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The Effects of Software Program "Fractions v2.0"

to Enhance Understanding of Fractions

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Abstract: The purpose of this quasi-experimental research study is to determine the effects of a software program, specifically "Fractions v2.0", when it is used as a supplemental tool to traditional math instruction as compared to using only traditional math instruction in fourth grade classrooms in order to enhance the understanding of fractions deeply and effectively. A total of 115 of fourth grade students participated in the project. The study occurred during a four-week time frame in eight public elementary schools in Abha, Saudi Arabia.

Pre-and post-tests were used for data collection. Findings revealed that use of Fractions v2.0 as a supplement to traditional math instruction would lead to an improvement in Knowledge, Comprehension, Application, Analyzing, Creating, and Evaluating scores. Also, findings revealed that improvement in lower-order thinking scores did not differ significantly across conditions, $F(1, 113) = .00$, $p = .988$, while they improved across time $F(1, 113) = 4044.61$, $p < .001$. In addition, findings revealed that improvement in higher-order thinking scores did not differ significantly across conditions, $F(1, 113) = .05$, $p = .828$, while they improved across time, regardless of condition, $F(1, 113) = 2831.83$, $p < .001$.

Key Words: Fractions v2.0, Understanding of Fractions, Lower-Order Thinking, Higher-Order Thinking

Introduction

Most students usually feel that fractions are confused and senseless. This is because they learn fractions based on procedural knowledge not conceptual knowledge (Mills, 2011). In addition, most teachers struggle when teach fractions because of difficulty to understand it (Lamon, 2007). These issues require a need for a better way to teach students fractions to give them a basic understanding of fractions concepts so that they can be successful with fraction computations and other mathematical areas in the future.

Problem of Statement

One of the challenge that students encounter in schools is a lack of fractions' knowledge (Smith, 2002). A major reason for this is because instruction is based on rules and procedural computation rather than conceptual understanding (Lamon, 2007), which can lead to the student feeling that fractions are meaningless

(Brown & Quinn, 2006). If teachers don't change radically the way of teaching fractions, then the rate of failure in algebra and statistics will continue to be high (Wu, 2001).

According to NCTM standards, in grades three through five all students should be able to (1) develop an understanding of fractions as parts of unit wholes; (2) use models and equivalent forms to judge the size of fractions; and (3) recognize and generate equivalent forms of commonly used fractions, decimals, and percentages (National Council of Teachers of Mathematics [NCTM], 2000). Furthermore, mathematics is considered to be an important aspect for success in school for every student (NCTM, 2000). Due to the country's issues with children learning mathematics and NCTM standards, the No Child Left Behind Act (NCLB) of 2001 was created, which states, "our nation must research the best way to teach math and measure students' progress in math" (US Department of Education, Facts about mathematics achievement, n.d., p. 1).

It is common for students to have difficulty with computations involving fractions because they do not have the basic understanding of them. Therefore, students have to obtain a conceptual knowledge of fractions learning the procedures of fractions (Bogen, 2008). In addition, determining the size of fractions is still a challenge for most students. Fractions would be easier for learners when they understand the size of fractions and they will be able to compute any kind of fractions (Clarke et al., 2008). These issues make it difficult for both the student and the teacher to make all the appropriate connections of fractions known as "Kieren's system of five sub-constructs", which are part-whole, measure, quotient/division, operator, and ratio (Clarke et al., 2008).

Another issue for students when they are learning fractions is that they find them difficult, confusing, and meaningless (Verschaffel, Greer & Torbeyns, 2006). Understanding what a fraction means and how to execute computations with fractions is often a daunting task for many students (Empson, 2003). Furthermore, procedures and rules, which are necessary for understanding fractions, do not appear to be relevant to students. Therefore, many students have difficulty working with fractions because there is a "heavy emphasis on procedural knowledge, symbolic rules and manipulation" (Tanner, 2008, p. 28).

As previously mentioned, one of the issues with students learning fractions is understanding them as parts of whole numbers. To help students build a better understanding of this concept many researchers suggest the use of models, or manipulatives, to represent fractions such as the use of circular "pie" pieces, fraction bars, Cuisenaire rods, paper folding, and pattern blocks (Van De Walle, 2007). Computers and the Internet make new methods of mathematics instruction possible; therefore, using such technological tools to visually clarify the concepts of fractions may assist students with learning arithmetic operations of fractions (Roblyer & Doering, 2009). There is currently a strong push for technology use and integration into the

Kindergarten through 12th grade classrooms for learning, reinforcement, and enrichment (Learning Points, 2007).

