Effect Of Think-Solve-Group-Share On Confidence And Performance In Linear Algebra Among Mathematics Students Of Colleges Of Education In Katsina State, Nigeria

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Abstract
This study investigated the Effect of Think-Solve-Group-Share (TSGS) on Confidence and Academic Performance in Linear Algebra among Mathematics Students of Colleges of Education in Katsina State. The population of the study was all 300 level NCE Mathematics students totaling 120, out of which a sample of 80 students was used for the study. The sub-groups were assigned to experimental group (N = 30) and comparison group (N = 50) randomly. Quasi-experimental design involving pretest posttest measure was used in the study. Two (2) instruments were used to collect data. They are System of Linear Equation Performance Test (SLEPT) and Linear Algebra Confidence Scale (LACS). The study has four (4) research questions and four (4) related hypotheses. The data collected were analyzed using descriptive statistics of mean and standard deviation and inferential statistics of ANCOVA and Mann-Whitney U-test, using SPSS (23 version) . Results indicated that TSGS improved students' confidence and enhanced their performance in linear algebra. Furthermore, the results revealed that both males and females produced similar performance and have similar improvement in confidence. The study recommended the use of TSGS strategy in mathematics instruction.
Keywords: Think-Solve-Group-Share, Confidence, Performance, Linear Algebra

I. Introduction:

Linear Algebra is a branch of mathematics that constitutes a study on vector spaces, basis and dimension, linear transformation, matrix algebra, diagonalization, system of linear equations etc. It is a Mathematics course that is studied at tertiary levels of education. Studies of Ferryansyah and Rahayu (2018) and Rensaa, Hogstad and Monagham (2020), observed that Linear Algebra is one of the difficult courses for students. Students are finding it difficult because they are; memorizing the concept without actually understanding it, failing in abstract thinking though the topics require abstract thinking, poor notion of definitions, inability to interpret verbal expressions and inability in the readiness level.

Method of instruction used, especially in tertiary institutions, in teaching Mathematics remains extremely teacher-centred with greater emphasis on lecture method and the use of textbook than engaging students in critical thinking across subject area and applying the knowledge acquired to real-world situations (Mpho, 2018). Umar as cited in Kajuru and Hassan (2022) buttressed that the persistent poor performance is directly linked to over use of lecture method. In this regard, it was observed that there is need for reforms in the way science, technology and mathematics subjects are being taught in Nigeria. This is in order to cultivate inquiry and rational mind for the conduct of a good life, democracy and also to produce scientists for national development as highlighted in the National Policy on Education (NPE) (Federal Republic of Nigeria, 2016). Hence the use of learner-centered strategy in teaching should be emphasized. Such strategy includes Think-Solve-Group-Share which is cooperative in nature.

Think-Solve-Group-Share (TSGS) is a variation of Think-Pair-Share (TPS) which is a strategy built upon three stages developed by Professor Frank Lyman and his colleagues at the University of Maryland in 1981 (Hassan, 2023). The TSGS has four stages;
(i) Think Phase,
(ii) Solve Phase,
(iii) Group Phase and
(iv) Share Phase.

The teacher posed a task to the students and time will be given for the students to read the question and think of appropriate algorithm to apply, then another time will be given for each student to solve the task

individually, then students will be allowed to discuss their solution in a group of three (3) to five (5) and finally, volunteer from a group will be allowed to present (share) their solution to the entire class. Constructive criticism will be allowed while the teacher acts as a moderator. This strategy will go a long way in developing students' mathematical communication. Similarly, it is expected to build confidence in students as it encourages them to be responsible for their learning. This prompted the researcher to investigate its effect on confidence and performance in linear algebra among NCE Mathematics students in Katsina state, Nigeria.

The effectiveness of TPS and TSGS on performance was established by many studies such as Haakachima and Lunjebe (2019), Akanmu (2019), Musa and Hassan (2022), Hassan (2023) among others. The current study was different from the aforesaid because TSGS as a variation of TPS has four stages. Though Musa and Hassan (2022) and Hassan (2023) used TSGS but their studies were conducted using secondary school students while this study used tertiary institutions' students.

Self-Confidence is a key factor in good performance in mathematics because it aids concentration, influence goals and enhance effort. Studies: Khun-Inkeeree, Omar-Fauzee and Othman (2017), Flanagan and Einarson (2017), Hannula, Maijala and Pehkonen (nd) and Çiftci and Yildiz (2019) all established that confidence has positive effect on performance in mathematics. Hence investigation on what improve students' self-confidence is of paramount importance. Thus, this study investigated whether TSGS improve students' confidence in linear algebra.

