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The Effectiveness of SimPly Worktext in the Teaching of Simplifying Rational Algebraic Expressions in Mathematics

(Keberkesanan Teks Kerja SimPly dalam Pengajaran Permudahkan Ungkapan Algebra Rasional dalam Matematik)

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ABSTRACT

Teaching mathematics pertains conceptualization, innovation and development of instructional materials that will be useful in the learning process, which will eventually lead to independent or self-reliant learning. This quasi-experimental study have investigated the effectiveness of the SimPly (Simplify-Apply) worktext in the teaching of Simplifying Rational Algebraic Expressions in Mathematics on 80 Grade 8 students. The students have underwent 10 learning sessions, whereby the experimental group was taught using SimPly worktext, and the control group was taught using conventional method. Pre-test and post-test was used as instrument. Findings show that the mean mathematical ability of the experimental group was comparable with the control group, and that in both groups, the mean values of the post-test scores were higher than the pre-test scores. There is a significant difference between the post-test mean scores of experimental and control groups, whereby the control group scored higher than the experimental group, which shows that the conventional method of teaching was more effective than using the SimPly worktext. However, there is no significant differences in the students' schievement according to their mathematical ability. In conclusion, the experimental group fared no better than the control group after following all learning sessions. This implicates that the intervention needs a lot of improvement to be effective in the teaching of mathematics.

Keywords: Worktext; Modular Instruction; Mathematics; quasi-experimental; intervention

ABSTRAK

Pengajaran matematik melibatkan konseptualisasi, inovasi dan pembangunan bahan pengajaran yang berguna dalam proses pembelajaran, yang akhirnya akan membawa kepada pembelajaran kendiri atau berdikari. Kajian kuasi-eksperimen ini mengkaji keberkesanan teks kerja SimPly (Simplify-Apply) dalam pengajaran Permudahkan Ungkapan Algebra Rasional dalam Matematik ke atas 80 orang pelajar Gred 8. Pelajar telah menjalani 10 sesi pembelajaran, di mana kumpulan eksperimen diajar menggunakan teks kerja SimPly, dan kumpulan kawalan diajar menggunakan kaedah konvensional. Ujian pra dan ujian pasca digunakan sebagai instrumen. Dapatan menunjukkan bahawa min keupayaan matematik kumpulan eksperimen adalah setanding dengan kumpulan kawalan, dan dalam kedua-dua kumpulan, nilai min markah ujian pasca adalah lebih tinggi daripada markah ujian pra. Terdapat perbezaan yang signifikan antara skor min ujian pasca kumpulan eksperimen dan kawalan, di mana kumpulan kawalan mendapat markah lebih tinggi daripada kumpulan eksperimen, yang menunjukkan kaedah pengajaran konvensional adalah lebih berkesan daripada menggunakan teks kerja SimPly. Walau bagaimanapun, tidak terdapat perbezaan yang signifikan dalam pencapaian pelajar mengikut kebolehan matematik mereka. Kesimpulannya, kumpulan eksperimen tidak lebih baik daripada kumpulan kawalan selepas mengikuti kesemua sesi pembelajaran. Ini mengimplikasikan bahawa intervensi ini memerlukan banyak penambahbaikan supaya menjadi berkesan dalam pengajaran matematik.

Kata kunci: Teks kerja; Instruksi Modular; Matematik; kuasi eksperimen; intervensi

INTRODUCTION

Teaching is fundamentally a communication between the teacher and the students. In the past, teaching depended entirely on oral communication. Although this kind of communication continues to play an important role in the teaching process, current educational practice acknowledges the value of a growing number of instructional materials as aids to effective teaching and learning. Instructional material in the teaching and learning process is significant throughout the delivery of educational programs.

Hence, with the need of such materials in different fields, the researcher used a new tool: a worktext called SimPly (Simplify-Apply). The worktext is focused on Simplifying Algebraic Expressions among the Grade 8 students in the Philippines. This study sought to evaluate its effectiveness in teaching Simplifying Algebraic Expressions.

Teachers believe that the utilization of instructional worktext could be an effective means in addressing the difficulty, since it enhances knowledge, thinking skills, and problem-solving abilities of the students, as well as incorporating recent advances in disciplinary content (Nicoll 2008; Mariotti & Homan 2012; Tupaz 2021). Correspondingly, the development of instructional materials for interactive learning are useful and beneficial for the improvement of students analyzing skills, where they provide contents which are suitable and effective to cater different learning styles and preferences; moreover, promote cooperative learning as perceived by the teacher experts and students who tried out and used them respectively (Mayas 2007; Tupaz 2021; Melo 2019). The use of workbooks/work texts is also found to be beneficial; resulting in not only higher scores but also an increase in power of self-direction which helps with learning, competency in basic procedures, ability to reason and problem solving (Gray 2007; Tupaz 2021; Mariotti & Homan 2012).

