THE EFFECT OF JIGSAW STRATEGY AND MASTERY LEARNING MODULE ON MATHEMATICS STUDENTS' ACHIEVEMENTS IN NIGERIAN SCHOOLS

Tukur Madu Yemi,
Faculty of Education, Federal University of Kashere, Gombe State Nigeria

Nurulwahida Azid
School of Education and Modern Languages, Universiti Utara Malaysia, Malaysia

And

Ruzlan Md-Ali
School of Education and Modern Languages, Universiti Utara Malaysia, Malaysia

Abstract

This research was aimed at designing and developing a mathematics module based on Jigsaw and Mastery learning strategy and to determine the effectiveness of Jigsaw Strategy and Mastery Learning Module (JSML) on Mathematics Students' Achievements in Nigerian Schools. The research used a mixed method approach of a non-equivalent pre-test post-test control group quasi-experimental design to collect the quantitative data via Mathematics achievement test while, the qualitative data was collected via interviews. A total of 120 students had participated in this research and they were divided into two groups; treatment and control. The treatment group was taught mathematics using the JSML module. The control group was conventionally taught. The quantitative data was analyzed using Analyses of Co variance (ANCOVA) while the qualitative data was thematically analyzed. The findings showed that: (1) the design of JSML module had satisfied valid conditions through the achievement of the module validation by experts which was 0.87. (2) The JSML group students achieved better than their counterparts and a statistically significant difference was observed between the control and treatment group ($p < .05$) in the Mathematics post-test scores. (3) The qualitative data revealed favorable responses from the teachers towards the use of JSML module.

Keywords: Cooperative learning, jigsaw strategy, mastery learning, mathematics achievement, ANCOVA test analysis

Introduction

Mathematics remains one of the fundamental subjects in school curriculum globally as it is used in day - to - day life (Baglama, Yikmis, & Demirok, 2017; Kakkar, 2016). It is the principal subject used for the comprehension of other major fields. To buttress this claim Akinsanya, Ajayi, and Salomi(2011) remarked that Mathematics is the queen and servant of all fields of study. Furthermore, Aguele and Usman (2007) described Mathematics as an application available for building theories in science and other areas of endeavor. This is because it is a basic part of human thinking which promotes logical understanding among people. Additionally, it gives an effective way of building mental disciplines, impulses, logical thinking and mental rigor. Mathematics is therefore far more than the ability to calculate, memorize formulae, or solve equations (Minarni, Napitupulu & Husein, 2016). Rather, it trains and promotes logical thinking. Due to the significance of Mathematics to the society, the Nigerian government enacted a policy which made the study of the subject an obligatory for all levels of education (Federal Republic of Nigeria, 2004). Consequently, credit pass in Mathematics becomes a prerequisite requirement for admission into tertiary institutions in the country (Awogbemi, Oloda & Alagbe, 2015). As a mark of commitment, the Federal Government of Nigeria has established National Mathematics Centre (NMC), with the mandate to expand the study of Mathematics and science. Despite this laudable effort, improvement is yet to be recorded because the mathematics achievement of students at the secondary school level remains poor.

In Gombe, a remote city of North Eastern Nigeria and a town with hundreds of secondary schools, poor performance in Mathematics is apparent. The overall performance of the students is as low as 5.68% (Langa & Yusuf, 2016; Ministry of Education, 2018). Similarly, the Chief Examiner's Report on West Africa Examination Council (WAEC) indicated poor performance and argued that such a result could indicate lower students' interest in Mathematics and general examinations. This perennial problem may be precipitated by the teaching technique in which the teachers still maintain the conventional method despite the emergence of new teaching methods, strategies, techniques, and approaches and with improved methods of teaching the old practice that is detrimental to the comprehension of the subject (Radovic, Maric & Passey, 2018). Tularam and Machisella (2018) observed that unconventional teaching methods have among other factors been responsible for the low performance exhibited by the students in Mathematics. This predicament could be overcome using a cooperative learning strategy which has been identified as one of the ways teachers may apply to increase students' academic achievement, attitude, and ensure active learning among

students (Le, Janssen & Wubbles, 2016). Studies by Mohammadjani and Tonkaboni (2015) have been conducted and conclusions have shown that cooperative learning strategy is a helpful instructional strategy which promotes students' learning achievement.