Statement of Problem

Linear Algebra is observed to be one of the difficult courses for the students. Some scholars assert that students are finding Linear Algebra difficult because they are; memorizing the concept without actually understanding it, failing in abstract thinking although the topics require abstract thinking, poor conception of definitions, inability to interpret verbal expressions and inability in the readiness level. Studies on linear algebra were more on identifying its difficult concepts and the reasons why students find such concepts difficult. This prompted the researcher to investigate the effect of a learner-centered strategy (Think-Solve-Group-Share) on students' self-confidence and performance in learning a concept in linear algebra (System of Linear Equation) due to its wide application in the course. Hence, this study is solution-oriented.

Objectives of the Study

The main objective of the study was to investigate the Effect of Think-Solve-Group-Share (TSGS) on Confidence and Performance in Linear Algebra among NCE Mathematics Students in public tertiary institutions in Katsina State. Specifically, the objectives of the study are to determine the students':

1. Performance in Linear Algebra when taught using TSGS learning strategy among NCE Mathematics Students in Katsina State.
2. Confidence level in learning Linear Algebra when taught using TSGS learning strategy among NCE Mathematics Students in Katsina State.
3. Performance, according to gender, in Linear Algebra when taught using TSGS learning strategy among NCE Mathematics Students in Katsina State.
4. Confidence level, according to gender, in learning Linear Algebra when taught using TSGS learning strategy among NCE Mathematics Students in Katsina State.

Research Questions

The study sought the answers to the following questions:

1. To what extent do mean scores in performance of students taught system of linear equations using TSGS differ from those taught same content using lecture method?
2. What is the difference in mean ranks confidence between students taught system of linear equations using TSGS and those same content using lecture methods?
3. Is there any difference in mean performance scores between males and females students taught system of linear equations using TSGS?
4. What is the difference in mean ranks confidence between males and females students taught system of linear equations using TSGS?

Research Hypotheses:

The following null hypotheses were formulated and tested at 0.05 significance level

HO$_1$: There is no significant difference in the mean scores in performance of students taught system of linear equations using TSGS and those taught same content using lecture method.

HO$_2$: There is no significant difference in the mean ranks confidence of students taught system of linear equations using TSGS and those taught same content using lecture method.

HO₃: There is no significant difference in the mean performance scores between males and females students taught system of linear equations using TSGS.

HO₄: There is no significant difference in the mean ranks confidence between males and females students taught system of linear equations using TSGS.

II. Methodology:

The study used quasi-experimental design involving pretest and posttest measures. The population of the study constitutes all 300 level NCE Mathematics students in the four (4) public tertiary institutions, in Katsina state, undergoing NCE Mathematics program totaling 120 students. The institutions are; Isa Kaita College of Education, Dutsinma, Federal College of Education, Katsina, Hassan Usman Katsina Polytechnic, Katsina and Yusuf Bala Usman College of Legal and General Studies, Daura. Isa Kaita College of Education, Dutsinma and Yusuf Bala Usman College of Legal and General Studies, Daura were used for the study. The sample for the study was 80 NCE 300 Level students drawn from the two (2) colleges randomly selected. The sampled colleges were assigned to experimental group (EG) and comparison group (CG) randomly, thus, coming up with EG (N = 30) and CG (N = 50).

The instruments used, for data collection, were System of Linear Equation Performance Test (SLEPT) which is a 15 items performance test based on NCE minimum standard and Linear Algebra Confidence Scale (LACS) which is a 15 items questionnaire adapted from Fogarty, Cretchley, Harman, Ellerton and Konki (2018) and Hendy, Schorschinsky and Wade (2014). The SLEPT was validated by two (2) experts in Mathematics Education and the LACS was also, validated by two (2) experts in Educational Psychology. The reliability coefficient of SLEPT obtained by test retest method was 0.87 and that of LACS obtained by split half method was 0.70. These values were considered high enough for the study.

The two (2) instruments were administered as a pretest. This was followed by the treatment for six (6) weeks; 2 hours weekly. The experimental group was taught system of linear equation using TSGS as shown in figure 1 while the comparison group was taught same content using lecture method. After the treatment, the same instruments were administered as posttest. Results obtained were used as data for the study. The data was analyzed using ANCOVA and Mann-Whitney U test, using SPSS (23 version), based on the formulated hypotheses. The idea of using system of linear equation in the treatment was born due to its wider application in the content of linear algebra concepts.
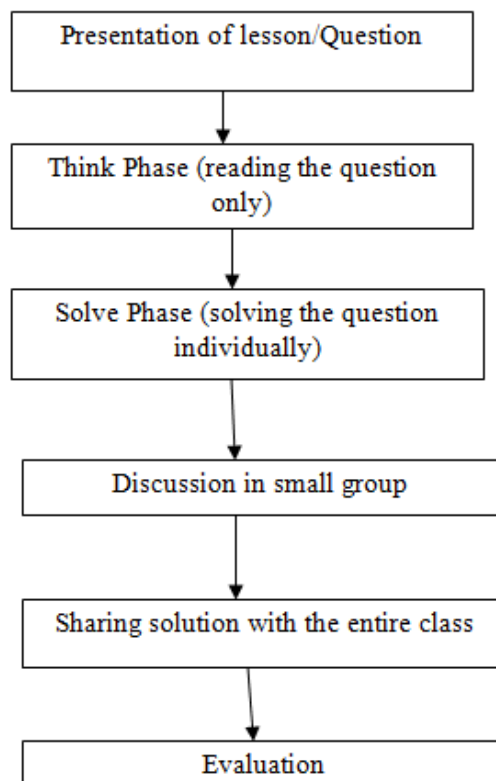

