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Improving Secondary School Students' Self-Concept In Mathematics Through The Use Of Jigsaw, Team-Pair-Solo And Reciprocal Teaching Strategies

CHIAKWELU Amaka Benedine

Department of Mathematics, Nwafor Orizu College of Education, Nusgbe, Anambra State, Nigeria

OKIGBO Ebele Chinelo

Department of Science Education, Nnamdi Azikiwe University, Awka, Nigeria

***Abstract:** The study focused on improving secondary school students' self-concept in mathematics through the use of Jigsaw, Team-pair-solo and reciprocal teaching strategies. Four research questions guided the study and five hypotheses were tested at 0.05 level of significance. The design of the study was quasi-experimental. The population of the study comprised 5, 898 senior secondary school year two mathematics students in Onitsha Education Zone, of Anambra state, out of which 211 students were sampled using a multi-stage sampling procedure. Mathematics Self-Concept Questionnaire (MSCQ) validated by two experts from Nnamdi Azikiwe University, Awka and one experienced secondary school mathematics teacher was used as instrument for data collection. The reliability MSCQ was established using Kuder-Richardson Formula 20 to be 0.71. The three experimental groups were taught mathematics using jigsaw, team-pair-solo and reciprocal teaching strategies respectively while the control group was taught using conventional method. The data generated from the study was analyzed using mean and standard deviation and analysis of covariance. The findings of the study revealed that there was significant difference in the mean self-concept scores of the students taught mathematics with team-pair-solo improving mathematics self-concept the most. The study recommended that mathematics teachers in secondary schools should adopt the use of these three cooperative teaching strategies to improve students' self-concepts of students in mathematics.*

***Keywords:** jigsaw, team-pair-solo, reciprocal teaching, self-concept, mathematics*

I. INTRODUCTION

Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, and beliefs with the goal of causing a change in behaviour. One of the subjects at the secondary level of education in Nigeria known to be important is mathematics. The National Policy on Education (FRN, 2013) clearly expressed the importance of mathematics when it stated:

> 'Mathematics should be visualised as the vehicle to train a child to think, reason, analyse and articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and reasoning. With the recent introduction of computers in schools, educational computing and the emergence of learning through the understanding of cause-effect relationships and the interplay of variables, the teaching of mathematics will be suitably redesigned to bring it in line with modern technological devices (p. 29).'

Mathematics is an indispensable subject at all levels of education. The important nature of mathematics arises from the very fact that it is the basis for all studies. Understanding in mathematics is pre-requisite in all scientific and social science studies. Owing to this importance of mathematics, it is a compulsory subject at the senior secondary level and students must make at least a credit pass in mathematics before they are admitted to study further in the higher institutions of learning. Despite the importance of mathematics, students' achievement in external examinations has remained poor as evidenced in the Analysis of WAEC results (1991-2016). The incessant poor academic achievement and the perceived fear among students that mathematics is difficult also diminish students' mathematic self-concept. Research studies have barely attended to mathematics students' self-concept and how to develop and improve healthy mathematics self-concept.

In attempt to ameliorate the persistent poor achievement in mathematics which is one of the key factors in students' poor mathematic self-concept, some studies have been conducted on the teaching strategies that could help improve students' achievement with the hope to improve mathematics self-concept alongside. The search for more innovative teaching strategies is necessitated by the fact that teaching method has been one of the most implicated factors which contribute to the students' poor achievement in mathematics and in turn low mathematics self-concept. However, most research in the area of teaching strategies do not take into cognizance the role of various forms of collaboration in learning and how it could improve students' mathematics self-concept in mathematics. Studies on the roles of such collaboration as a boost for the mathematics self-concept of students are not replete in literature. There is need therefore, to investigate whether various interactive strategies such as jigsaw, team-pair-solo and reciprocal teaching could improve students' academic self-concept in mathematics.

Jigsaw strategy was introduced by Aranson and Colleagues in 1978 to improve peer cooperation and create team solidarity among students through division of task, with each student assuming learning responsibility in a group. Accordingly, students work in two different groups: main and jigsaw group (Sengul & Katranci, 2014). The students first come together in their main groups and have the learning materials divided among themselves for a jigsaw group. The jigsaw group consist of the group members from different main groups that come together to study the same subject or topic area. The students in the jigsaw group after learning the topic area, return to their main groups and share information their learned with the members of their own main group (Sengul & Katranci, 2014). In Jigsaw strategy, each student in a group is given information to which no one else in the group has access, thus, making each students "expert" on the section of the subject matter. After receiving their assignment, each team member reads a section and different team members who have studied the same sections meet in "expert groups" to discuss their sections.

