Enhancing Retention in Algebraic Processes among Senior Secondary Students using 7Rs Instructional Strategy

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Abstract
This study investigated the effect of 7Rs instructional strategy on enhancement of retention in algebraic processes among senior secondary school (SSS) students. The study adopted the Randomized Pretest, Posttest, Follow-up (RPPF) experimental control group design. 200 students were randomly selected from a population of 180,500 SSI students during the 2017/18 academic session in Zaria Education Zone, Kaduna State, Nigeria. Two research objectives, questions and hypotheses were formulated to guide the study. The Algebraic Retention Test (ART), with a reliability coefficient of 0.78, was used for data collection. The results show that there was significant difference between the mean retention ability scores of the students exposed to 7Rs instructional strategy in algebraic processes and those taught using the conventional method. However, there was no significant difference between the mean retention ability scores of the male and female students exposed to 7Rs instructional strategy in algebraic processes. Consequently, the researchers recommend that mathematics teachers should engage students on the use of 7Rs instructional strategy when teaching algebraic processes. They may also develop a variant of this strategy when teaching other topics.

Keywords: 7Rs Instructional Strategy, Retention Ability, Algebraic Processes

Introduction

In recent years, there is a paradigm shift in instructional strategies in favour of the constructivist approach. This is particularly prevalent in the teaching of mathematics. Mathematics teachers are continuously being encouraged to adopt new instructional strategies that include the use of manipulatives and small group work which can facilitate development of cognitive thinking skills. This is probably premised on the reasoning that despite the fact that expertise in any subject matter area is necessary, the ability to transfer such knowledge to another person is what makes an excellent teacher stands out. A teacher who has all the facts but cannot communicate them in a way that others can comprehend cannot be adjudged to be an effective teacher. Comprehension, retention of skills and rules as well as recall of information or facts pose challenges to many students (Ellis, 2009) and, mathematics learning is basically about these. Therefore, strategies are needed to aid this important facet of learning. Towards this end, the 7R**s** strategy was conceived and developed by the researchers with the aim of making mathematics reading, recall of facts, retention of skills and rules easier. This strategy, which could be easily used in mathematics lessons, can help students to improve understanding and recall of facts. It was adapted from the PQ4R strategy developed by Thomas and Robinson

in 1972. This strategy employs the active reading process to enable students build their knowledge (Tandililing, 2011). PQ4R is an acronym for Preview, Question, Read, Recite, Reflect and Review. According to Makur (2019), PQ4R can help students to remember the materials they have read and can help the learning process in the classroom with the activities of reading a book of mathematics or other mathematics learning resources. The 7Rs acronym stands for Read, Recite, Reflect, Review, Repeat, Recall and Reach. The researchers are convinced that this strategy can be a practical system for teaching Mathematics. The 7R**s** strategy has seven phases. Each of these phases and how to deploy them for the purpose of teaching is discussed in the ensuing seven paragraphs.

The first R stand for Read: Before the commencement of teaching, the teacher should take a minute or two to introduce the topic. State what the topic is about and what he intends to cover in that lesson. He should then raise some questions that can help him prepare a basic outline of the lesson and present these in a creative manner to make the class more interesting, captivating and allow students to mentally prepare for the class. The questions may serve as an introduction and make the class friendly. Students are then requested to read through the material, bearing in mind the questions which they need to find solutions. This way of active reading followed by a discussion assists the process of learning as the student are now able to form an association between the problem(s) to be solved (i.e. material(s) being read) and the material(s) (i.e. problem(s)) taught. This practice assists students to engage in inquiry based and active learning instead of passively listening to a lecture.

The second R stands for Recite: The teacher should have a class discussion by dividing the class into groups so that each group should have a problem to solve and thereafter make an oral presentation about their solution. The students should be given problems that have to be solved and presented during the lesson so that time coverage will not exceed the entire time slated for the lesson. Thereafter, the teacher is to put the problem or text aside and request the students to try to recall steps used in solving the problem or the material that they have read by answering the questions formulated earlier. Verbal presentation enhances problem-solving, reading ability and further strengthens the learning.