Computer-aided instruction (CAI) software can be described as the use of a computer to provide course content in the form of drill, practice, tutorial, and/or simulation (Roblyer & Doering, 2009). CAIs give visual information presented in a logical sequence through a computer and the student is able to learn by reading the text presented and by observing the visual information displayed. This type of software technology could be useful in accommodating student needs and improving math achievement (Traynor, 2003) and several research studies (Aql, 2011; Tienken & Wilson, 2007; Traynor, 2003) have shown that there is a positive relationship between the use of CAI software and students' academic achievement improvement in mathematics. The software program used as the focus of this research study, "Fractions v2.0", can serve as an effective tool in teaching students to think proportionally about fractions to enhance their basic conceptual knowledge prior to attempting fraction computations.

Purpose of the Study

The purpose of this quasi-experimental research study is to determine the effects of a software program, specifically "Fractions v2.0", when it is used as a supplemental tool to traditional math instruction as compared to using only traditional math instruction in fourth grade classrooms in order to enhance the understanding of fractions deeply and effectively. Fractions v2.0 is computer-aided instructional (CAI) software program designed for interactive learning to assist students with improving their mastery of understanding fractions concepts.

Objectives

The objectives of this research study are:

1. To determine the effectiveness of the software program "Fractions v2.0" as a supplement to traditional math instruction to see if it assists fourth grade students in understanding fractions concepts more easily.
2. To determine the effectiveness of the software program "Fractions v2.0" as a supplement to traditional math instruction to see if it there is a difference on the understanding of fractions between gender in fourth grade.

Research Questions

The research questions that would be examined in this research study are:

1. When used as a supplement to traditional instruction methods, does the software program “Fractions v2.0” help fourth grade students understand fractions concepts more easily?
2. Is there any difference between male and female in fourth grade when use the software program "Fractions v2.0" as a supplement to traditional instructional methods?

Significance and Rationale

Students have difficulty with understanding basic fraction concepts, thus making it even more difficult for them to move on to fraction computations (Mills, 2011). When students do not learn to make sense of fraction interpretations, their lack of understanding continues to persist into adulthood (Lamon, 2007). To assist students, many researchers suggest the use of visual tools, such as circular pie pieces, fraction bars, Cuisenaire rods, paper folding, and pattern blocks (Van De Walle, 2007). Computer-aided instructional (CAI) software programs such as “Fractions v2.0” can help teach a student the basic concepts through the use of multiple visual aids. For example, early in the “Fractions v2.0” software tutorial, there is a unit entitled “Fractions Concepts” that teaches detailed fraction basics such as numerators, denominators, lowest common denominator, mixed numbers, improper fractions, comparing fractions and much more (Core Learning, Fractions step by step, n.d.). These are the necessary tools needed in order for a student to move on to actual fraction computations that are taught later.

Since it is hypothesized that CAIs can assist students with learning aspects of fractions that they have the most difficulty with, which will in turn help them in the future, the purpose of this research study is to investigate the effectiveness of the specific CAI software program “Fractions v2.0” when fourth grade students use it in conjunction with their traditional classroom. The study would look at whether or not the software is useful and to what extent, as compared to fourth graders in the same geographical area who are being taught fractions using only traditional teaching methods. It is hopeful that “Fractions v2.0” will clarify fractions concepts for the fourth graders in the experimental group and enhance their learning in terms of mathematical operations using fractions instead of traditional approaches of memorization and repetition (Huang & Kellsohn, 2009) that is used in most classrooms.

If the results of the research show a significant difference between the experimental and control groups, the results could help teachers meet the diverse needs of all the students in their classrooms by determining which strategies should be used. The findings from this study could also provide school officials with needed information to help them make informed decisions about implementing CAI software in elementary mathematics classrooms. In addition to school officials, this research study could have policy implications at a district level, state, regional, or even national level. Political leaders may provide professional development to teachers, training for parents, and possibly even include "Fractions v2.0" in the curriculum. If the results are significant showing that "Fractions v2.0" is effective, the study could easily serve as a springboard for future, broader studies that attempt to eliminate any gaps in this study and further show validity and reliability.