Jigsaw teaching strategy affords the students opportunity to learn from each other. The strategy further allows the students to learn not only from one person to whom they are close to but from many others. The social atmosphere created in the jigsaw classroom allows students to actually seeks and acquire learning while motivating others to try to learn topics perceived as difficult in such groups. The motivation to learn arises from the fact that students have other students at their level who have learnt the material in an expert groups and who is their team member. Students also learn the material meaningfully, thus, building their mathematics self-concept.

According to Ogunleye (2011) TPSTS is a strategy of cooperative learning whereby students are grouped into teams where they first solve a problem as a team, then with a partner and finally on their own as individuals. The steps that explains the general concept of team-pair-solo involves first, the formation of a team. The team according to Endah and Sudarsono (2017) can be heterogeneous or homogeneous, randomized and students-selected teams. The team can be in groups of four or six. Usually, an even number team may be preferred, so that students could form pairs easily during the second step that involves formation of a pair with a partner. Each team are given a problem and team members make sure that every students in their team knows how to solve the question. In the second step, students break into pairs and solve a problem like the one that was solved as a team. The last step, solo, involves the students as individuals working on their own.

TPSTS allows the students to study in groups but differs from Jigsaw, in that students meet in pairs to study and properly conceptualize the material. The pair by pair study affords the students the opportunity to critically ask questions, learn in quite a friendly and supportive way given that they may not have such opportunity in the group learning. TPS further requires the students to evaluate their learning by studying and solving problems individually after learning in pairs. The individualized level of learning enables the students to ascertain whether the concepts have been fully mastered or whether there is still need for further group or pair learning. The individual learning and practice is similar but differs significantly from reciprocal teaching strategy (RTS).

RTS according to Raslie, Mikeng & Ting (2015) is a strategy for teaching students to become metacognitive readers. The originators explained that it involves teacher-modelling of four comprehension fostering and comprehension monitoring strategies in interactive and social group setting (McHugh, 2016). The strategies are questioning, clarifying, summarizing and predicting (McAllum, 2014). Although, RTS was designed original for reading comprehension (Henter, 2012; Mandel, Osana & Venkatesh, 2013), a modification of reciprocal teaching was useful for developing comprehension of mathematical word problems (Gorlewski & Moon, 2011). The four major components of this adapted approach according to Gorlewski and Moon (2011) are: descriptive; searching; brief; and preparation. Throughout a reciprocal teaching class on mathematical word problems, the students are separated into small groups, and one student is assigned the position of leader. The leader asks the group members to silently read a word problem. Later, when the entire group has read the problem, the leader asks for vocabulary or phrases that need to be clarified. Any group member can provide the meaning of a word or phrase. After all words and phrases have been clarified, the leader uses questions to recognize the key parts of the problem. The group leader then summarizes the purpose of the word problem.

The leader guides the group in devising a plan to answer the problem. The steps and operations necessary to solve the problem are listed. Once the plan has been checked to make sure that it makes sense, the mathematical word problem is solved. Solving the problem may be done independently or jointly. Following the solution of the problem, a new leader is chosen to assist in solving of the next problem. In this study, a similar approach will be adopted where students are divided into groups of five. The mathematics teacher will write out an exercise and using question, guide the students to clarify the steps in solving the problem. Thereafter, the teacher along with the students summarize the necessary steps to solving similar problems and have them predict possible alteration in the steps when solving other problems that are similar but may be at variance in approach to its solution. The students in the group take turns during the lesson to act as the teacher in modelling the steps of reciprocal teaching through questioning, clarifying, summarizing and predicting. When a student takes the position of leading others to learn a mathematical concept or operation, they boost their mathematic self-concept (Chaika, 2012).

Self-concept is the aggregate of ideas, concepts and attitudes about oneself at any specific moment of time (Cherry, 2018b). It is generally seen as the perceptions, feelings, and attitudes that a person has about himself or her-self (Chaika, 2012). Self-concept is the individual's belief including the person's attributes about who and what the self is (Mujis, 2011). Mathematics self-concept therefore, is the notion or set of ideas students have about the ability to understand and solve mathematical problems. Students build their self-concept of a subject like mathematics according to their level of self-confidence that they can understand and solve mathematical problems correctly. Such self-concept may not be achieved through a teaching strategy wherein students do not take responsibility for their own learning. However, cooperative teaching strategies through jigsaw, TPSTS and RTS may give both male and female students opportunity to master learning in mathematics by being involved in the learning process. Male and female students may thereby improve on their mathematics self-concept.

Gender effects on self-concept have remained inconclusive. The problem of gender stereotyping in science learning is a widely debated issue (Mujis, 2011). The problem is complicated by the fact that some culture limits the education of the girl child (Okorie, 2017). Researchers (example Sarah, 2015) hold the opinion that certain discipline should be relegated to the male or female folk as the case may be. In the classroom also, teachers sometime focus on the males who are believed to thrive in science oriented courses that needs mathematics and therefore, pay less attention to the females (UNESCO, 2012). Studies further revealed that effect due to gender differ significantly in various subject areas (Jacob & Linus, 2017; Judith, Nicholaus & John, 2018) while other reported that the effect due to gender did not differ significantly (Busari, Ernest & Ugwuanyi, 2016; Monica & Ofem, 2015).