Reflect stands for the third R: In this phase, the teacher is to encourage the students to think back on the material(s) learnt. The teacher must be able to determine whether their questions have been answered and whether they have new queries. To accomplish this, the teacher may prepare small slips that can be filled out by the students. He can ask questions that check how much the students have learned and what they have not understood. This serves as a method to help students realize their own potential of learning. Students are then requested to go over any example used and think about how the material(s) relate(s) to what they already know.

The fourth R is Review: In this phase, the students are made to review the problem(s) or material(s) they learnt at the end of the class with what was presented at the beginning of the class. The teacher must determine whether students have covered the topics presented in the outline and whether all their queries have been answered. This review phase helps students to

recall the various facts they learnt thereby reinforcing their learning. The students are then made to go back and compare their solutions to see if there are any discrepancies that need correction.

Repeat is the fifth R where the teacher is to make the students go back and do it again after solving the problem or reading the comprehension given. The students should be encouraged to be optimistic that the solutions or facts they will present will be correct. Students may tend to think that if they have solved a problem or read some material once, that is enough. It is not. There is a possibility for making a common error that can be avoided.

The sixth R is Recall: This is the evaluation phase where students should be made to bring (facts, events or situations) back into their minds what they have learnt. Similarly, they are to give a description of what they remember or recollect in oral or written form. This is what we called the assessment step. Students should be given problems to solve individually or in group so as to test their short-term or long-term memory.

The final R is Reach: In this phase, the teacher asks deep explanatory questions that will allow the students to extend and transfer the knowledge gained in different areas of life. In asking these questions, teachers should encourage students to think about the answers and provide feedback in their own words. We believe that asking for deep explanations and description promotes elaborative processing and thus enhances long-term retention, transfer of knowledge and application.

When evaluating learning strategies, retention ability is a significant aspect of consideration. Retention can be categorized into two, viz: short-term and long-term. This study is concerned with the short-term, i.e. how a student can recall material immediately or after a very short time in examinations. It requires a student to reproduce correctly what has been previously learned. According to Ado (2014) retention is the ability to retain and later recall information or knowledge after learning. Comprehension, retaining of skills and rules, and recalling information or facts is a challenge to many students (Ellis, 2009). Therefore, strategies are needed to aid this important facet of learning. This forms the basis for the conception and development of the 7Rs instructional strategy. To determine the efficacy of the 7Rs instructional strategy of teaching mathematics, this study investigated its effect in enhancing retention of algebraic processes among senior secondary students.

Statement of the Problem

Comprehension, retaining of skills and rules, and recalling information or facts is a challenge to many students (Ellis, 2009). Therefore, strategies are needed to aid this important facet of learning. In particular, specific strategies are needed for specific areas in order to stimulate students' attitudes, skills, retention ability and performance which seems to decline from the beginning to the middle of the school year for each grade level. Coupled with the low participation of women in mathematics and other science related subjects (Ado, 2014), this problem becomes very worrisome. This problem may be due to some poor instructional strategies used by the teachers. Despite the significance of algebraic processes and their

applications in science and technology, it is difficult to be teach at secondary school level (Ado, 2014). The challenge in teaching algebraic processes is to create experiences that engage students to supports their own learning, understanding, enhance academic performance and knowledge retention, evaluation and application of strategies needed to make them constructive learners. The 7R**s** instructional strategy, whose effect on enhancing retention was investigated in this study, was conceived and developed to address this shortcoming.

Objectives of the Study: To determine whether the retention abilities of the:

1. students exposed to 7Rs instructional strategy in algebraic processes will be more enhanced than those of their counterparts taught algebraic processes using the conventional approach.
2. male students exposed to 7Rs instructional strategy in algebraic processes male will be more enhanced than those of their female counterparts.

Research Questions: Will the retention abilities of the:

1. students exposed to 7Rs instructional strategy in algebraic processes be more enhanced than those of their counterparts taught algebraic processes using the conventional approach?
2. male students exposed to 7Rs instructional strategy in algebraic processes be more enhanced than those of their female counterparts?

Null Hypotheses: The following null hypotheses were formulated and tested at $\alpha = 0.05$ level of significance**:**

Ho$_1$: There is no significant difference between the mean retention ability scores of the students exposed to 7Rs instructional strategy in algebraic processes and that of their counterparts taught algebraic processes using conventional approach.

Ho$_2$: There is no significant difference between the mean retention ability scores of male and female students exposed to 7Rs instructional in algebraic processes.