Methodology

The purpose of this research study was to examine the effects of the CAI software program "Fractions v2.0" as a supplement to traditional mathematics instruction methods in order to enhance understanding of fractions in fourth grade classrooms in Eight Public Elementary Schools in the southern region, Saudi Arabia (Abha City). The design was quasi- experimental (Campbell & Stanley, 1963) with a non-equivalent control group that is considered a suitable alternative to an experimental design when randomization is not possible (Gall, Gall & Borg, 2006). The understanding of fractions of the experimental and control groups would be measured based on the Cognitive Domain of Bloom's Taxonomy that includes eight categories; knowledge, comprehension, application, analysis, synthesis, evaluation, lower-order thinking skills, and higher-order thinking skills.

Research Design and Procedure

The research design for this study was the non-equivalent control group design. The reasoning for this choice is because the participants involved in the study cannot be randomly assigned to experimental and control groups (Gall et al., 2006). Eight comparable classrooms were chosen and broken into control and experimental groups that are as similar as possible to provide the fairest comparison. The experimental groups used the software program "Fractions v2.0" in addition to their traditional mathematics instruction, while the control groups was only taught through traditional instruction methods. Both groups completed the Understanding of Fractions pre-test. At the completion of the study, both groups completed the Understanding of Fractions post-test. The students' post-test scores were compared across groups, controlling for pre-test scores using statistical analysis. Descriptive statistics was presented for all the major characteristics, including demographics of all the participants. The design is depicted in Table 1 below.

Table 1 Nonequivalent Control-Group Design

	Pretest	Treatment	Posttest
Experimental	T_1	X	T_2
Control	T_1		T_2

T_1 represents the Understanding of Fractions test that will be used as the pretest.

X represents the experimental treatment. The treatment will be the software program "Fractions v2.0".

T_2 represents the Understanding of Fractions test that will be used as the posttest.

Description of the independent variable. "Fractions v2.0" is a comprehensive course for teaching fractions to third through sixth graders (earlier grades for accelerated learners and sixth grade for remedial students). It has 30 lessons organized in seven units that flow in a logical and easy to follow learning path (Figure 1). The program offers on-screen audio support, provides printable worksheets for additional practice, and is designed for self-paced instruction. At the end of each lesson is a quiz so that the student can identify areas where he/she needs additional help before moving on to the next lesson in the unit. At the end of each unit, the student takes a unit test and, upon passing, can print a certificate of completion (Core Learning, Basic math help, n.d.). Although the certificate is not necessary, it does help the student with self-esteem and confidence.