PURPOSE OF THE STUDY

The purpose of the study was to investigate the effects of jigsaw, team-pair-solo and reciprocal teaching strategies on secondary school students' self-concept in mathematics. Specifically, the study investigated the:

- ✓ Differences in the mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS), team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method.
- ✓ Difference between the mean self-concept scores of male and female students taught mathematics using JTS.
- ✓ Difference between the mean self-concept scores of male and female students taught mathematics using TPSTS
- ✓ Difference between the mean self-concept score of male and female students taught mathematics using RTS

RESEARCH QUESTIONS

The following research questions guided the study.

- ✓ What are the differences in the mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS), team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method?
- ✓ What is the difference between the mean self-concept scores of male and female students taught mathematics using JTS?
- ✓ What is the difference between the mean self-concept scores of male and female students taught mathematics using TPSTS?
- ✓ What is the difference between the mean self-concept scores of male and female students taught mathematics using RTS?

HYPOTHESES

The following hypotheses were tested at 0.05 level of significance:

- ✓ There is no significant difference in the mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS) team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method.
- ✓ There is no significant difference in the mean self-concept scores of male and female students taught mathematics using JTS.
- ✓ There is no significant difference in the mean self-concept scores of male and female students taught mathematics using TPSTS.
- ✓ There is no significant difference in the mean self-concept scores of male and female students taught mathematics using RTS.
- ✓ There is no significant interaction effect of teaching strategies and gender on students' self-concept in mathematics.

II. METHOD

RESEARCH DESIGN

The design to be adopted for the study was quasi-experimental. Specifically, a pretest posttest non-equivalent control group design was used. Quasi-experimental design is an experiment where random assignment of subjects to experimental and control groups is not possible (Nworgu, 2015). Nworgu noted that in such experiments, intact or pre-existing groups are used which are assigned to the experimental and control groups. The choice of quasi-experiment design was because the administrative set up in the secondary school system will not allow for the randomization of students for experiments. The design of the experiment is shown in Figure 1.

E_1	O_1	X_1	O_2
E_2	O_1	X_2	O_2
E_3	O_1	X_3	O_2
C	O_1	~X	O_2

Where;
E1 = Experimental group 1
E2 = Experimental group 2
E3 = Experimental group 3
C = Control group
O_1 = pretest
O_2 = post-test
X_1 = experimental treatment using Jigsaw teaching strategy (JTS)
X_2 = experimental treatment using Team-Pair-Solo teaching strategy (TPSIS)
X_3 = experimental treatment using Reciprocal Teaching Strategy (RTS)
~X = control using conventional lecture method (Conventional Method)
--- = non-equivalent group

AREA OF THE STUDY

The area of the study is Onitsha Education Zone of Anambra State. Onitsha Education Zone comprises three Local Government Areas namely; Onitsha North, Onitsha South and Ogbaru. The occupants of the zone are mainly traders, farmers, artisans, and civil servants. There are 32 state owned secondary schools in Onitsha Education Zone.

POPULATION OF THE STUDY

The population of the study was made up of 5, 898 (2,733 males and 3,165 females) senior secondary school year two (SS2) mathematics students in Onitsha Education Zone of Anambra State (Source: Planning, Statistics and Research Department, Post Primary Schools Services Commission, Onitsha Zone, 2019).

SAMPLE AND SAMPLING TECHNIQUES

The sample of the study was 211 SS2 mathematics students from four public secondary schools in Onitsha Education Zone of Anambra state. The sampling involved multi-stage. The coeducational schools under Onitsha Education Zone were first listed according to local government area. Secondly, four coeducational schools were purposively selected. The reason for selecting the schools was to make sure that the schools are far apart from each other to remove class interaction. One school each was selected from Onitsha south and Ogbaru while two schools were selected from Onitsha North local government area. On the third stage, the selected schools were randomly assigned (simple balloting) into the experimental and control groups. Lastly, one intact class of mathematics students was selected at random in each school for the study. The experimental group one has 57 students (29 males, 28 females), experimental group two has 54 students (30 males, 24 females), experimental group three has 49 students (21 males, 28 females) and the control group has 51 students (27 males, 24 females).