Methodology

The study adopted Randomized Pretest, Posttest, Follow-up (RPPF) experimental – control group design. The RPPF design is a common longitudinal design in intervention or treatment research (Rausch, Maxwell, & Kelley, 2003) where participants are randomly assigned to treatment and control conditions with only participants in the treatment group receiving the intervention or treatment. Furthermore, all participants are measured before the intervention (pretest), immediately after the intervention (posttest), and at some time following the termination of the intervention (follow-up). In the RPPF design, researchers are usually interested in whether the intervention is effective and whether the treatment effects are sustained or even accentuated over time. This study is interested in the second aspect, i.e. determination of retention ability which bothers on determination of whether treatment effect (in this case, 7Rs instructional strategy) is sustained or even accentuated over time. Hence the adoption of

this design. According to Roberts and Ilardi (2003), the RPPF design is suitable for testing the long-term strength of intervention effects once treatment is completed. In this study therefore, retention ability test which was used to ascertain the retention ability of the students was considered as a follow –up test. 200 Senior Secondary One (SSI) students were randomly sampled from a population of 180,500 (i.e. 100,180 male and 80,320 female) SSI students from different backgrounds, cultures and locations in Zaria Education Zone, Kaduna State admitted during the 2017/18 session. 95% Confidence and 5.0% Margin of Error (Research Advisors, 2006) was employed to arrive at the sample size. The samples were split into two equal groups, viz: experimental and control groups with both groups equally having 50 males and 50 females.

The instrument used for this study was the Algebraic Retention Test (ART), which was made up of 50 multiple choice objective questions chosen from a pool of 75 items constructed in line with a list of learning objectives. The 50 questions were arrived at after item analysis whereby some questions whose discrimination index did not fall between 0.4 and 0.6 were discarded. ART was given to senior lecturers in mathematics education section at Ahmadu Bello University, Zaria who subjected the test items to face and content validities. In addition, a pilot study was conducted to ascertain the effectiveness of the instruments. The test-retest method was used to ascertain its reliability index which was found to be 0.78. The 7Rs instructional strategy (treatment) was employed to teach the experimental group algebraic processes for five weeks while the control group was taught using the conventional approach for the same period of time. In order to determine whether the groups were homogeneous in terms of performance, a pretest was administered to both groups before the commencement of treatment where no significant difference in the performance of both groups in the pretest was found. This implies that both groups were of the same average ability in performance. Hence, the basis for comparison of data collected after treatment is justified. *After the 5weeks treatment, ART was administered to both groups as the posttest. After 2 weeks was ART again was administered as follow–up teat to* both groups. At the end the tests, scripts were collected and marked by the researchers.

Results

Research Question 1: Will the retention abilities of the students exposed to 7Rs instructional strategy in algebraic processes be more enhanced than those of their counterparts taught algebraic processes using the conventional approach?

Table 1: Descriptive statistics of the posttest and retention-ability test scores for experimental and control groups (N = 100)

Test	Group	Mean	SD	Mean Difference
Posttest	Experimental	62.42	15.70	4.08
	Control	58.34	14.88	
Retention - Ability test	Experimental	63.00	14.80	5.12
	Control	57.88	13.20	

Table 1 shows that the mean difference between the retention-ability test scores of the experimental and control group is 5.12 and that this is higher than the mean difference between the posttest scores of the experimental and control group (i.e. 4.08). It could however be seen from Table 1 that the mean retention – ability score of the experimental group is higher than the mean of its posttest score whereas the mean retention – ability score of the control group is lower than the mean of its posttest score. This means that the retention ability of the experimental group has been enhanced whereas that of the control group is not. It follows that the retention abilities of students in exposed to 7Rs instructional strategy in algebraic processes were enhanced while those of their counterparts taught algebraic processes using the conventional approach were not.

Research Question 2: Will the retention abilities of the male students exposed to 7Rs instructional strategy in algebraic processes be more enhanced than those of their female counterparts?