Cooperative learning strategies involve grouping students into small mixed ability learning groups. It is premised on the fact that students work together cooperatively and interdependently in small groups (Dat, 2016). There are various examples of cooperative learning strategies. These include Students Teams– Achievement Division (STAD), Team-Games-Tournaments (TGT), Jigsaw Method, Team Accelerated Instruction (TAI), Group Investigation (GI), Team Assisted Individualization. (TAI), Cooperative Learning Teaching Scripts (CLTS), Cooperative Integrated Reading and Composition (CIRC), Cooperative Learning Structures, and Complex Instruction (Maddinabeita, 2006; Ardiyani, Gunarhadi & Riyadi, 2018). Of all these, studies indicate that the use of Jigsaw strategy increases positive educational outcomes and attitude (Mengduo & Xiaoling, 2010; Sahin, 2010). It is based on the relevance of the Jigsaw strategy of cooperative learning that the present research was premised. The Jigsaw strategy was developed by Elliot Aronson and Associates in the early 1970s.

In Jigsaw application, the concept of learning was sub-divided into different segments, and each student was assigned to a sub-topic so as to enable him/her to specialize which means all students with similar topics formed their expert groups. This group of students reconvened as soon as learning was over, in order to solve self-assessment questions individually. This learning process inspired students to listen and engage in a group setting such that each member of the group played a vital role in the group. When students relate and discuss freely, there is a high propensity for them to unveil the areas of their learning difficulty which the teacher can utilize in order to improve his classroom teaching. A typical illustration is the case of Nigerian Senior Secondary School One (SS1) curriculum in which many students misconceived indices, logarithms, simultaneous equations, and algebra. Instead of studying the formulae, the students ended up memorizing a few formulae which did not enable them to solve serious mathematical problems (Ministry of Education, 2018). To strengthen the above claim, Sunandar, Zaenuri, and Dwidayati (2018) in their study revealed that problem-solving ability of students has not met expectations and students often have difficulty in understanding the problem.

According to Lemos, Sandars, Alves and Costa (2014), it is essential for a teacher to adopt various approaches to teaching and learning so as to influence the students' understanding which is paramount in the teaching of Mathematics and it is called Mastery Learning Technique. This approach can

be applied to all ages and should be well-matched with common teaching approaches (Candler, 2010). Similarly, Candler (2010) argues that mastery learning can be defined as an instruction given to the students which are more than showing mastery of instructional content. Furthermore, mastery learning can be used in almost every subject, but it is more suitable in Mathematics instruction since it helps students to develop a solid foundation of mathematical understanding in order to solve mathematical problems which involve a higher-level thinking and reasoning. Hence, its application in cooperative situations will promote a strategy that enhances mathematics achievement. Therefore, the researcher's view that Jigsaw Strategy and Mastery Learning Module could be one way to improve the Mathematics achievement of students if properly applied.

A. Jigsaw Strategy of Cooperative Learning, Mastery Learning and Academic Achievement

Some Past Research literature has highlighted the effectiveness of both Jigsaw Strategy of Cooperative Learning and Mastery Learning in promoting student learning and higher achievement in the classroom (Johnson & Johnson, 1994; Johnson & Johnson, 2009; Wolfensberger & Canella, 2015). Knowing that Jigsaw Strategy of cooperative learning encourages student involvement and engagement in their own learning, it provides all students with opportunities to make their thoughts visible to others, allows them to talk about their own ideas, and permits them to consider the ideas of others which enhances their higher order thinking skills (Johnson & Johnson, 2009).