INSTRUMENT FOR DATA COLLECTION

The instrument for data collection was Mathematics Self-Concept Questionnaire (MSCQ) developed by the researcher. MSCQ was adapted from questionnaire on Self-Concept towards mathematics by Oluwatayo (2011) and Academic Self-Concept Questionnaire by Joyce and Yates (2007). MSCQ consists of 20 items of which 12 items were adapted from Oluwatayo (2011) and the remaining eight items from Joyce and Yates. The major modification in the items adapted from Oluwatayo was the conversion of the statements to first person singular to express more, the students self-report of mathematics self-worth by their own evaluation. Joyce and Yates (2007) believed that academic self-concept can be characterized by two elements namely: descriptive (example, I like mathematics) and evaluative (example, I am good at mathematics) aspects of self-perception. Thus, the original instrument by Joyce and Yates measure students' school subject self-concept, general and academic status scale focusing on academic confidence (competence) and effort. The researcher therefore, took only those items that expressed measurement of self-concept towards subjects. MSCQ contained statements on which students are required to rate their degree of agreement on a four point scale. The scales are strongly agree, agree, disagree and strongly disagree. The researcher also developed lesson plans using jigsaw, team-pair-solo and reciprocal teaching. The lesson plans were used for the treatment of respective experimental groups.

VALIDATION OF THE INSTRUMENT

The instrument, objectives of the study, the research questions and hypotheses were then given to lecturers from the Department of Science Education and Education Foundations, Nnamdi Azikiwe University, Awka and one experienced secondary school mathematics teacher for validation. The validators were requested to vet the instrument in terms of language clarity, plausibility of distractors, suitability for the level of students under study. They are to write against item in the MSCQ Delete (D), Modify (M) or retain (R) against any question or item they wish the research to delete, modify or retain respectively. The corrections, suggestion and recommendations given by the validators were effected in the final draft of the instrument.

RELIABILITY OF THE INSTRUMENT

The reliability of the MSCQ was established using Cronbach Alpha. Cronbach Alpha was used because it is a suitable reliability estimate for polytomously scores instruments. MSCQ was administered to 40 students in Ogidi Education Zone of Anambra state outside the area of the study but which has similar characteristics with the area being studied. The generated scores were subjected to Cronbach Alpha which yielded the coefficient of internal consistency of 0.63.

EXPERIMENTAL PROCEDURE

The study was conducted in two phases. In the first phase, briefing was conducted for the regular mathematics teachers who were used as research assistants. The briefing was done in one week, with three contacts. The second phase was administration of pretest. All the teachers in the three treatment groups and the control group administered MSCQ as pretest. There was no feedback or revision on the pretest. After the pretest, the treatment followed in the third phase.

TREATMENT

The treatment commenced with brief orientation of the various groups (Jigsaw, TPS and RTS) for the various experimental group schools. The mathematics teachers oriented the students on their group function, expert group function, pair function, individual function and leader function as the case may be the treatment procedure for each group is described as follows:

JIGSAW

Generally, before the lesson, the teacher assigned students to team containing only five students. The teacher gave the students before each lesson period, sections of the learning materials to be studied by every five members of the groups. All the group members assigned to study a particular section outside studying the entire materials gathered in another expert group to discuss the particular section given to them. After all other experts who have mastered their section within the specified time, all experts w returned to their original teams and to teach team members their own aspect of the materials which they must have mastered. Each team solved questions relating to all sections of the materials as a group and later as individuals.

During the lesson, the teacher directed the students to sit according to their team, familiarize themselves with their team members. Lesson activities where the teacher asked the team to find solutions to problems was done by team effort, ensuring that all every team member learn and understands what is done in the team. For instance, during the lesson for algebraic fraction, the teacher demanded the students to find the common factors. Finding the common factors was done by team effort during the lesson and all team members and by their interaction learned how to find the common factors.

Members of the team took turns to represent their team as expert members in expert groups. For every period of the lesson, the teacher gave assignment to the expert groups. These assignments constitute the part of the learning materials the expert groups are to master and go back to teach their team members before the next lesson. In order to ensure the systematic involvement of the team members in expert group activities, members sent to discuss the first period of the lesson assignment, became permanent expert group 1. The team members sent to learn the section of the material for the second period of the formed permanent expert group 2, those for the third and fourth periods, formed permanent expert group 3 and expert group 4 respectively. The expert groups were not be limited to the assignments due to the groups, but solved other exercises in their mathematics textbooks to ensure better mastery of concepts. With this mastery and understanding, the expert group members go back to their team to teach them, answer their questions and help them anytime there are questions relating to what they have studied in the expert group. End of lesson evaluation questions were solved by individuals and with group effort. The expert group who are to master that aspect of the material also helped the team members latter after the lesson, should they have any further questions on the evaluation questions.

