

Efficacy of Differentiated Based Learning (DBL) and Scaffolding Based Learning (SBL) Instructional Approaches on Senior Secondary School Students' Task Persistence in Mensuration

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Abstract

This study investigated the efficacy of differentiated based learning (DBL) and scaffolding based learning (SBL) instructional approaches on senior secondary school students' task persistence in mensuration in Obollo-Afor Education Zone of Enugu State. Three research questions and three hypotheses guided the study. The study employed quasi-experimental design. Two thousand seven hundred and forty eight (2,748) students were used for the study. Mensuration Task Persistence Rating Scale (MTPRS) was the instrument used for the study and it was validated and trial tested. Mean, standard deviation and Analysis of Covariance (ANCOVA) were used in analyzing the data. The results revealed that both instructional approaches improved students' task persistence in mensuration. The interaction effect of gender and instructional approaches on mean task persistence scores of students was not statistically significant. It was recommended among others that Mathematics teachers should use both DBL and SBL instructional approaches while teaching the subject.

Keywords: Differentiated based learning, Gender, Interaction, Mensuration, Scaffolding based learning and Task Persistence

Introduction

The knowledge of Mathematics is needed by everyone in order to be useful members of the society i.e for anyone to be productive in any discipline the knowledge of Mathematics are required. Perhaps, that is why the subject is made compulsory in Nigeria primary and secondary school level (Federal Republic of Nigeria, 2014). The subject Mathematics is regarded as an essential tool for scientific and technological development of any country (Okoye, 2021). Mathematics is the science of numbers, shapes and quantities. In spite of the acknowledged importance of Mathematics in national development, and the tremendous efforts being made by educationists and other Mathematics stake holders to improve the teaching and learning of the subject in secondary schools in Nigeria, students' task persistence ability in Mathematics is still low (Ndukwu, 2017). Iji, Abakpa and Takor, 2013 opined that teachers should be charged with the responsibility of improving the ability of the students' confidence to learn, skills needed while answering questions in examination for better achievement. Mensuration is the branch of Mathematics that students' do not perform well in (WAEC Chief Examiners Report, 2018 - 2021). Mensuration is the branch of Mathematics that deals with measurement of area, length, or volume in 2-Dimensional and 3-Dimensional shapes. The concept related to this topic

is used in every home and society knowingly or unknowingly by everyone (Janak, 2020).

Mensuration is a very important topic in Mathematics especially when it comes to the geometry of the universe. For instance, everything that concerns man namely; his clothing, his shelter, etc must be measured in relation to the man's size. Even the money he receives in his daily transaction is in respect to what his activities is up to. When a man earns salary or wage for work done, he measures the rate of expenditure of the money in respect to when the next salary will come. Thus, the application of mensuration to real life is needed by everyone.

Despite the importance of mensuration to real life, students do not do well in it. Thus, it had been suggested that the strategies used by Mathematics teacher in the classroom is the cause of these failures (Yakubu & Bolaji, 2019). In view of that, the researchers decided to see if the usage of two innovative approaches could avert the poor task persistence scores of students. Two teaching approaches whose efficacies are needed to be determined in students' task persistence in mensuration are Differentiated Based Learning (DBL) and Scaffolding Based Learning (SBL) instructional approaches.

Differentiated based learning (DBL) is a structural learning that transforms teaching from

teachers concentrating on the entire class to paying attention to individual problems arising from students. The techniques of differentiated based instruction namely: the content, the process, the product and the learning environment requires the Mathematics teacher to be flexible in their approach to teaching Mathematics and adjust the curriculum and presentation of the information to the learners rather than expecting students to modify themselves for the curriculum (Tomlinson, 2015). Differentiated based instruction means the approach to teaching and learning that gives students multiple options for taking in information and making sense of ideas in classroom setting. As a teaching approach, this is based on the premises that instructional approach should vary and be adapted in the relation to individual and diverse nature of students in the classroom (Muthomi & Mbugua, 2014). Some studies have worked on differentiated instructions using different techniques and found that it was effective in different areas. Researchers such as (Anakpa, Nzeakor & Emefo, 2021; Ukwueze, Ugwuanyi & Ogbu, 2022) worked on effectiveness of differentiated instruction on students' achievement in geometry and quadratic equation respectively and found that the usage of the approach was effective in their respective areas. None of the above researchers was on mensuration and with task persistence variable like the present study was doing. The second approach is scaffolding based learning.