Table 2: Descriptive statistics the posttest and retention-ability test scores of the male and female students in the experimental group (N = 50)

Test	Gender	Mean	SD	Mean Difference
Posttest	Male	62.89	12.81	0.94
	Female	61.95	12.72	
Retention - Ability test	Male	63.53	12.31	1.06
	Female	62.47	12.33	

Table 2 shows that the mean difference between the retention-ability test scores of the male and female students in the experimental group is 1.06. Since this is slightly higher than the mean difference between the posttest scores of the male and female students in the experimental group (i.e. 0.94), it follows that the retention abilities of both male and female were enhanced. However, since Table 2 shows that the mean retention-ability test score of the male students is more than that the female students in the experimental group, it follows that the retention abilities of male students exposed to 7Rs instructional strategy in algebraic processes were more enhanced than those of the female students also exposed to 7Rs instructional strategy in algebraic processes.

Hypotheses Testing

Ho_1: There is no significant difference between the mean retention ability scores of the students exposed to **7Rs** instructional strategy in algebraic processes and that of their counterparts taught algebraic processes using conventional approach.

Table 3: Independent sample t-test analysis of the retention-ability test scores of the experimental and control groups (N = 100)

Group	Mean	SD	df	t_{cal}	t_{tab}
Experimental	63.00	14.80	198	2.58	1.96
Control	57.88	13.20			

Table 3 shows that since $\mathbf{t_{cal}}$ = 2.58 > $\mathbf{t_{tab}}$ = 1.96 for 198 df; then **Ho$_1$** cannot be retained. Therefore, the difference in the mean retention ability of the experimental and control groups is significant.

Ho$_2$: There is no significant difference between the mean retention ability scores of male and female students exposed to **7Rs** instructional in algebraic processes.

Table 4: Independent sample t-test analysis of the retention-ability test scores of the male and female students in the experimental group (N = 50)

Gender	Mean	SD	df	t_{cal}	t_{tab}
Male	63.53	12.31	98	0.43	1.98
Female	62.47	12.33			

Table 4 shows that with a $\mathbf{t_{cal}}$ = 0.43 < $\mathbf{t_{tab}}$ = 1.98 for **df** = 98, the performance of both male and female students in the experimental group is not significantly different. Therefore, **Ho$_2$** cannot be discarded. This means that the difference in the mean retention ability of the male and female students exposed to 7Rs instructional strategy is not significant.

Discussion of Findings

The significant difference between the mean retention ability scores of the students exposed to the **7Rs** instructional strategy in algebraic processes and that of their counterparts taught algebraic processes using the conventional method confirmed the findings of Christina & Ronald **(**2003) and Logsdon (2007), who have shown that students have good knowledge retention ability when constructivist approach is used to teach them. The studies of Qureshi, Azeem, Ejaz, Marvi, Soomro, Hasina & Khan (2017) and Michael & Harvey (1980) also supports this finding where they were able to show that students demonstrated significantly enhanced retention functions for mathematics skills after participating in a learning-in-work environment than those in the traditional learning environment.

The absence of significant difference between the mean retention ability scores of male and female students exposed to 7Rs instructional strategy in algebraic process suggests that the strategy is gender friendly. This finding agrees with that of Ajai & Imoko (2015) who found no significant difference between male and female students' achievement and retention scores in algebra after they were taught using Problem Based Learning method and thereby concluded that male and female students are capable of competing and collaborating in mathematics.

The findings of this study confirm and extend the basis for the adoption of the constructivist paradigm adopted in the studies of Yusuf (2014) and Yusuf, Kajuru & Musa (2014). Yusuf (2014) found significant difference between the Mathematics Anxiety Levels (MAL) of the students exposed to a Computer Mediated Systems Teaching Approach (CMSTA) and their counterparts taught using the conventional. He however found no significant difference between the male and female students taught mathematics using the CMSTA. In the same vein, Yusuf, Kajuru & Musa (2014) found significant difference between the attitude

towards mathematics disposition of the students exposed to CMSTA and their counterparts taught using the conventional and also found no significant difference between the male and female students taught mathematics using the CMSTA.

Conclusion

This study investigated the effect of 7Rs instructional strategy in enhancing senior secondary schools' students' retention ability in algebraic processes. Based on the empirical evidences presented, 7Rs instructional strategy has enhanced the retention ability of students in algebraic processes.

Recommendations

The following recommendations are made:

1. Mathematics teachers should engage students on the use of 7Rs instructional strategy when teaching algebraic processes.
2. Mathematics teachers should be encouraged by their immediate school authorities to develop a variant of this strategy when teaching other topics so as to foster students interest and retention ability in mathematics

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