Figure 1: Flow Chart for TSGS
Source: Musa and Hassan (2022)

III. Results:

Research Question One: To what extent do mean scores in performance of students taught system of linear equations using TSGS differ from those taught same content using lecture method? Summary of scores analyzed between the EG and CG were presented in Table 1.

Table 1: Mean and Standard Deviation of Performance Scores between EG and CG

Group	N	Mean	SD	Mean Diff.
EG	30	9.90	2.139	
CG	50	6.46	2.375	3.44
Total	**80**			

Table 1 showed that the mean scores of the EG and CG were 9.90 and 6.46 respectively with a mean difference of 3.44. This implied that treatment enhance performance of students in EG. Significance of the mean difference was tested in hypothesis one.

Null Hypothesis One (HO₁): There is no significant difference in the mean performance scores of students taught system of linear equations using TSGS and those taught same content using lecture method. HO₁ was tested using Analysis of Covariance (ANCOVA). Summary of the result was presented in Table 2.

Table 2: ANCOVA Result on Performance between EG and CG

Variables	SS	Df	MS	F	P-value	Remark
Between Groups	319.387	1	319.387			
Within Groups	58.430	77	0.759	420.897*	0.001	Sig.
Total	**377.817**					

*Significant at $p \leq 0.05$

Table 2 Results indicated that there exist significant difference between EG and CG since the p-value observed = 0.001 is less than the alpha value of 0.05. This means that there was statistically significant difference between students taught system of linear equation using TSGS (EG) and those taught same content using lecture method (CG). However, the result did not reveal where the difference lied. To determine that, a pairwise multiple comparison was conducted and the result was presented in Table 3.

Table 3: Post Hoc Pairwise Comparison of Performance between EG and CG

Group (i)	Group (j)	MD	Std. Error	P-value	Remark
EG	CG	4.071*	0.228	0.001	Sig.
CG	EG	-4.071	0.228		

*Significant at 0.05 level of significance

Table 3 revealed that significant difference exists between EG and CG since the calculated p=0.001<0.05 level of significance with a mean difference of 4.071 in favour of EG. This implied that TSGS was more effective than Lecture when used to teach system of linear equation, hence will improve performance in Linear Algebra.

Research Question Two (HO₂): What is the difference in mean ranks confidence of students taught system of linear equations using TSGS and those taught same content using lecture method? Data collected were described using mean ranks and sum of mean ranks. The summary of the description was presented in Table 4.

Table 4: Mean Ranks of Confidence between EG and CG

Group	N	MR	Sum of MR	MR Diff
EG	30	61.42	1842.50	
CG	50	27.95	1397.50	33.47
Total	**80**			

Table 4 indicated that there is a difference in the mean ranks between EG (TSGS) and CG (Lecture) with mean rank difference of 33.47. This suggests that the TSGS enhance students' confidence in system of linear equation. Significance of the mean rank was tested in the related hypothesis.

Null Hypothesis Two (HO₂): There is no significant difference in the mean ranks confidence of students taught system of linear equations using TSGS and those taught same content using lecture method. The HO₂ was tested using Mann-Whitney U test. The summary of the result was presented in Table 5.

Table 5: Summary of Mann-Whitney U-Test comparison of Mean Ranks Scores of Confidence for EG and CG.

Group	N	MR	SMR	MRD	U	P-Value	Remark
EG	30	61.42	1842.50				
CG	50	27.95	1397.50	33.47	-6.241[*]	0.001	Sig.
Total	80						

[*]Significant at 0.05 level of significance

Results in Table 5 showed that there exist statistically significant difference in mean ranks between EG (TSGS) and CG (Lecture) with U-test (Z = -6.241) and mean rank difference of 33.47. Since p-value observed = 0.001 < 0.05 alpha level, the HO_2 was rejected. This means that students taught system of linear equations using TSGS have more improved confidence than those taught same content using lecture method. This implied that TSGS improve students' confidence toward Linear Algebra.

Research Question Three: Is there any difference in mean performance scores between males and females students taught system of linear equations using TSGS? The descriptive statistics in Table 6 presented the mean difference performance scores of the males and females.