In the light of this, Azmin (2016); Chu (2014); Eachempi, KS and Ismail (2017); Yu and Yu (2017) noted that Jigsaw strategy enhanced students' academic achievement. Mastery learning classroom have been revealed that it increases the achievement of students to greater high as compared to conventional forms of teaching (Bala, 2019). The mastery learning model has been established to be useful in many situations. It permits trying struggling students a chance to master critical concepts before new content is presented. Also, it offers a challenge for gifted students. This type of learning permits talented students to hasten through the program and move to the next level or to engage in enrichment activities which will increase their understanding of the subject (Mitee & Obaitan, 2015)

Research Question

1. What is the reliability of the JSML Module?
2. What is the mean Mathematics Achievement score of Control and Treatment Group in the Pre-test and Post test?

3. What are the teachers' and students' perceptions on the implementation of Jigsaw Strategy and Mastery Learning Module on Nigerian Secondary School Students in relation to Mathematics Lessons?

Research Hypothesis

Ho: There is no significant difference between the Post-test Mathematics Achievement scores of the Control and Treatment Groups by controlling the pretest.

Theoretical Basis for The Study

Two forms of theories are considered very relevant to the present study. They are the cognitive and constructivist theory.

Conceptual Framework

The conceptual framework of this research was based on the Social Learning and Behavioral Models of Constructivism theory developed by Piaget (1950). The framework shows that jigsaw and mastery learning strategy module is an intervention in the teaching and learning process which concerns mathematics concepts under the topics which include: simultaneous equations, algebra, logarithms and indices. The Treatment Group was based on Jigsaw Strategy via Mastery Learning module, while the Control Group was related to the same topics using the Conventional method of teaching.

The two teaching methods were the independent variables while the dependent variable was the student's Mathematics achievements as presented in the conceptual framework below:

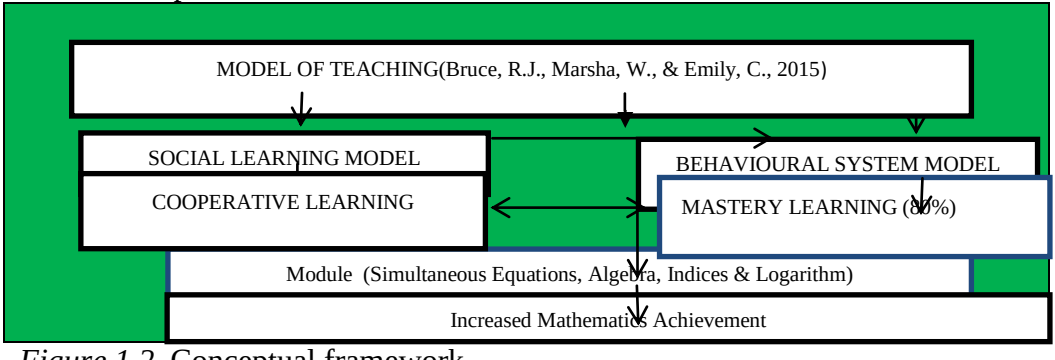

Figure 1.2. Conceptual framework

Methodology

The study employed the used of the mixed method (quantitative and qualitative approaches) in view of its significance for this research (Creswell, 2013). For the quantitative method, the study applied a non-equivalent pre-test post-test control group quasi-experimental design. Thus, intact classes were randomly allocated to the control and treatment group respectively. The treatment group was taught Jigsaw Strategy via Mastery Learning (JSML)

while the control group was taught using the conventional method respectively. Treatment group received a pre-test, treatment (X1) and post-test while control group was given a pre-test but not received the treatment (X2) followed by a post-test as shown in Table 1 below:

Table 1. Nonequivalent pretest - post-test control group design

Group	Pre-test	Treatment	Post-test
Treatment group	O_1	X_1	O_2
Control group	O_1	X_2	O_2

Population and Sample

The population for this research consisted of 5,901 Senior Secondary One (SS 1) students drawn from 42 secondary schools of Gombe State metropolis in Nigeria. The sample of this research work comprised of 120 SS 1 students whereby 60 students were identified as Treatment Group, and another 60 students were considered as Control Group.