All forms of an individualized instruction materials are effective and economical in developing specific knowledge and skills. One of these forms is the worktext. It induces learning with minimum teacher direction and supervision. Moreover, these materials develop learning and grading strategies, improve classroom management techniques, and encourage achievement for greater use of existing educational resources through establishment of realistic obtainable learning goals within an individualized program of studies (Rillo 2005; Selga 2013; Tan-Espinar & Ballado 2017).

According to Guido (2014), he pointed that individualized instruction material is characterized as self-contained unit of a planned series of learning activities designed to help a student achieve certain well-defined objectives. The learner should continue at this pace of his own and recycle when appropriate. It emphasized analysis and application of concepts and techniques and gives concrete style of concepts. It also provides active participation of students in responding and a wait to meet areas of individual interest and helps the teacher more individualized instruction in school and at home.

In junior high school for example, there are still many students who find difficulty in doing math problems. Many of them argue that there are certain materials in mathematics that are difficult to understand. Algebra is a material that is often used in everyday life. Learning algebra material in school is necessary because it can help students to think critically, systematically, logically, analytically, creatively, and cooperation. It is also because of the algebraic material encountered in everyday life. Because algebra is one section of mathematics, the understanding of the concept of algebra is one of the goals to be achieved in mathematics learning in junior high school. The difficulty of learning mathematics experienced by students also means difficulty in learning the sections in mathematics.

The difficulties experienced by students will allow a mistake when answering test questions. Errors that students do in answering algebraic issues are evidence of the difficulties experienced by students on the material. It confirms that difficulty is the cause of error. From the various efforts that have been done by teachers, learning difficulties is still faced by students. Students often said that they could follow a concept and solution presented by their teacher in class; but were unable to compose solutions by themselves when required to do so for homework, as claimed by Barnard (2010). Inability to deeply investigate mathematical statements causes this difficulty among the students.

Similar with the problems discovered in past literatures, the researcher finds an evident of difficulty in simplifying algebraic expression among Grade 8 students in the Philippines. Hence, there is a need to develop an appropriate instructional material to scaffold the students to better grasp the concept deemed necessary. With the challenges faced in the teaching and learning process in mathematics, the researcher is committed to evaluate and discuss the importance of employing the SimPly (Simplify-Apply) worktext in teaching mathematics. Thus, the researchers used Worktext as an aid to address the difficulty in simplifying algebraic expressions among the Grade 8 students of Cantilan National High School. Specifically, it sought to answer the following questions:

1. What is the mean mathematical ability of the respondents in the control and experimental groups?
2. What is the pre-test and post-test mean scores of the control and experimental groups?
3. Is there a significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups?
4. Is there a significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups according to their mathematical ability?

Below are the hypotheses for this study:

H_{01}: There is no significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups

H_{02}: There is no significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups according to their mathematical ability

WORKTEXT IN THE TEACHING AND LEARNING OF ALGEBRA

The objective of democratic education is the optimum development of the individual. To meet this end, it is imperative that greater attention should be given to the need of individual learners – thus the demand for individual instruction (Lim 2016). According to Telus (2008), work-text is designed to suit the course rather than the course being designed to fit the text as what is usually done in some courses.

Castaniares (2006) even stressed that the advantage of a work-text is that the student is able to insert additional notes or examples into appropriate location with blank spaces intended for this purpose so that notes and text are completely integrated. One technique to individualized instruction is to use modular instruction, where individual differences of students in their capacities to learn are taken into account. Students are encouraged to question, criticize and argue their point of views. The basis for this approach is the fact that every student is unique with his own potentials, abilities, interests, and needs. Thus, no two students can learn the same concepts at the same time at the same rate in the same manner (Lim 2016). In connection, one of the mathematical problems that can be transformed to everyday life is the concept of fraction. Fraction is an essential topic to learn (Gabriel 2012). However, many students have difficulty understanding the concept of fraction. (Nasution et.al 2018).