TEAM-PAIR-SOLO TEACHING STRATEGY (TPSIS)

Before the lesson, the teacher assigned students to group categories containing only four students according to their scores in the pretest. The groups were arranged such that, those with varying scores meet in the same group. In the groups, students with varied scores were paired. The teacher gave the students group, paired and individual exercises during the lesson. The students were scored individually for every exercise. Before each lesson, the teacher directed the students to seat according to their groups. In the lesson, after the teacher has given the solution to a problem as an example, the teacher gave the students similar problems to solve as a group activity. The students in their groups, using group effort tried to solve the problems. After the group has found the solution to the problem, the group made sure that all the members of the groups learns the procedure to getting the solution.

The group activity were immediately be followed by pair-activity. These pair activities constituted the teacher asking the students to solve with their pairs, the pair-exercise question. Students at this time paired up accordingly and solve the questions as a pair within the time frame given. The answers from the pair activity were written on the board by the teacher to compare and correct mistakes and identify the right answer. In the pair learning activity, the students are to make sure that their pairs learned what is required and how to solve related problems. After the pair learning, the teacher evaluated the lesson by giving students problems according to the steps of the lesson to solve individually. The questions may sometime be different structured problems not taken from the questions in the lesson evaluation sections. The teacher may also combine both the lesson evaluation question and other related problems for individual students to solve. Students were scored individually at the time of individual activity.

RECIPROCAL TEACHING STRATEGY (RTS)

Generally, in the reciprocal teaching class the teacher led the class first by introducing the lesson, solving an example and then hand over to the groups. There were groups of 5 students. In the groups one student was assigned the position of leader for one exercise and another students, a leader for another exercise, until the five members take their turns. The function of the leader is to ask the group members to silently read a problem. Later, when the entire group has read the problem, the leader asks for vocabulary or phrases that need to be clarified (questioning). Any group member can provide the meaning of a word or phrase or their understanding of the problem. After all words and phrases have been clarified, the leader uses questions to recognize the key parts of the problem (questioning). The group leader then summarized the purpose of the problem (clarifying) from the interaction among the group. The leader guides the group in devising a plan to answer the problem. The steps and operations necessary to solve the problem are listed (summarizing and predicting). Once the plan has been checked to make sure that it makes sense, the mathematical problem is solved. Solving the problem may be done independently or jointly. Following the solution of the problem, a new leader was chosen to assist in solving of the next problem. However, after the solution to each problem has been found, the leader made all the group members learn as much as other members know. The group questions and activities were the evaluation of the teacher's lesson. Where a group cannot solve the problem, at the end of the group activity and closure, the teacher summarized the questions and solve the problems to correct the groups' effort. There were also be take home assignments for group study and individual revisions outside the classroom and at home. The assignments are to keep the students busy and to help them do a personal self-evaluation of how much they understand and the questions they can solve.

The control group was taught using conventional method. The same content was taught using presentation of fact with little questioning. The last stage of the exercise which is the fourth stage involves the administrated of the posttest. The obtained scores were collated and analyzed.

CONTROL OF EXTRANEOUS VARIABLES

- ✓ *HAWTHORNE EFFECT:* Hawthorne effect occurs when students fake the behaviour (mechanical) owing to their sensitiveness to the fact that they are being used in an experiment. The researcher therefore made use of the regular mathematics teachers who were monitored closely for the experiments.
- ✓ *INITIAL GROUP DIFFERENCE (NON-EQUIVALENCE):* the initial group difference was eliminated through the adoption of analysis of covariance (ANCOVA). In the analysis, the students' pretest was used as the covariate.
- ✓ *CLASS INTERACTION:* When the subject from the different experimental groups interacts, the result of the study may be invalidated. The researcher therefore, only used those schools situated miles apart for the study.
- ✓ *EXPERIMENTER BIAS:* When the researcher organizes the experiment such that a particular group is favoured above the other, or the experimental conditions favour such group, the tendency is that such favored group may outperform their counterpart. The researcher therefore, used the regular mathematics class teachers who adhered to the same lesson contents.
- ✓ *TEACHER VARIABLE:* The researcher in order to control for variability in teacher factors which could affect the outcome of the study, ensured that the teachers used the lesson plans prepared by the researcher. The teachers were trained and monitored by the researcher during the course of the experiment.
- ✓ *TEST KNOWLEDGE:* Since the same instrument was used for both the pretest and posttest, the questions were reshuffled both in the answer option and in the serial numbering of the questions during the posttest. The instrument was also printed on a different coloured paper during the posttest.

METHOD OF DATA COLLECTION

MSCQ were administered to the students in the experimental groups and the control group as pretest before treatment and as posttest after treatment. This testing was conducted by the four research assistants who are the regular mathematics classroom teachers under the supervision of the researcher. The scores obtained were collated by the teachers and given to the researcher for analysis.