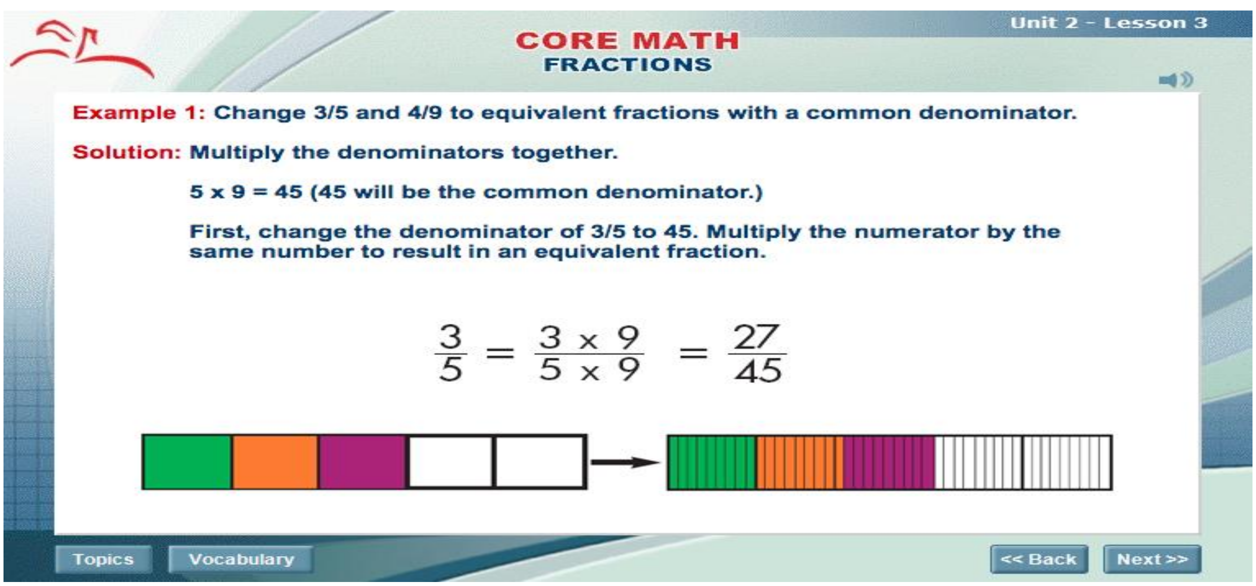

Figure 1: Software Program of Fractions v2.0

Sampling

Participants were recruited from the K-6 public elementary schools in the Abha City, southern region in Saudi Arabia. The August 2017 student enrollment data indicated that 3108 students were in attendance at the schools. The demographic background of the student population for the 2017-2018 school year consisted of 94.6% Saudis and 5.4% Non-Saudis. Fourth grade students totaled 492, or approximately 15.8% of the student population.

Table 2: Demographic Population

Item	Percentage
Saudis' Students	94.6%
Non-Saudis' Students	5.4%
TOTAL	100%

For the purposes of this study, students from eight fourth-grade mathematics classes were the sampling for analyses. The student sample was comprised of fourth grade students who received traditional instruction in mathematics in regular education, elementary mathematics classrooms during the 2017-2018 school year. The fourth grade classroom setting has been chosen because of the high amount of time spent in direct teacher contact with students in math. In the district where the study took place, fourth grade teachers spend six hour and 30 minutes per day in direct contact with students. The researcher was chosen eight classes for the study, each similar in number of students, ethnicity, and gender. The goal of class selection was that the eight classes chosen are as similar as possible so that any differences can be attributed to the independent variable.

Instrumentation:

Understanding of fractions. The researcher has reviewed the math curriculum and it shows that fractions are introduced in the first grade. By the end of the fourth grade, the topics of introductory work with fractions (shading and identifying parts of figures); fractions of areas and fractions of numbers; fraction-decimal conversions; and addition and subtraction of common fractions are covered (Ministry of Education, 2017). To assess students' understanding of fractions in the experimental and control groups, a general measure of understanding was obtained from all students for use as a possible covariate. However, since no existing test has been judged as an adequate measure of understanding of fractions, pre-tests and post-tests were constructed in cooperation with previous research that used similar tests.

To create the covariate tests, items were either constructed or adapted from one of two sources: (a) tasks used in previous research studies of rational number understanding (Hannula, 2003; Nieme, 1996); or (b) third and fourth grade textbooks. The test is comprised of constructed-response items. Each level of Bloom

Taxonomy levels has four questions in this test in order to measure the ability of acquisition this skill easily. Also, each correct answer is worth three points and each incorrect answer is worth zero points.

Data Collection:

Operational Procedures. This study was introduced to study participants by the research assistant at the beginning of the study in August 2017 and was completed four weeks later. The study was conducted using a source of data, which is the Understanding of Fractions pre/posttest that is built by the researcher in order to measure the understanding of fractions effectively.

Experimental treatment. Approximately one day after the pre-test, the experimental group would receive an introduction session on "Fractions v2.0" in the school's computer lab. An email group was created for the teachers to facilitate communication between the researcher and the experimental teacher groups. The experimental phase would take place between three and four weeks in August 2017.

Pre-test assessment. Both the experimental and control groups participated in the pre-test during single 45-minute sessions. The Understanding of Fractions test was administered to both groups, which includes 24 constructed-response items. This test was scored by the researcher, research assistant, and teachers who are participating in the study to help minimize experimenter effects and/or researcher bias.

Post-test assessment. At the conclusion of the treatment, both the experimental and control groups participated in the post-test during single 45-minute sessions. The administration of the post-test was identical to the 24-item pre-test that was given prior to the treatment period. The Understanding of Fractions test was administered to both groups to measure students' understanding of fractions post-treatment. This test was also scored by the researcher, research assistant, and teacher who were participating in the study.

Data Analysis:

Following the administration of the Understanding of Fractions pre-test, standard scores for each participant was calculated. After exposure to "Fractions v2.0" supplemented with traditional math instruction (experimental group) or traditional math instruction only (control group), the Understanding of Fractions post-test was administered and standard scores was calculated using SPSS Student Version 22.0 for Windows.

The research study would be using a non-equivalent control group design. The 2x2 Mixed Factorial Design (Mixed-ANOVA) with the pre-test scores on the Understanding of Fractions test as the covariate would be used to control for initial differences in student understanding of fractions between groups.