Many educators emphasize that learners should be able to simplify algebraic fractions with confidence, yet algebraic fraction is one of the most challenging concepts for learners to grasp (Kaplan 2007). It is essential to note also that the knowledge of algebraic fractions helps with simplifying and solving mathematical tasks in topics such as functions, calculus, trigonometry, financial mathematics, and others (Fennell 2007). Essentially, it means good knowledge of algebraic fractions is crucial for success in mathematics education (Brown & Quinn 2006).

Other scholars, on the other hand, stated that even algebra students who are excellent at simplifying a variety of polynomial expressions frequently face a significant challenge when presented with rational expressions, which is the quotient of two polynomials, and concluded the many possible reasons for this. These are the students' misconceptions classified as cancellation, partial division, like-term error, and linearization. However, it is the goal of Mathematics Education to encourage the use of precise and accurate thinking to solve the mathematical problems.

One of the manifold responsibilities of teachers in the field of education is to accommodate different types of learners in their teaching without leaving others behind. But problems like financial constraints, consistent tardiness, physical disability, problems in distance and many others may hinder the vision of teachers in differentiated instruction. In this case, modular instructional materials may be of help (Bedaure 2012).

According to Salandanan (2009), a module is a self-contained, independent unit of instruction prepared for the purpose of attaining specific instructional objectives. It is characteristically self-directing since it includes instructions on how the various investigations will be pursued also included is a listing of materials and other resources that should accompany the text of the module. Classroom instruction using modules is described as self-pacing where the pupils progress through the learning tasks at their own rate.

The best features of self-instructional materials are also described by Navarro (2009). He explained that self-instructional materials may come in the form of modules, self-learning kits, and the like, and are interaction centered rather than content centered. These are written to entice the learner or get the learner interested and involved. Self-instructional materials develop self-esteem of learners and give them confidence boost. Moreover, Simbulan (2011) defined module as a set prepared self-directed instructional materials that can be used by individual learners or by group at their own pace. Generally, modules are on specific topics and are conversational in form, such that there is minimal supervision from the teacher. It is usually a do-it-yourself booklet with the user recording or charting his or her own progress.

THEORETICAL FRAMEWORK

This study is guided by Bruner's Constructivism Learning Theory of Bruner, which is a philosophy that enhances students' logical and conceptual growth. The underlying concept within the constructivism learning theory is the role which experiences or connections with the adjoining atmosphere or play in student education. This theory argues that people produce knowledge and form meaning based upon their experiences. Two of the key concepts within the constructivism learning theory which create the

construction of individual's new knowledge are accommodation and assimilation. In connection, the role of teachers is very important within the constructivism learning theory instead of giving a lecture, the teachers function as facilitators whose role is to aid the student when it comes to their own understanding. This takes away the focus from the teacher and lecture and puts it upon the student and their learning (McLeod 2019).

Furthermore, this study is also anchored by the Kolb's Experiential Learning Theory (ELT) which defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience. The ELT model portrays Concrete Experience (CE) which suggests that learning requires abilities that are opposites, and that the learner must continually choose which set of learning abilities he or she will use in a specific learning situation (Cherry 2020).

Learning theories are diversified in scope but relates closely to contextualized teaching and learning. Another type of learning theory which gives highlight on contextualized teaching and learning is motivation theory. To motivate the students, the teacher should give an interesting problem as the basis of instruction. The reasons that make the child come to school to listen to the teachers and to learn is divided into two main motivational aspects. Extrinsic motivation is when the student follows the school discipline without a direct interest in the disciplines itself – on what is taught – however, they were there to receive, directly or indirectly, certain rewards, especially moral ones. Intrinsic motivation is where the school disciplines – the learning and the knowledge acquisition – interests the student directly. The perceived value of contextualized teaching and learning is that this method can create a commonsense structure with which to focus instruction (Dweck 1986).

All of these theories have been applied in the teaching and learning process in Mathematics. In order to uplift Mathematics achievement, students are required regular practice, hands on experience, and activities that will train and motivate them. This made these theories relevant to this study.

METHODOLOGY

RESEARCH DESIGN

This study utilized the quasi-experimental pre-test and post-test research design to determine the effectiveness of SimPly (Simplify-Apply) Worktext in teaching Simplifying Rational Algebraic Expressions in Mathematics. The participants were divided into two groups: the experimental group were taught using the SimPly worktext, while the control group were taught using conventional method, which is lecture (see Table 1). A total of 10 sessions were conducted for each group, in which two out of the ten sessions (the first and last) were utilized to conduct the pre-test and post-test. Each session lasted around one hour and 20 minutes. The participants involved was briefed of the details of the study and they have consented to participate in the study. Permission to conduct the study has been obtained from the Ministry of Education of Philippines as well as the school in which the study was conducted. All procedures performed in the fulfillment of this study were in accordance with the ethical standards of the university research committee.