METHOD OF DATA ANALYSIS

Data relating to the research questions were analyzed using mean and standard deviation while Analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. Scheffe PostHoc analysis was used to determine the direction of significance whenever a significant main effect of the treatment was observed. The Decision rule was to reject the null hypotheses where the Pvalue is less than or equal to 0.05 ($P \leq 0.05$)level of significance and not to reject the null hypotheses where the Pvalue is greater than 0.05 ($P > 0.05$) level of significance.

III. RESULT

RESEARCH QUESTION 1: What are the pretest posttest mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS), team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method?

Method	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
JTS	57	29.04	1.65	71.88	1.43	42.84
TPSTS	54	22.04	1.30	77.81	1.72	55.77
RTS	49	30.74	1.20	66.80	1.31	36.06
Conventional	51	33.00	1.60	63.67	1.52	30.67

Table 1: Mean Pre-test and Posttest Self-Concept Scores of Students taught Mathematics using JTS, TPSTS, RTS and those taught using Conventional Method

Table 1 shows that the group taught mathematics using JTS has mean gain self-concept score of 42.84, those taught using TPSTS has mean gain self-concept score of 55.77, those in RTS group has mean gain self-concept score of 36.06 while those taught using conventional method has mean gain self-concept score of 30.67. The spread of score was greatest in the posttest mean of those taught using TPSTS, followed by those taught using conventional method, JTS while those taught using RTS having the least scores spread.

RESEARCH QUESTION 2: What is the difference between the mean self-concept scores of male and female students taught mathematics using JTS?

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Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Male	29	29.59	2.03	72.38	1.24	42.79
Female	28	28.46	0.84	71.36	1.45	42.90

Table 2: Difference Between the Mean Pre-test and Posttest Self-concept Scores of Male and Female Students taught Mathematics using JTS

Table 2 shows that the male students taught mathematics using JTS has mean gain self-concept score of 42.79 while the females has mean gain self-concept score of 42.90. The spread of scores was greatest among the females.

RESEARCH QUESTION 3: What is the difference in the mean self-concept scores of male and female students taught mathematics using TPSTS?

Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Male	30	22.90	0.85	79.00	1.34	56.10
Female	24	20.96	0.91	76.33	0.64	55.37

Table 3: Mean Pre-test and Posttest Self-concept Scores of Male and Female Students taught Mathematics using TPSTS

Table 3 shows that the male students taught mathematics using TPSTS has mean gain self-concept score of 56.10 while the females has mean gain self-concept score of 55.37. The spread of scores was greatest among the males.

RESEARCH QUESTION 4: What is the difference in the mean self-concept scores of male and female students taught mathematics using RTS?

Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Male	21	31.48	1.25	67.62	1.43	36.14
Female	28	30.18	0.82	66.18	0.77	36.00

Table 4: Mean Pre-test and Posttest Self-concept Scores of Male and Female Students taught Mathematics using RTS

Table 4 shows that the male students taught mathematics using RTS has mean gain self-concept score of 36.14 while the females has mean gain self-concept score of 36.00. The spread of scores was greatest among the males.

HYPOTHESIS 1: There is no significant difference in the mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS) team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method.

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	6036.774[a]	4	1509.194	665.944	.000	
Intercept	2523.205	1	2523.205	1113.385	.000	
Pretest	.734	1	.734	.324	.570	
Method	1044.536	3	348.179	153.637	.000	Sig
Error	466.847	206	2.266			
Total	1047275.000	211				
Corrected Total	6503.621	210				

Table 5: ANCOVA on Difference between the Mean Self-concept Scores of Students taught using JTS, TPSTS, RTS and those taught using Conventional Method

Table 5 shows that at 0.05 level of significance, 1df numerator and 210 df denominator, the calculated F is 153.637 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean self-concept scores of students taught mathematics using jigsaw teaching strategy (JTS) team-pair-solo teaching strategy (TPSTS), reciprocal teaching strategies (RTS) and those taught using conventional method.

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
JTS	TPSTS	-4.853*	.592	.000	-6.021	-3.685
	RTS	4.729*	.275	.000	4.187	5.272
	CONVENTIONAL METHOD	7.637*	.380	.000	6.888	8.386
TPSTS	JTS	4.853*	.592	.000	3.685	6.021
	RTS	9.582*	.725	.000	8.152	11.012
	CONVENTIONAL METHOD	12.490*	.877	.000	10.760	14.220
RTS	JTS	-4.729*	.275	.000	-5.272	-4.187
	TPSTS	-9.582*	.725	.000	-11.012	-8.152
	CONVENTIONAL METHOD	2.907*	.292	.000	2.331	3.484
CONVENTIONAL METHOD	JTS	-7.637*	.380	.000	-8.386	-6.888
	TPSTS	-12.490*	.877	.000	-14.220	-10.760
	RTS	-2.907*	.292	.000	-3.484	-2.331

Based on estimated marginal means

**. The mean difference is significant at the .05 level.*

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 6: Scheffe PostHoc Analysis on Significance of Mean Difference in Self-concept between Groups

Table 6 reveals that significant difference exists between the mean mathematics self-concept scores of students taught using JTS and TPSTS in favour of TPSTS. Table 10 also reveals that a significant difference exists between the mean mathematic self-concept scores of students taught using JTS and RTS in favour of JTS. Table 10 further shows that there is significant difference between the mean mathematic self-concept scores of students taught using RTS and TPSTS in favour of TPSTS. This shows that the direction of significance moves from TPSTS, JTS and RTS.