Descriptive Statistics

Description of the Sample:

Half of the participants were assigned to the experimental condition (*n* = 60). Also, half of the participants were female (*n* = 55). The proportion of males to females did not differ significantly across conditions, $\chi^2(1) = .24$, $p = .626$.

Table 3 Frequencies and Percentages for the Demographic Variables (N = 115)

Variables	*n*	%
Condition		
Control	55	47.8
Experimental	60	52.2
Gender		
Male	60	52.2
Female	55	47.8

Description of Study Variables

The findings in Table 4 reveal that the mean score for the Lower-Order Thinking pretest (M = 18.87, SD = 1.75) was lower than the mean score for the Lower-Order Thinking posttest (M = 31.34, SD = 1.43; $p < .001$). Similarly, the mean score for the Higher-Order Thinking pretest (M = 8.83, SD = 1.82) was lower than the mean score for the Higher-Order Thinking posttest (M = 22.17, SD = 1.93; $p < .001$).

Table 4 Descriptive Statistics for Fractions Performance (N = 115)

	Pretest			Posttest		
Test	Range	M	SD	Range	M	SD
Lower-order thinking	15 to 22	18.87	1.75	29 to 34	31.34	1.43
Knowledge	3 to 7	5.35	1.08	12 to 12	12.00	.00
Understanding	6 to 10	7.65	1.13	9 to 12	10.91	.78
Application	4 to 8	5.87	1.08	6 to 11	8.43	1.27
Higher-order thinking	5 to 11	8.83	1.82	18 to 27	22.17	1.93
Analyze	2 to 6	3.74	1.08	7 to 11	5.61	1.01
Create	1 to 5	2.96	1.00	4 to 9	6.00	1.03
Evaluate	0 to 4	2.13	.95	6 to 10	7.57	1.06

Results of the Hypothesis Tests

It was hypothesized that improvement in fractions performance from pretest to posttest would differ across the control and experimental groups. Mixed ANOVA procedures were conducted to test this hypothesis. The within-subjects variable was time (i.e., pretest vs. posttest) and the between-subjects variable was condition (i.e., control vs. experimental). To determine whether improvement across time differed across conditions, the interaction term was evaluated at an alpha of .05.

Lower-Order Thinking Skills

Overall lower-order thinking score. The mixed ANOVA findings in Tables 5 & 6 reveal that improvement in lower-order thinking scores did not differ significantly across conditions, $F(1, 113) = .00$, $p = .988$, partial $\eta 2 = .000$. Rather, lower-order thinking scores improved across time, regardless of condition, $F(1, 113) = 4044.61$, $p < .001$, partial $\eta^2 = .973$.

Table 5 Means and Standard Deviations for Pretest and Posttest Lower-Order Thinking Scores within the Control and Experimental Groups (N = 115)

	Control				Experimental			
	Pretest		Posttest		Pretest		Posttest	
Test	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Lower-order thinking	18.82	(1.76)	31.29	(1.39)	18.92	(1.76)	31.38	(1.46)
Knowledge	5.33	(1.09)	12.00	(.00)	5.37	(1.09)	12.00	(.00)
Understanding	7.62	(1.18)	10.87	(.87)	7.68	(1.10)	10.95	(.75)
Application	5.87	(1.09)	8.42	(.96)	5.87	(1.08)	8.43	(1.33)

Table 6 Mixed ANOVA Results for Lower-Order Thinking Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
Condition	**1**	**.52**	**.18**		**.002**
Error	**113**	**2.95**			
Within subjects					
Time	**1**	**8923.97**	**4044.61**	***	**.973**
Condition x time	**1**	**.00**	**.00**		**.000**
Error	**113**	**2.21**			

*** p < .05. ** p < .01. *** p < .001.**

Knowledge scores. The findings in Table 7 indicate that improvement in knowledge scores did not differ significantly across conditions, $F(1, 113) = .04$, $p = .847$, partial $\eta^2 = .000$. Instead, knowledge scores improved across time, irrespective of condition, $F(1, 113) = 4283.03$, $p < .001$, partial $\eta^2 = .974$.

Table 7 Mixed ANOVA Results for Knowledge Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects	1				
		.02			
Condition	113				
		.59	.04		.000
Error					
Within subjects	1				
		2540.30	4283.03		.974
Time	1				
		.02	.04		.000
Condition x time	113			***	
		.59			
Error					

* $p < .05$. ** $p < .01$. *** $p < .001$.