Instrument

In this research, two instruments, namely Mathematics achievement test and Attitudinal Inventory Scale (AIS) were used for data collection.

Mathematics Achievement Test

The mathematics achievement test used in this research was constructed by the researchers. The test which was consisted of thirty multiple – choice items on algebra, simultaneous equations, indices and logarithms topics with four options of answers. The test items were derived from the past questions from West African Examination Council (WAEC) based on mathematics SS1 syllabus. The researchers designed mathematics achievement test taking into the account students' level of understanding, and previous knowledge of the study. The Mathematics achievement test was constructed by adopting a discrimination power of 0.5 and above as being acceptable. Test items with discrimination power below 0.5 were eliminated and reconstructed. On difficulty levels, a difficulty level of items from 25% to 85% was accepted. Items with difficulty level below and above the stated range were removed and replaced with another items. The reliability coefficient of .70 and higher indicated that the instrument was reliable (Fraenkel, Wallen & Hyun, 2015; Taber, 2017). The reliability coefficient of this research instrument was found to be 0.82 using Kuder – Richardson 21 formula. The initial draft of mathematics questions was validated by experts from university. The Mathematics achievement test was used as the pre-test and post-test to assess the students' mastery of the topics of both student groups. Subsequently, the

table of specification was constructed to guide the allocation of questions in to the three cognitive domains (Knowledge, Comprehension and Application) of Blooms taxonomy of behavioral objectives as presented in Table 2;

Table 2. Specification test for mathematics achievement score

Unit	Topics	Objective (cognitive domain)			Total	Per (%)
		Know	Comp	Applica		
1	Indices	1,2,3,4	5,6,7	8	8	27
2	Logarithms	9,10,11,12	13,14	15	7	23
3	Algebra	16,17,18,19	20,21	22,23	8	27
4	Simultaneous Equations	24,25,26	27,28	29,30	7	23
Total Items		15	9	6	30	100%
Percentage (%)		50%	30%	20%	100%	

The table of specification above shows the number of questions for the test which was thirty (30) with 8 questions on indices, 7 questions on Logarithms, 8 questions on Algebra, and 7 questions on Simultaneous equations.

Development of JSML Module

The development of JSML module was based fully on the steps proposed by Donnelly & Fitzmaurice (2005), namely: (1) Determine the needs of the stakeholder, (2) Specify the layout of the modules, (3) Determine the level of the learners, (4) State the module's aims and objectives, (5) Identify the criteria to measure the study outcomes, (6) Provide the subject contents of the modules, (7) Select the teaching strategies/theories, (8)Arrange the learning activities of the module, (9) Provide the module assessment questionnaire, (10) Test the two modules (Piloting), (11) Assessment of the JSML modules through experts, (12) Improvement of JSML module based on the experts' assertion of the content, and (13) Apply the modules using quasi experimental research design. The uniqueness of JSML modules is its integrated two types of learning strategy namely (i) Jigsaw and (ii) Mastery learning. There were four units in this module and each student must have achieved at least 80% in each unit assessment for them to move to the next unit.

Validation of JSML Module

Content validity typically involves specific examination of individual items to ensure that each objective of the module is appropriately addressed (Taber, 2017). The module evaluation questionnaire for content validity was

constructed by the researchers based on the scope and objectives of the module to assess the suitability of each of the unit. The score for each response was given on the five-point Likert scale, having a value of 1 to 5 as presented in Table 3.