TABLE 1. Research design

Group	Pre-test	Treatment	Post-test
Experimental - Using SimPly Worktext	O1	T1	O2
Control - Lecture Method	O1		O2

TABLE 2. Students' mathematical ability based on academic grade

Mathematical Ability	Methods of Teaching		Total no. of Students
	Using a Work text *(Experimental Group)*	Lecture method *(Control Group)*	
Above Average	5	5	10
Average	25	25	50
Below Average	10	10	20
Total	40	40	80

RESEARCH PARTICIPANTS

The participants of this study were a total of 80 Grade 8 students of the Regular K-12 Program of Cantilan National High School, School Year 2019-2020 Province of Surigao del Sur, Philippines. Purposive sampling technique was employed in the selection of the participants. Table 2 shows the distribution of participants according to their mathematical ability and methods of instruction. The level of mathematical ability in the table is indicated by the students' academic grades in Mathematics based on the grading system mandated by the Department of Education of Philippines. Both experimental and control groups have an equal number of distributions in terms of their mathematical ability.

INSTRUMENTATION

The SimPly (Simplify-Apply) Worktext was utilized in this study to determine its effectiveness in teaching Simplifying Rational Algebraic Expressions in Mathematics. The worktext was designed and developed by the researchers and was thoroughly validated by experts in the field of Mathematics, which were the Division Learning Resource Manager of the Department of Education of Philippines, Division Math Supervisor of the Department of Education of Philippines, and Tertiary Mathematics Instructor and Mathematics Coordinator of the High School Department. The tool used for the validation of the worktext was in adherence to the guidelines and standard set by the Department of Education of Philippines. The tool contains evaluation on the criteria such as its Content, Format, Presentation and Organization, and Accuracy and Up-to-datedness of Information. The worktext also contains the following parts: Objectives, Inputs/Discussion on Simplifying Rational Algebraic Expressions, Examples and Exercises with solutions provided.

The pre-test and post-test utilized in the study contain questions about simplifying rational algebraic expressions in which these questions were made and guided by the Table of Specification in the grade school Mathematics syllabus. Also, these tests were validated by experts in the field of mathematics.

DATA ANALYSIS

Descriptive and inferential statistical analysis was used to analyze the data gathered. Mean was used in determining the mathematical ability of the participants in the control and experimental groups. Mean and standard deviation was utilized in determining students' achievement both in the control and experimental groups in the pre-test and post-test. One-way analysis of variance (ANOVA) was used in determining the differences between the pre-test and post-test mean scores to indicate students' achievement following the intervention and without following the intervention. One-way analysis of covariance (ANCOVA) was employed in determining students' achievement both in the control and experimental groups when grouped according to their mathematical ability.

FINDINGS AND DISCUSSION

PARTICIPANTS' MATHEMATICAL ABILITIES

Table 3 presents the participants' mean mathematical ability. Both the experimental and control group has an average level of mathematical abilities: the experimental group's mean mathematical ability is 84.64 and the control group's mean mathematical ability is 85.00. It is asserted that the mean mathematical ability of the experimental group was about the same as the mean mathematical ability of the control group. If the values are rounded to whole numbers, they are of the equal mathematical ability, that is 85. It is worth noting that the experimental group's standard deviation is 4.15, while the control group's deviation is 4.67, as the control group was more distributed than the experimental group.

PARTICIPANTS' PRE-TEST AND POST-TEST MEAN SCORES

Table 4 shows the experimental and control groups' mean pre-test and post-test mean scores. It can be shown that for the pre-test score, the experimental group obtained a mean of 5.089 and standard deviation of 1.917. As for the control group, it obtained a mean of 5.778 and standard deviation of 1.731. For the mean post-test score, the experimental group obtained a mean of 8.044 and standard deviation of 2.078, while the control group obtained a mean of 9.644 and standard deviation of 2.413. It is indicated that in both groups, the mean values of the post-test scores were higher than the mean values of the pre-test scores.

As observed in the table, it is distinct that students in both groups have improved in their achievement in the topic of simplifying rational algebraic expressions, with or without the intervention of SimPly worktext. The study's outcome disagrees with Madriaga's (2014) study on the Effects of Modular Instruction in Teaching Physics which revealed that the performance on the modular instruction-exposed experimental group was better than the traditional method of teaching. The result conforms to the study of Javid (2012), shows that in the lecture method the impact of the learning rate was greater than the problem-based method.