Table 6: Mean and Standard Deviation of Males and Females in EG

Gender	N	Mean	SD	Mean Diff
Male	19	9.68	2.262	
Female	11	10.27	1.954	0.59
Total	30			

Table 6 indicated the mean performance scores of males and females in EG as 9.68 and 10.27 respectively with an insignificant mean difference of 0.59. The level of the difference was tested in hypothesis three.

Null Hypothesis Three HO₃: There is no significant difference in the mean scores in performance between males and females students taught system of linear equations using TSGS. The HO_3 was tested using ANCOVA. The summary of the result was presented in Table 7.

Table 7: Summary of ANCOVA Result on Students' Performance in EG based on Gender.

Variables	SS	Df	MS	F	P-value	Remark
Between Group	2.374	1	2.374			
Within Group	28.387	27	1.051	2.258[*]	0.145	Not Sig.
Total	30.761					

[*]Significant at 0.05 alpha value

Results in Table 7 revealed that there was no statistically significant difference in performance between males and females students in EG (TSGS). Since the p-value observed = 0.145 > 0.05 alpha value, the HO_3 is not rejected; meaning students taught system of linear equation using TSGS performed almost the same irrespective of their gender. Hence, TSGS produces similar performance, in Linear Algebra, amongst students; gender not being a barrier.

Research Question Four: What is the difference in mean ranks confidence between males and females students taught system of linear equations using TSGS? Table 8 presented the summary of the mean rank confidence of the students in EG.

Table 8: Summary of Mean Rank Confidence of Students in EG by Gender

Gender	N	MR	SMR	MRD
Males	19	17.74	337.00	
Females	11	11.64	128.00	6.10
Total	30			

Table 8 showed the mean ranks of males and females in the EG as 17.74 and 11.64 respectively with a mean rank difference of 6.10. Since the difference, looking at the value, is from mean rank, it is not enough to say whether it is significant or not. The test of related hypothesis will judge its significance.

Null Hypothesis Four (HO₄): There is no significant difference in the mean ranks confidence of males and females students taught system of linear equations using TSGS. The HO_4 was tested using Mann-Whitney U test. Results were presented in Table 9.

Table 9: Summary of Mann-Whitney U-Test of Confidence of Students in EG based on Gender.

Gender	N	MR	SMR	MRD	U	P-value	Remark
Males	19	17.74	337.00				
Females	11	11.64	128.00	6.10	-1.840	0.066	Not Sig.

Total	30						

*Significant at 0.05 confidence level

The results in Table 9 revealed that there was no significant difference in Confidence between males and females in the EG with U-test ($Z = -1.840$). Since the p-value observed = 0.066 is greater than 0.05 confidence level, the null hypothesis HO_4 is rejected. This means that students taught system of linear equation using TSGS have similar confidence toward system of linear equation, regardless of their gender. Hence, TSGS aid confidence in Linear Algebra.

IV.   Discussion Of The Results:

This study investigated the efficacy of Think-Solve-Group-Share strategy on confidence and performance in linear algebra. Testing HO_1 revealed that TSGS improved students' performance better than lecture method. This finding agrees with that of Musa and Hassan (2022) and Hassan (2023). Relatively, the finding supports that of Haakachima and Lunjebe (2019), Akanmu (2019) and Rif'i and Lestari (2018) who established the effectiveness of TPS on students' performance. Result of testing HO_3 also confirmed the efficacy of TSGS on performance since it indicated that both male and female students displayed similar performance as a result of receiving treatment using TSGS.

Result of testing HO_2 showed that TSGS have positive effect on students' confidence, which in turn improved performance in learning linear algebra better than lecture method. This is in line with the findings of Hannula, Maijala and Pehkonen (nd), Khun-Inkeeree, Omar-Fauzee and Othman (2017) and Çiftci and Yildiz (2019) who established that confidence improve students' achievement in mathematics. The finding also support that of Flanagan and Einarson (2017) who found that Math-Confidence improved performance in undergraduate Biology. Conversely, the finding of Kunhertanti and Santosa (2018) contradicts the aforementioned studies by finding that there is no significant relationship between students' self-confidence and students' achievement.

V.   Conclusion:

Mathematics instruction is dominated by lecture method which contributed in making the subject more abstract than its nature of abstraction. Hence, learners find it very difficult to comprehend. This study investigated whether a learner friendly strategy, TSGS, can boost students' confidence and improve their performance in linear algebra. Results established that TSGS improved students' confidence positively and enhance their performance in linear algebra. Unlike lecture method, TSGS gives maximum opportunity for students to participate during instruction. The students showed their enthusiasm, especially, during Group and Share phases. This will definitely change our students' mindset that mathematics is for special people.

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