Table 3. Score for module evaluation

Item	Scores
Excellent	5
Very good	4
Good	3
Fair	2
Poor	1

The module was validated by 12 experts in the field of mathematics and mathematics education. Six university lecturers from Malaysia and three lecturers from Nigeria university and also three trained secondary school teachers from Nigeria. The module evaluation questionnaire was given to twelve experts to honestly response to each statement by ticking (√) the most appropriate to them. Content validity coefficient that is 70% and above is considered as high validity (Fraenkel, Wallen and Hyun, 2015). The Cronbach's Alpha reliability coefficient for the module was 0.87. According to Taber (2017), Cronbach's Alpha coefficient of 0.80 and above is considered very high. Based on the high reliability and validity coefficient obtained, it was decided that the JSML Module could perfectly be applied in the real study. In order to improve the quality of the JSML module by finding out the applicability of the JSML module, the researcher piloted JSML module on 30 students with two teachers in a school different from the study school sample. As expected, there were some confusion on sentence usage and grammar in the module. Thus, some amendments were made to the current version.

Result

The results of the study are presented according to the research questions and hypotheses.

Effects of JSML Module on Students Mathematics Achievement:

To determine the effects of JSML Module on student's mathematics achievement, the mean mathematics achievement scores of control and treatment group in the pre-test and post-test were calculated. Table 4 shows the mean score of Mathematics achievement of the two groups in pre-test and post-test. The Mathematics achievement score of JSML group exceeded the Mathematics achievement of the control group, as the Mathematics achievement of students who taught JSML had the mean of (9.75, 19.35) while those students who were in the control group had the mean of (9.45, 14.75)

respectively. This revealed that the control and treatment group improved in their achievement after the experiment however, students' in the treatment group gained by mean achievement difference of 9.60, while those in the control group gained by 5.30 which was noticeably low compared to the treatment group.

Table 4. The mean mathematics achievement score of control and treatment groups in pre-test and post-test

Group	Mathematics Achievement Pre-test Score		Mathematics Achievement Post-test Score	
	Mean	N	Mean	N
Treatment Group (JSML)	9.750	60	19.350	60
Control Group	9.450	60	14.750	60
Total	9.150	120	16.550	120

Teachers and Students Perceptions on the implementation of JSML modules on the Nigerian school students in relation to mathematics lesson.

To determine the teachers' and students' perceptions on the implementation of Jigsaw Strategy and Mastery Learning JSML Module on Nigerian School Students in relation to Mathematics Lessons, interviews were conducted with five teachers, and ten randomly selected students from the questionnaire set. Based on the teachers' and students' responses, the data was examined by deriving common themes and categorized.

Table 5. The summary of the common themes

S/N	Themes	Teacher Perception	Students (S) Perception	Example of interview extracts
1	Better understanding	JSML module increases secondary school student's interest to learn.	The students exhibited a deep understanding of Mathematics as they worked together as a team.	"JSML helps in enhancing students' understanding" (S_2 and S_4).
2	Making friends	Due to group interaction they make friends	Due to the positive interaction among the students we	"the lesson helped make new friends" (S_1)

			created new friendship.	
3	Energetic	JSML module is effective in capturing the students focus on the lesson.	Being active in class	"The lesson involved us to go around the class" (S_2).
4	Improved confidence	Worked examples in the JSML module makes them more attentive and focus on learning mathematics.	Felt more confident in communicating with group members, by getting help, discussing and sharing information and teaching others.	"Using JSML and JS in learning was enjoyable because we shared ideas which boosted our confidence level" (S_3, and S_5).
5	Enjoyable	The application is very effective for SS1 students to use the JSML module	The presentation of information in the module	"Worked examples in the module were clear and attractive which made me have interest in learning Mathematics" (S_2, S_3, and S_4).

Research Hypothesis

Ho: There is no significant difference between the Post-test Mathematics Achievement scores of the Control and Treatment Groups by controlling the pretest.

Effects of using JSML Module on Students' Mathematics Achievement

In response to the Research hypothesis, the ANCOVA test result in Table 5 shows that there was a major effect of the independent variable of the sample group which was significant towards the post-test of the dependent variable of the Mathematics achievement [$F(2,115) = 8.54$, $p<.05$]. In addition, there was a significant major effect on the pre-test of the controlled variable towards the post-test of the dependent variable of the Mathematics achievement [$F(2, 115) = 6.02$, $p<.05$]. Based on the result, the researcher

rejected the null hypothesis. Hence, the use of Jigsaw Strategy and Mastery Learning Modules has proved to enhance achievement in mathematics.