Scaffold is a term used to describe certain kinds of support which learners receive in their interaction with parents, teachers, and other mentors as they move to new skills, concepts or levels of understanding. For this study, offering explanations, worked examples and inviting students' participation techniques were used. Scaffolding based learning (SBL) approach as would be used in this study means supporting the learners in reaching the highest level of understanding and gaining the skills needed in accomplishing a Mathematical task. The approach consists of teaching new skills by engaging learners collaboratively in tasks that would be too difficult for them to complete on their own. Many research findings (Ibeneme & Nzewi, 2011; Olatunbosum & Monica, 2013; Casem & Oliva, 2013; Ihechukwu, 2020) have all tried usage of scaffolding instructional strategies and revealed that it was effective in improving students' achievement in their respective subjects. None of the researchers worked on students' task persistence in mensuration as the present study is doing.

Task persistence is an individual's capability to exhibit resilience and spontaneity in the face of troubles, obstacles and difficulties so as to achieve

success. In respect to teaching and learning of Mathematics students should feel okay and on a normal solving Mathematics problem, that is students' tendency in solving or practicing Mathematics exercises without being forced. According to Ndukwu (2017), task persistence means standing with a task despite its difficulty level. The task persistent skill of the learners depends on the approach that the Mathematics instructor uses in the classroom while teaching the subject. Mathematics teachers should emphasize on the need for students to persist in their given undertaken in order to progress both academically and in life endeavors. The relationship between persistence and academic achievement have been repeatedly documented as positive correlates (Boe, May, & Boruch, 2012; McClelland, Acock, Piccinin, Rhea, & Stallings, 2012; Deater-Deckard, Petrill, Thompson, & DeThorne, 2015). None of these reports were done in Nigeria and also, in mensuration. Hence, there is need to investigate other teaching approaches to see if it could boost students' task persistence which in turn boost the achievement in mensuration.

Students' reaction when introduced to different instructional approaches with a Mathematical task may vary from individual to individual depending on the students' gender which may also indicate how they may persist in Mathematics tasks and their extent of achievement in the subject. Gender refers to the social roles, behaviours, activities and attributes that a given society considers appropriate for men and women (World Health Organization, 2012). Based on various reports on gender differences in Mathematics task persistence, the inconclusive scholarly reports, the use of DBL and SBL instructional approaches could possess a high tendency of bridging the gap between male and female students' task persistence ability in Mathematics.

This study therefore, sought to investigate among SSI students' the extent to which teaching and learning of mensuration with DBL and SBL instructional approaches would improve students' task persistence in mensuration.

Research Questions

The study was guided by the following research questions:

1. What are the mean task persistence scores of students taught mensuration using differentiated based learning (DBL) approach and those taught using scaffolding based learning (SBL) instructional approach?
2. What is the influence of gender on the mean task persistence scores of students in mensuration?

3. What is the interaction effect of instructional approach and gender on the mean task persistence scores of students in mensuration?

Hypotheses

The following null hypotheses guided the study and were tested at 0.05, level of significance.

H₀₁: There is no significant difference in the mean task persistence scores of students taught mensuration using differentiated based learning (DBL) approach and those taught with scaffolding based learning (SBL) instructional approach.

H₀₂: There is no significant influence of gender on the mean task persistence scores of students in mensuration.

H₀₃: There is no significant interaction effect of instructional approach and gender on the mean task persistence scores of students in mensuration.