HYPOTHESIS 2: There is no significant difference between the mean self-concept scores of male and female students taught mathematics using JTS.

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	24.074[a]	2	12.037	7.217	.002	
Intercept	1001.698	1	1001.698	600.574	.000	
Pretest	9.190	1	9.190	5.510	.023	
Gender	21.759	1	21.759	13.046	.001	S
Error	90.067	54	1.668			
Total	294595.000	57				
Corrected Total	114.140	56				

Table 7: ANCOVA on Difference between the Mean Self-concept Scores of Male and Female Students taught using JTS

Table 7 shows that at 0.05 level of significance, 1df numerator and 56df denominator, the calculated F is 13.046 with Pvalue of .001 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean self-concept scores of male and female students taught mathematics using JTS.

HYPOTHESIS 3: There is no significant difference between the mean self-concept scores of male and female students taught mathematics using TPSTS.

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	95.288[a]	2	47.644	39.925	.000	
Intercept	466.519	1	466.519	390.939	.000	
Pretest	.473	1	.473	.397	.532	
Gender	35.426	1	35.426	29.686	.000	Sig
Error	60.860	51	1.193			
Total	327134.000	54				
Corrected Total	156.148	53				

Table 8: ANCOVA on Difference between the Mean Self-concept Scores of Male and Female Students taught using TPSTS

Table 8 shows that at 0.05 level of significance, 1df numerator and 53df denominator, the calculated F is 29.686 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean self-concept scores of male and female students taught mathematics using TPSTS.

HYPOTHESIS 4: There is no significant difference between the mean self-concept scores of male and female students taught mathematics using RTS.

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	25.423[a]	2	12.712	10.343	.000	
Intercept	254.696	1	254.696	207.232	.000	
Pretest	.524	1	.524	.426	.517	
Gender	21.097	1	21.097	17.165	.000	Sig
Error	56.536	46	1.229			
Total	218705.000	49				
Corrected Total	81.959	48				

Table 9: ANCOVA on Difference between the Mean Self-concept Scores of Male and Female Students taught using RTS

Table 9 shows that at 0.05 level of significance, 1df numerator and 48df denominator, the calculated F is 17.165 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean self-concept scores of male and female students taught mathematics using RTS.

HYPOTHESIS 5: There is no interaction effect of teaching strategies and gender on students' mathematics self-concept.

Source	SS	df	Mean Square	F	Sig.	Decision
Corrected Model	6206.540[a]	8	775.817	527.516	.000	
Intercept	1649.530	1	1649.530	1121.597	.000	
Pretest	4.420	1	4.420	3.005	.085	
Gender	668.652	3	222.884	151.550	.000	
Method	39.553	1	39.553	26.894	.000	
Method * Gender	111.165	3	37.055	25.196	.000	Sig
Error	297.081	202	1.471			
Total	1047275.000	211				
Corrected Total	6503.621	210				

Table 10: ANCOVA for Testing of Interaction Effect of Teaching Strategies and Gender on Students' Mathematics Self-concept

Table 17 shows that at 0.05 level of significance, 1df numerator and 210 df denominator, the calculated F is 25.196 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is interaction effect of teaching strategies and gender on students' mathematics self-concept.

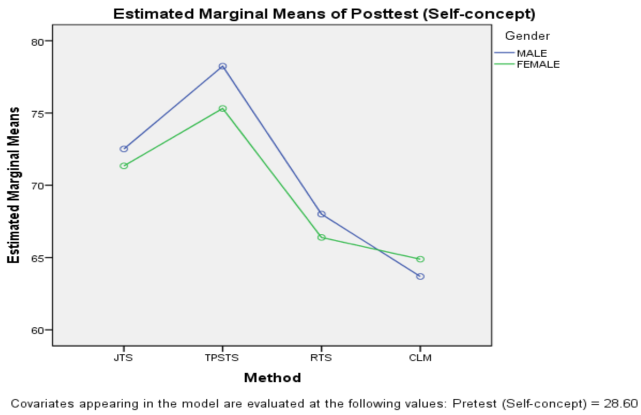

Figure 2: Plot of Interaction Effect of Teaching Strategies and Gender on Students' Mathematics Self-concept

The plot of the interaction effect between teaching strategies and gender on mathematic self-concept is significant and disordinal. This shows that the teaching strategies have different effects on mathematic self-concept of students on different conditions, for example, the effect of the teaching strategies on mathematic self-concept changed when gender was put into consideration.