Table 6.ANCOVA dependent variable: The post-test mathematics achievement

Resources	Total of Squares Type III	Df	Mean Square	F	Sig.
Corrected Model	401.902	3	133.967	8.016	.000
Intercept	1399.713	1	1399.713	83.751	.000
Pre-test	100.626	1	100.626	6.021	.016
Group	285.512	2	142.756	8.542	.000
Error	1921.964	115	16.713		
Total	21459.000	119			
Corrected Total	2323.866	118			

a. R Squared = .173 (Adjusted R squared = .151)

Discussion

The analysis of this present research revealed that there was a significant difference in the mean score of students' Mathematics achievement among the two groups, where the treatment group showed greater mean scores than their counterpart in the control group. This indicated that the application of Jigsaw Strategy and Mastery Learning Module has positively affected students' Mathematics achievement as supported by many other researches (Chu, 2014; Eachempi, et al, 2017; Yu and Yu, 2017). This shows that the application of Jigsaw and mastery learning strategy module has successfully improved students' Mathematics achievement. This obviously supported the application of the JSML module as a successful and efficient tool of teaching and learning Mathematics. Besides that, the Learning Activity, self-Assessment and worked examples in the module were also other significant reasons that contributed to the improvement of students' Mathematics achievement.

The JSML module was precisely developed to illustrate the step-by-step Mathematics concepts needed in order to solve Mathematics problems which help student to be more focused, and appreciate the learning process. When this happens, students will be able to understand what is being learned. In addition, the research revealed that students exposed to the Jigsaw strategy and Mastery learning really made use of the method of learning Mathematics presented in the module thereby stirring in them the skills of manipulation and problem-solving. Thus, the activity-oriented nature of the Jigsaw strategy and mastery learning made students in the group to obtain significant Mathematics achievement scores compared to their counterparts in the other group. This

result validates the previous findings indicated that Jigsaw strategy and Mastery learning improve students' academic achievement.

One more interesting finding of this present research was that the JSML modules appropriateness in group work in Mathematics classroom displayed advantages of Jigsaw strategy and mastery learning with increased students' Mathematics achievement. According to Han (2015) and Azmin (2016) cooperative learning had successfully lessened students' anxiety, increases students' mathematics attitude, encourages students-student's relationships, and increases self-confidence.

Cooperative strategies were proven to have positive effects on Mathematics learning outcomes like enhanced students' Mathematics achievement scores. Moreover, during group work activities, students from the treatment group were also seen to be more participative than the students in the control group. This assertion was made by the assigned teachers. For some students, using Jigsaw Strategy via Mastery Learning has made them understood the lesson well and were successful in their self-assessment tests as most of the work was undertaken individually.

Recommendations

A few of the limitations of this present research comprised of sample size, and the use of a single school, all making it hard to generalize to other populations. Future research should try to include a diversity of locations, preferably from different areas, and large-scale treatment. The challenge in doing this was finding teachers who were willing to participate in the study and implement Jigsaw strategy and mastery learning in their schools and Mathematics classrooms. Another challenge that may have affected the outcome of the study was the short length of time of the intervention. Due to the need to find baseline data with both the teachers and the students before the Jigsaw strategy and mastery learning treatment, and as well the school calendar, it is hard to make the period of the treatment longer.

It is also important that only selected subject areas are studied because the Jigsaw strategy and mastery learning method may not be appropriate for all subject areas, especially those classes where scores are more subjective in nature. Future research should also focus on the form of assessment such as essay items to evaluate the learning outcomes of the students, since this study used only objective multiple-choice items. Finally, the present study is therefore limited to the issue of evaluating the learning outcomes of this study immediately after the completion of the treatment. Therefore, it was not possible to find out whether the increased in students' Mathematics achievement reported was a result of short period. To address this, there is the need to conduct a research on evaluation of the level of Mathematics

knowledge remembering on SS1 Nigerian students among the two groups in the future research.