Methods

The study was carried out using a quasi-experimental, specifically the non-equivalent groups design. The choice of this design was because the participants were not randomly assigned to experimental groups by the researcher (Ezeh, 2015). The population of the study comprised of two thousand seven hundred and forty eight (2,748) students (males=1,158; females=1,590) found in Senior Secondary School Student (SSSI) class of 2022/2023 academic session. The sample size for this study consisted of one hundred and forty two (142) Senior Secondary School Student one (SSS1) students found in four intact classes in four schools. Multistage sampling procedure was employed in the study. In the first stage, schools in the zone were stratified based on the local government. In the second stage, proportionate stratified random sampling was used to sample two schools from Igbo-Eze North, one school each from Udenu and Igbo-Eze South LGAs. In the third stage, simple random sampling by balloting without replacement was used to draw one intact class from each of the school sampled. Simple random sampling by balloting was

used to assign four classes to treatments groups; two classes to DBL and two classes to SBL (DBL group=70: Males=32, Females=38, SBL group=72, Males =34, Females=38).

The researchers developed a 20-item Mensuration Task Persistence Rating Scale (MTPRS) which was used for the study. The instrument contains two sections: Section A for demographic information and Section B for the item statements. It contains four point response scale of Always (A) = 4, Sometimes (ST) = 3, Rarely (R) = 2, and Never (N) = 1, for the positively cued items. The negatively cued items were scored in a reverse order as follows: A = 1. ST = 2, R = 3, and N = 4. The total score of the instrument was 80 and the least score was 20.

The researchers developed two sets of lesson plan for this study. One set was used in teaching students in DBL group while the other one was used in teaching students in SBL group. Each set was written based on the following sub-topics in mensuration thus: week one; Length of an arc and perimeter of a sector of a circle, week two; Area of sector and segment of a circle, week three; Surface area and volume of common solid/compound shapes

The MTPRS and the lesson plans were validated by three experts, one from Measurement and Evaluation Unit, one from Mathematics Education Unit and one from Educational Foundation Unit. The reliability of the MTPRS was estimated by subjecting them to trial testing using 30 SS1 students. The reliability coefficient index of 0.899 was determined using Cronbach's Alpha. The researcher trained four research assistants for this study who were their regular Mathematics teachers from the four sampled schools. The training lasted for three days using two validated lesson plans and the instructional guides developed for the study.

Data generated for the study were analyzed using SPSS version 20 in carrying out both descriptive and inferential statistics. The research questions were answered using the mean and standard deviation while Analysis of Covariance (ANCOVA) was employed in testing the null hypotheses at 0.05 significant levels

Results

Table 1: Pre-task and post-task mean scores and standard deviations of students exposed to (DBL) and (SBL) approaches in mensuration.

Treatment	N	Pre-task		Post-task		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
DBL: Approach	70	42.24	8.70	65.17	5.47	22.93
SBL: Approach	72	49.81	6.90	66.99	3.31	17.18



Table 1 data showed that the students who were taught mensuration using DBL (experimental group 1) instructional approach had a pre-task persistence mean score of 42.24 with a standard deviation of 8.70 and a post-task persistence mean score of 65.17 with a standard deviation of 5.47. Similarly, the students who were taught mensuration

using SBL (experimental group 2) instructional approach had a pre-task persistence mean score of 49.81 with a standard deviation of 6.90 and a post-task persistence mean score of 66.99 with a standard deviation of 3.31. The mean gain score of 23.93 and 17.18 respectively were got for DBL and SBL groups.

