adamu, I., Shago, M. M. and Kusa, G. W. (2019). Relationship between Occupational Stress and Job Satisfaction among Business Educators in Public Secondary Schools in Taraba State, Nigeria. *Annals of Technology Education Practitioners Association of Nigeria (ATEPAN) Journal* .2 (2), 70-79
- Aktas, I and Bilgin, I (2015). The effect of the 4MAT learning model on the achievement and motivation of 7th grade students on the subject of particulate nature of matter and an examination of student opinions on the model. *Research in Science and Technological Education*, 33(1):1-21
- Aktaş, I. (2011). *The effect of the 4MAT system on the 7th grade students' the success in structure and properties of matter unit, motivation toward science and technology course and learning styles.* Unpublished Master Thesis, MustafaKemal University, Hatay, Turkey.
- Andressa, H., Mavrikaki, E and Demitzaki, I. (2015). Adaption of the student's motivation towards science learning questionnaire to measure Greek students' motivation towards biology learning. *International journal of biology education*, 4(2), 78-93

- Anowar H, and Rohani, A. T. (2013). Effects of cooperative learning on students' achievement and attitudes in secondary mathematics. 3rd World Conference on Learning, Teaching and Educational Leadership (WCLTA). *Procedia - Social and Behavioral Sciences* 93, 473 – 477
- Ardıç, E. Ö. (2013). Sınıfgeometrikcisimlerkonusununöğretiminde 4MAT öğretimodelininetkisi. Yayınlanmamış YüksekLisansTezi. Karadeniz Teknik ÜniversitesiEğitimBilimleriEnstitüsü, Trabzon
- Baş, G. and Beyhan, Ö. (2013). Correlation between teachers' teaching-learning conceptions and their student control ideologies [Special Issue]. *Hacettepe ÜniversitesiEğitimFakültesi iDergisi*, 1, 14-26.
- Bichi, S. S. (2002). Effect of problem-solving strategy and enriched curriculum on students' achievement in evolution concept among SSS students. Unpublished PhD Thesis ABU Zaria 14-16.
- Ebel, R. L. & Frisbie, D. A. (1986). *Essentials of education measurement*. Englewood Cliffs, NJ: Prentice Hall.
- Ergin S, Sari M (2012). Effects of the 4MAT Instruction Method on the Achievement of High School Students with Different Learning Styles on the Subjects of Work, Power and Energy in Physics. *Energy Educ. Sci. Technol. Part B-Soc. Educ. Stud.* 4(2):807-820
- Federal Republic of Nigeria (2014). *National policy on education*, 7th Ed. Lagos: NERDC Press
- Filiz T. D. Ö. (2012). The Effect of the 4MAT Model on Student's Algebra Achievements and Level of Reaching Attainments. *International Journal of Contemporary Mathematical Sciences*. 7(45):2197 – 2205
- George D and Mallery P, 2003. *SPSS for Windows step by step: A simple guide and reference*. 11.0 update (4th ed.). Boston: Allyn & Bacon
- Göksel, A., and Aydın, B. (2012) Leader-Member Relationship within the form of Organizational Commitment: Süleyman Demirel ÜniversitesiİktisadiVeİdariBilimlerFakültesi Magazine . From <https://explorable.com/pretest-posttest-designs>
- Joan N (2012) Assessing the Impact of 4MAT for College. Retrieved From [www.auburn.edu > clajlsrj](http://www.auburn.edu/~clajlsrj)
- Kanadir, S. (2016). A Meta-Analysis on the Effect of Instructional Designs based on the Learning Styles Models on Academic Achievement, Attitude and Retention. *Education Science: Theory & Practice*, 2058–2088
- Martyn, S. (2006). Pretest-Posttest Designs. Retrieved Nov 08, 2018 from Explorable.com:
- Nikolaou, A., & Koutsouba, M. (2012). Incorporating 4MAT model in distance instructional material – An innovative design. *The European Journal of Open, Distance and E-Learning-EURODL*, 1. <http://www.eurodl.org/?article=497> Accessed 22 November 2012.

- Rhonda M. Wilkerson, K. & White, P. (2019). Effects of the 4MAT System of Instruction on Students' Achievement, Retention, and Attitudes. *The Elementary School Journal*. Accessed March 14th, 2019 from <https://about.jstor.org/terms>
- Şedat K. (2015). Investigation into the Effect of the use of learning styles on students' learning levels in social studies [teaching]. *Kastamonu Eğitim Dergisi*, 19(1), 251–266
- Serap E. and Şengül A. (2013). Comparative Analysis of the Effectiveness of 4MAT Teaching Method in Removing Pupils' Physics Misconceptions of Electricity. *Journal of Baltic Science Education*. 12(6): 1648–3898
- Tatar E, Ramazan D (2009). The effect of the 4MAT method (learning styles and brain hemispheres) of instruction on achievement in mathematics. *Int. J. Math. Educ. Sci. Technol.* 40(8):1027-1036
- Usman, K. O. & Memeh, I. M. (2007). Using Guided Scoring Teaching Strategy to Improve Students' Achievement in Chemistry at Secondary School Level in Nigeria. *Journal of the Science Teachers Association of Nigeria*, 42(1&2), 60-65
- Uyangör S.M. & Dikkartın F.T. (2009). The Effects of The 4MAT Education Model On The Student Achievements and Learning Style. Necatibey Faculty of Education. *Electronic Journal of Science and Mathematics Education*. 3(2).178-194.
- Uyangor, Sevinç and Mert (2012). The effectiveness of the 4MAT teaching model upon student achievement and attitude levels. *Int. J. Res. Stud. Educ.* 12:43-53
- Yusuf, I., (2018) 'The Effect of Using the 4MAT Teaching Method in 6th-Grade Social Studies Education on the Academic Achievement of Students. *Review of International Geographical Education Online (RIGEO)*, 8(3), 440-458. Retrieved from <http://www.rigeo.org/vol8no3/Number3winter/RIGEO-V8-N3-2.pdf> on 13th may, 2020.
- Zandi Nia, Z. (2011). *Identification and comparison of inter-organizational factors effective on academic performance of top students and dropped students in Hormozgan University* (Master's thesis)