Conclusion

The aim of this research was to describe the design, pilot and evaluation of JSML module for SS1 students in Nigeria with Jigsaw and Mastery learning strategy. The JSML Module was developed with the aim of improving mathematics achievement. During the development process, the researcher applied the thirteen (13) steps proposed by Donnelly and Fitzmaurice (2005) design model. After completing the development of the JSML Module, the validity of the JSML module was identified by referring it to twelve experts. Investigation showed that the JSML Module has high reliability and validity. Additional research was used to test the appropriateness of the content and success of learning methods on senior secondary school one students. Thus, the JSML module was appropriate and could be applied in teaching Mathematics in Nigerian secondary schools.

From the analysis of this research, the quantitative results exposed that the treatment group showed better Mathematics achievement than their counterpart who have learned Mathematics through conventional method of teaching in mathematics achievement. Another characteristic that was found in students from this research was that students felt comfortable. They asked questions from their teammates to get clarification on content that was blurred. This means that the classroom environment during the treatment was no longer frightening that students were able to give his or her contribution to their group discussion.

References

Aguele, L.I. & Usman, K.O. (2007). Mathematics education for the dynamic economy in Nigeria in the 21st Century. *Journal of Social Science*, *15*(3), 293-296.

Akinsanya, O.O., Ajayi, K.O. & Salomi, M.O. (2011). Relative effects of parents' occupation, qualification and academic motivation of wards on students' achievement in senior secondary school mathematics in Ogun State. *British Journal of Arts and Social Sciences, 3*(2), 242-252.

Ardiyani, S.M., Gunarhadi & Riyadi. (2018). Realistic mathematic education in cooperative learning viewed from learning activity. *Journal on Mathematics Education, 9*(2), 301-310.

Awogbemi, C.A., Oloda, F.S. & Alagbe, S.A. (2015). A correctional analysis of students' achievement in WASSCE and NECO (SSCE) mathematic. *IOSR Journal of Research & Method in Education (IOSR-JRME), 5*(4), 14-21.

Azmin, H.N. (2016). Effect of the jigsaw-based cooperative learning method on student performance in the general certificate of education advanced-level psychology: An exploratory Brunei case study. *International Education Studies, 9*(1), 91-106.

Baglama, B., Yikmis, A. & Demirok, M.S. (2017). Special education teachers' views on using technology in teaching mathematics. *European Journal of Special Education Research, 2*(5), 125-134.

Bala, P. (2019). Effect of mastery learning approach (MLA) on the achievement in mathematic of students with mathematical difficulties. *IOSR Journal of Humanities and Social Science (IOSR-JHSS), 24*(5), 29-35.

Chu, S.Y. (2014). Application of the jigsaw cooperative learning method in economics course. *International Journal of Managerial Studies and Research, 2*(10), 166-172.

Creswell, J.W. (2013). Steps in conducting a scholarly mixed methods study. DBER Speaker series. University of Nebraska Discipline-Based Education Research Group (Online). Retrieved from: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1047&context=dberspeakers

Dat, T. V. (2016). The effects of jigsaw learning on students' knowledge retention in Vietnamese higher education. *International Journal of Higher Education, 5*(2), 236-253.

Eachempati, P., KS, K.K. & Ismail, A.R.H. (2017). Cooperative learning through jigsaw classroom technique for designing cast partial dentures-a comparative study. *Med Ed Publish, 6*,11-14.

Federal Republic of Nigeria. (2004). National policy on education (4th ed.). Lagos: Federal Government Press

Fraenkel, J.R., Wallen, N.E. & Hyun, H.H. (2015). *How to design and evaluate research in education (8th ed.)*. New York, NY: McGraw-Hill.