Table 2: Analysis of Covariance (ANCOVA) of the effect of DBL and SBL instructional approaches on students' task persistence scores in mensuration

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	425.558a	4	106.389	5.751	.000	.144
Intercept	13327.262	1	13327.262	720.463	.000	.840
Pretask	241.815	1	241.815	13.072	.000	.087
Treatment	11.306	1	11.306	.611	.436	.004
Gender	21.059	1	21.059	1.138	.288	.008
Treatment * Gender	40.275	1	40.275	2.177	.142	.016
Error	2534.252	137	18.498			
Total	623229.000	142				
Corrected Total	2959.810	141				

a. R Squared = .144 (Adjusted R Squared = .119)

Table 2 data showed the analysis of data with the calculated value of $F(1,137) = .611$, with associated probability value of .436 ($p > .05$), with a very small effect size (partial eta squared = .004) was obtained with regard to treatment as main effect on the task persistence mean scores of students who were exposed to DBL and those exposed to SBL. Since the

associated probability (.436) was greater than .05 level of significance, the null hypothesis was not rejected meaning that there is no significant difference in the mean task persistence scores of students taught mensuration using DBL approach and those taught using SBL approach.

Table 3: Mean and standard deviation of pre-task and post-task scores of students exposed to (DBL) and those exposed to (SBL) approaches in mensuration as a result of gender.

Gender	N	Pre-task		Post-task		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
Male	66	46.56	8.94	65.77	4.82	19.21
Female	76	45.66	8.49	66.09	4.58	20.43

Table 3 data showed the difference in the mean task persistence scores of male and female students in mensuration. The analysis showed that male students had a pre-task persistence mean score of 46.56 with standard deviation of 8.94 and a post-task persistence mean score of 65.77 with standard deviation of 4.82 while their female counterparts had pre-task persistence score of 45.66, with standard deviation of 8.49 and post-task persistence score of 66.09 with the standard deviation of 4.58 respectively. The mean gain score of 19.21 and 20.43 were got for male and female students respectively. This indicated that female students had a higher mean

gain score than their male counterpart in mensuration. The standard deviations of 4.82 and 4.58 for male and female students respectively, indicating a similar variation in their individual scores from their group means.

Table 2 data above revealed the calculated value of $F(1, 137) = 1.138$ with associated probability value of .288 ($p > .05$) with a very small effect size (partial eta squared = .008) for the influence of gender on students' task persistence score in mensuration. Since the associated probability (.288) was greater than, 0.05 level of significance, the null

hypothesis was not rejected. Thus, there is no significant influence of gender on the mean task persistence scores of students in mensuration.

Table 4: Mean and Standard deviation interaction effect of (DBL) and (SBL) approaches and gender on mean score task persistence students in mensuration.

Treatment	Gender	N	Pre-task		Post-task		Mean Gain
			\bar{x}	SD	\bar{x}	SD	
DBL: Approach	Male	32	42.19	9.17	64.47	7.07	22.28
	Female	38	42.32	8.85	66.03	6.31	23.71
SBL: Approach	Male	34	50.71	5.95	67.00	4.33	16.29
	Female	38	49.00	7.81	66.97	5.56	17.97

Table 4 data revealed the interaction effect of instructional approach and gender on task persistence scores of students in mensuration. The result showed that the male students exposed to DBL had a pre-task persistence mean score of 42.19 with a standard deviation of 9.17 and a post-task persistence mean score of 64.47 with a standard deviation of 7.07 while the male students who were exposed to SBL instructional approach had a pre-task persistence mean score of 50.71 with a standard deviation of 5.95 and a post-task persistence mean score of 67.00 with a standard deviation of 4.33. Female students who were exposed to DBL had a pre-task persistence mean score of 42.32 with a standard deviation of 8.85 and a post-task persistence mean score of 66.03 with a standard deviation of 6.31, while the female students who were exposed to SBL instructional approach had a pre-task persistence mean score of 49.00 with a standard deviation of 7.81 and a post-task persistence mean score of 66.97 with a standard deviation of 5.56. The mean gain scores of 22.28, 23.71 and 16.29, 17.97 were respectively got for male and female students in DBL and SBL groups.

Data on Table 2 above showed that the calculated value of $F(1, 137) = 2.177$ for the interaction effect of approach and gender on students' task persistence in mensuration had an associated probability value of .142 ($p > .05$) with a small effect size (partial eta squared = .016). Since the associated probability (.142) was greater than .05, level of significance, the null hypothesis was not rejected implying that there was no significant interaction effect of instructional approach and gender on students' task persistence in mensuration.