IV. DISCUSSION

The finding of the study showed that team-pair-solo teaching strategy significantly and positively improved students' mathematics self-concept, followed by jigsaw-teaching strategy and reciprocal learning. The observed result may be attributed to the greater role the students played in the team-pair-solo group which has direct bearing on their personality. The students in the team-pair-solo group, have to learn a concept within a team with team effort, then share with another students in pairs and further internalize the concept by studying individually. All along the team-pair-solo learning, the students is given room for greater self-assertiveness in the group and in pair. Students do the conceptualization of what is taught, how it can be taught or shared to another and eventually master these processes as an individual. Students therefore end up believing in their ability to handle problems relating to such concepts and have their self-concept boosted.

In the team-pair-solo, each team are given a problem and team members make sure that every students in their team knows how to solve the question. In the second step, students break into pairs and solve a problem like the one that was solved as a team. The last step, solo, involves the students as individuals working on their own. The various steps make the student to evaluate themselves along the different steps in solving a problem. It therefore, completely eliminates any negative thought about students' perceptions of themselves in relation to what is being learnt. The team-pair-solo approach give students room to ask questions in the bigger group and go further to learn from another individual in pair where the student can ask more personal questions. The highest point of the self-evaluation is when the student tackles the problem alone (solo) and succeed. The students cannot but conclude that they can solve any related problem and such thought increase their self-image and self-worth leading them to esteem themselves high.

Jigsaw like team-pair solo also improved students' self-concept significantly. This is because jigsaw also ensures active role where students teach others as expert. Being experts in a particular aspect of the learning material, students perceive esteem themselves high. Getting to have other students rely on them gives them a feeling of positive attitude towards self, leading to improved self-concept. Jigsaw strategy improves peer cooperation and creates team solidarity among students through division of task, with each student assuming learning responsibility in a group. In Jigsaw strategy, each student in a group is given information to which no one else in the group has access, thus, making each students "expert" on the section of the subject matter. Jigsaw strategy therefore, gives students room to verbalize their understanding especially in teaching other group members as experts.

Reciprocal learning also improved self-concept significantly as the findings of the study revealed. In reciprocal learning, students and teacher take turns in leading the class learning, teaching, dialogue, discussion, demonstration of any learning mode as the case may be. When the student assumes the role of the teacher, it directly affects their self-image and influences their attitude towards themselves. Such positive attitude towards self increases or boost self-concept.

The findings of the study is in line with the findings of other studies on other related psychological concepts such as self-efficacy, attitude and motivation. The findings of the study supports that of Abdullah (2010) that jigsaw teaching significantly enhanced the psychological construct of attitude than the teacher-centred approach. The study also lends credence to the findings of Sengul and Katranci (2014) that jigsaw technique significantly improved the psychological construct of self-efficacy among mathematics students. The finding of the study is line with that of Uroko (2010) that reciprocal tutoring significantly improved the psychological constructs of interest and perceived self-efficacy. The findings of Hairul, Mohammad and Abbas (2012) that reciprocal teaching had a significantly positive effect on the English reading motivation is also in line with the findings of the study since it established that reciprocal teaching improves psychological constructs.

The findings of the study showed that there were significant differences between the mean mathematics self-concept scores of students taught using jigsaw and team-pair solo strategy. There were significant disordinal interaction effects of the teaching methods and gender on the mathematics self-concept of the students in mathematics. The teaching strategies have different effects on mathematic self-concept of students on different conditions, for example, the effect of the teaching strategies on mathematic self-concept changed when gender was consideration. The methods were therefore, sensitive to gender. In grouping students, certain approach favoured more of the male and at other times the female. In the jigsaw group, females developed better self-concepts than the males while the male improved more than the females in their self-concepts when team-pair-solo and reciprocal teaching was used. These disparity and sensitivity to gender of the teaching methods is as a result of the nature of the group activities and the roles assigned to group members.

V. CONCLUSION

The study established that jigsaw, team-pair-solo and reciprocal teaching strategies significantly improved mathematics self-concept more than conventional method. It is concluded therefore, that students' mathematics self-concept could be improved through the use of these cooperative teaching strategies. However, team-pair-solo strategy is more suitable when the focus is improving students' mathematics self-concept.

VI. RECOMMENDATIONS

The following recommendations were made based on the findings:

- ✓ Mathematics teachers in secondary schools should adopt the use of these three cooperative teaching strategies to improve self-concepts of students in mathematics.
- ✓ Seminars, conferences and workshops should be organized for mathematics teachers by the government to familiarize them with different strategies of collaborative learning such as jigsaw and team-pair-solo.

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