Han, M. (2015). An empirical study on the application of cooperative learning to English listening classes. *English Language Teaching*, *8*(3), 1-10.

Johnson, D.W. & Johnson, R.T. (2009). An educational psychology success story: social interdependence theory and cooperative learning. *EducRes. 38*(5), 365–79.

Johnson, D. & Johnson, R. (1994). *Learning together and alone, cooperative, competitive, and individualistic learning*. Needham Heights, MA: Prentice-Hall.

Kakkar, R. (2016). Effect of Vedic mathematics on achievement in algebra among adolescent students. *International Education and Research Journal,* 2(12), 127-128

Langa, H.B. & Yusuf, I.A. (2016). Problems and prospects of teaching and learning of physics: A case study of five selected senior secondary school in Gombe Metropolis, Gombe State, Nigeria. *International Journal of Public Policy and Administrative Studies, 11*(1), 25-34.

Le, H., Jassen, J. & Wubbles, T. (2016). Collaborative learning practices: Teacher and students perceived obstacles to effective student collaboration. *Cambridge Journal of Education, 48*(1), 103-122.

Lemos, A.R., Sandars, J.E., Alves, P. & Costa, M.J. (2014). The evaluation of students-centeredness of teaching and learning: a new mixed-method approach. *International Journal of Medical Education, 5*, 157-164.

Maddinabeita, C.S. (2006). Cooperative Learning. *GRETA*, 14, 80 – 84.

Mengduo, Q. & Xiaoling, J. (2010). Jigsaw strategy as a cooperative learning technique: focusing on the language learners. *Chinese Journal of Applied linguistics, 33*(4), 113-125.

Minarni, A., Napitupulu, E.E. & Husein, R. (2016). Mathematical understanding and representation ability of public junior high school in north Sumatra. *Journal on Mathematics Education, 7* (1), 43-56.

Ministry of Education. (2018). An investigation into the causes of poor performance among students in selected secondary schools in Billiri L.G.A. of Gombe State. Retrieved from https://gombestate.gov.ng/

Mitee, T.L. & Obaitan, G.N. (2015). Effect of mastery learning on senior secondary school students cognitive learning outcome in quantitative chemistry. *Journal of Education and Practice, 6*(5), 34-38.

Mohammadjani, F. & Tonkaboni, F. (2015). A comparison between the effect of cooperative learning teaching method and lecture teaching method on students' learning and satisfaction level. *International Education Studies, 8*(9), 107-112.

Radovic, S., Maric, M. & Passey, D. (2018). Technology enhancing mathematics learning behaviours: Shifting learning goals from "producing the right answer" to "understanding how to address current and future mathematical challenges". *Education and Information Technologies, 24*(1), 103-126.

Sahin, A. (2010). Effect of jigsaw 11 techniques on achievement in written expression course. *Educational research and Review, 5*(12), 777-787.

Sunandar, M.A., Zaenuri, Z. & Dwidayati, N.K. (2018). Mathematical problem solving ability of vocational school students on problem based learning model nuanced ethnomathematics reviewed from adversity quotient. *UNNESS Journal of Mathematics Education Research, 7*(1), 1-8.

Taber, K.S. (2017). The use of Cronbach alpha when developing and reporting research instrument in science education. *Research in Science Education,* 48, 1273-1296.

Tularam, G.A. & Machisella, P. (2018). Traditional vs non-traditional teaching and learning strategies the case of e-learning. *International Journal for Mathematic Teaching and Learning, 19*(1), 129-158.

Wolfensberger, B. & Canella, C. (2015). Cooperative learning about nature of science with a case from the history of science. *International Journal of Environment & Science Education, 10*(6), 865-889.

Yu, A.T.W. & Yu, A.T.W. (2017). Using jigsaw method to enhance the learning of research and consultancy techniques for postgraduate students. *Engineering, Construction and Architectural Management, 24*(6), 1081-1091.