Discussion

The result of the study revealed that students exposed to SBL instructional approach using offering

explanation, worked examples and inviting students participation techniques had a slightly higher post-task persistence mean score in mensuration than those exposed to DBL instructional approach using sub-content and process way differentiating techniques. However, it was further found that there was no significant difference in the mean task persistence score of students taught mensuration with DBL instructional approach and those taught with SBL instructional approach as both improved students task persistence score in mensuration considerably. Adapting the sub-content and process way in DBL instructional approach, students have demonstrated being focused and persisting in their learning of mensuration. Also, by gradually removing the support, in SBL instructional approach, students have demonstrated being encouraged, motivated and persisting in their efforts, thus developing deeper understanding of mensuration concept. The techniques employed in this study were found to be great in enhancing the task persistence scores of students, thus this was because of the fact that students like working in group and independently as they learn mensuration.

This result is in agreement with the earlier research findings of Onyishi (2017), who reported that differentiated instructional approach improved students task persistence in Mathematics. Onyishi, Onah, Liziana and Eze (2015) who reported that strategic content learning teaching strategy improved the task persistence of students with learning disability as well as students without learning disabilities in general education settings over their counterparts in the control group. The findings also provided support to Gagne (1977) who proposed that all learning was not alike and that learning tasks can be organized in a hierarchy according to complexity.

The findings of the study revealed that male and female students who SBL had slightly higher mensuration task-persistence mean scores than male and female students exposed to DBL. However, the slight difference was not statistically significant as indicated in the analysis of covariance (ANCOVA) for gender as main effect in table 2. Implying that, gender was not a significant factor in students' task-persistence in mensuration. This could be the fact that both male and female students had equal opportunity in learning mensuration using both approaches.

However, the finding of this study debunked the finding of Torgrimson, Tan and Grammer (2021) who revealed that girls were found to be more likely to demonstrate high task persistence than boys. Also, the finding contradicted the earlier research findings of Brody, Scheiner, Ari, Tzadok, Aalsvoort, Van der and Lepola (2020) who reported that girls between the ages of 4-8 often outperform boys in behavioral regulation, and have high ratings of task orientation.

The findings of the study revealed that there was no significant interaction effect of instructional approaches and gender on students' task-persistence score in mensuration. This implies that the improvement in the mensuration task-persistence score of students was caused by the intervention using instructional approaches and not any other factors. The approaches improve students' task persistence irrespective of gender. The findings give credence to Ndukwu (2017) and Eze (2013) who revealed no significant interaction effect between gender and instructional approach on task persistence in Mathematics learning.

Conclusion

On the basis of the findings of the study, the following conclusions have been drawn.

Both approaches improved students' task persistence in mensuration in a similar way, though the group exposed SBL had higher Task persistence score than their counter part in DBL group.

Gender had no significant influence on the students' task-persistence in mensuration when taught using DBL and SBL approaches. There was no significant interaction effect of instructional approach and gender on students' task-persistence in mensuration. It was concluded that these instructional approaches were effective in bridging the gender difference in students' task-persistence in mensuration of senior school students one of Obollo-Afor Education Zone of Enugu State.

Recommendations

Based on the findings of this study, the researcher made the following recommendations:

1. Students should embrace both differentiating based learning and scaffolding based learning sinstructional approaches to the learning of Mathematics as this was found to improve students' task persistence in mensuration.
2. Mathematics teachers should embrace and employ the instructional approach such as the use of differentiating techniques of sub-content and process way and scaffolding techniques of offering explanation, worked examples and inviting students' participation in the teaching and learning of Mathematics.
3. Policy makers and other stakeholders in Mathematics education should organize workshops, in-service training, conferences and seminars for Mathematics teachers where the guides on how to use both differentiated based learning and scaffolding based learning techniques in the teaching and learning of Mathematics can be presented.

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