TABLE 3. Mean Mathematical Ability of the Participants

Group	Mean Mathematical Ability	Standard Deviation	Mathematical Ability Level
Experimental	84.64	4.15	Average
Control	85.00	4.67	Average

TABLE 4. Pre-test and Post-test Mean Scores of the Control and Experimental Groups

Group	N	Mathematical Ability	Pre-test		Post-test	
			$\bar{x}$	SD	$\bar{x}$	SD
Experimental	40	Above Average	7.20	1.48	10.80	1.92
		Average	5.30	1.54	8.23	1.63
		Below Average	3.30	1.77	6.10	1.52
		Mean	5.089	1.917	8.044	2.078
Control	40	Above Average	7.60	1.67	12.20	1.48
		Average	5.97	1.38	10.03	1.94
		Below Average	4.30	1.70	7.20	2.15
		Mean	5.778	1.731	9.644	2.413

TABLE 5. Analysis of variance of the pre-test and post-test mean scores

	Group	N	Mean Score	SD	F	P-value	Interpretation
Pre-test	Experimental	40	5.089	1.917	3.20	0.077	Not significant
	Control	40	5.778	1.731			
Post-test	Experimental	40	8.044	2.078	11.36	.001	Significant
	Control	40	9.644	2.413			

TABLE 6. Analysis of differences in the students' achievement according to mathematical ability

Source of Variation	Type III Sum of Squares	df	Mean Square	F-Value	P-value
Covariate	.019	1	.019	.002	.968
Factor A (Mathematical Ability)	320.251	2	160.126	12.943	.000
Factor B (Teaching Strategy)	1378.059	1	1378.059	111.388	.000
AxB	2.426	2	1.213	.098	.907

DIFFERENCES BETWEEN THE PRE-TES AND POST-TEST MEAN SCORES IN EXPERIMENTAL AND CONTROL GROUPS

Table 5 presents the analysis of the differences between the pre-test and post-test mean scores in both groups.

For the pre-test mean scores, it is observed that there is no significant differences between the mean scores of experimental and control groups (F=3.20, p=.077). Therefore, H_{O1} is accepted. This shows that both experimental and control groups have the same level of performance before the teaching of simplifying ratioal algebraic expressions is done, whether using SimPly worktext for the experimental group and using lecture for the control group.

For the post-test mean scores, it is observed that there is a significant difference between the mean scores of experimental and control groups (F=11.36, p=.001). Therefore, H_{O2} is rejected. The finding shown suggests that the students in both groups have acquired more knowledge in simplifying rational algebraic expressions after having completed the learning sessions. The results however indicate that the control group participants had fared way better than the experimental group students. Hence, it can be said that the conventional method is more effective than the SimPly worktext in teaching simplifying rational algebraic expressions.

DIFFERENCES BETWEEN THE PRE-TES AND POST-TEST MEAN SCORES IN EXPERIMENTAL AND CONTROL GROUPS ACCORDING TO STUDENTS' MATHEMATICAL ABILITIES

Table 6 shows the analysis of the differences in the students' achievement according to their mathematical ability as the covariate. It was found that there is no significant differences in the students' schievement according to their mathematical ability (F=.098, p=.907). Hence, this finding shows that the students in different classes have varied level of conceptual

understanding in mathematics subject. This has provided an insight that the benefits of the use of worktext in teaching and learning mathematics might depend on the extent of appreciation by the students towards the material.

CONCLUSION

This quasi-experimental study have investigated the effectiveness of the SimPly worktext in the teaching of Simplifying Rational Algebraic Expressions in Mathematics. The findings show that the mean mathematical ability of the experimental group was comparable with the mean mathematical ability of the control group, and that in both groups, the mean values of the post-test scores were higher than the mean values of the pre-test scores. Findings also show that there is a significant difference between the post-test mean scores of experimental and control groups, whereby the control group scored higher than the experimental group, which shows that the conventional method of teaching was more effective than using the SimPly worktext. However, there is also no significant differences in the students' schievement according to their mathematical ability. In conclusion, the experimental group fared no better than the control group in gaining knowledge on Simplifying Rational Algebraic Expressions topic after following both learning sessions. This implicates that the intervention needs a lot of improvement to be effective in the teaching of mathematics.

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