Understanding scores. The findings in Table 8 show that improvement in understanding scores did not differ significantly across conditions, $F(1, 113) = .00$, $p = .950$, partial $\eta2 = .000$. Understanding scores improved across time, regardless of condition, $F(1, 113) = 1128.72$, $p < .001$, partial $\eta2 = .909$.

Table 8 Mixed ANOVA Results for Understanding Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
	1	.29			
Condition			.21		.002
	113	1.36			
Error					
Within subjects					
	1	610.16			
Time			1128.72		.909
	1	.00			
Condition x time			.00	***	.000
	113	.54			
Error					

* $p < .05$. ** $p < .01$. *** $p < .001$.

Application scores. The findings in Table 9 reveal that improvement in application scores did not differ significantly across conditions, $F(1, 113) = .01$, $p = .944$, partial $\eta^2 = .000$. Rather, application scores improved across time, regardless of condition, $F(1, 113) = 285.93$, $p < .001$, partial $\eta^2 = .717$.

Table 9 Mixed ANOVA Results for Application Scores (N = 115)

Source	df		MS		F		Partial η^2
Between subjects							
Condition	1		.00				
Error	113		1.50		.00		.000
Within subjects							
Time	1		374.96				
Condition x time	1		.01		285.93		.717
Error	113		1.31		.01	***	.000

* p < .05. ** p < .01. *** p < .001.

Higher-Order Thinking Skills

Overall higher-order thinking score. The mixed ANOVA findings in Tables 10 & 11 reveal that improvement in higher-order thinking scores did not differ significantly across conditions, $F(1, 113) = .05$, $p = .828$, partial $\eta 2 = .000$. Instead, higher-order thinking scores improved across time, regardless of condition, $F(1, 113) = 2831.83$, $p < .001$, partial $\eta 2 = .962$.

Table 10 Means and Standard Deviations for Pretest and Posttest Higher-Order Thinking Scores within the Control and Experimental Groups (N = 115)

	Control				Experimental			
	Pretest		Posttest		Pretest		Posttest	
Test	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Higher-order thinking	8.95	(1.76)	22.24	(2.11)	8.72	(1.88)	22.12	(1.78)
Analyze	3.73	(1.10)	8.62	(1.05)	3.75	(1.07)	8.60	(.99)
Create	3.00	(.98)	6.02	(1.10)	2.92	(1.03)	5.98	(.97)
Evaluate	2.22	(.96)	7.60	(1.06)	2.05	(.95)	7.53	(1.07)

Table 11 Mixed ANOVA Results for Higher-Order Thinking Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
Condition	**1**	**1.74**	**.50**		**.004**
Error	**113**	**3.48**			
Within subjects					
Time	**1**	**10221.46**	**2831.83**	***	**.962**
Condition x time	**1**	**.17**	**.05**		**.000**
Error	**113**	**3.61**			

*** p < .05. ** p < .01. *** p < .001.**

Analyze scores. The findings in Table 12 indicate that improvement in knowledge scores did not differ significantly across conditions, $F(1, 113) = .02$, $p = .879$, partial $\eta^2 = .000$. Instead, knowledge scores improved across time, irrespective of condition, $F(1, 113) = 1320.52$, $p < .001$, partial $\eta^2 = .921$.

Table 12 Mixed ANOVA Results for Analyze Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
Condition	**1**	**.00**	**.00**		**.000**
Error	**113**	**1.18**			
Within subjects					
Time	**1**	**1361.40**	**1320.52**	***	**.932**
Condition x time	**1**	**.02**	**.03**		**.000**
Error	**113**	**1.03**			

*** p < .05. ** p < .01. *** p < .001.**

Create scores. The findings in Table 13 show that improvement in create scores did not differ significantly across conditions, $F(1, 113) = .03$, $p = .873$, partial $\eta 2 = .000$. Create scores improved across time, regardless of condition, $F(1, 113) = 407.37$, $p < .001$, partial $\eta^2 = .783$.

Table 13 Mixed ANOVA Results for Create Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
Condition	**1**	**.20**	**.26**		**.002**
Error	**113**	**.77**			
Within subjects					
Time	**1**	**531.23**	**407.34**	***	**.783**
Condition x time	**1**	**.03**	**.03**		**.000**
Error	**113**	**1.30**			

*** p < .05. ** p < .01. *** p < .001.**

Evaluate scores. The findings in Table 14 reveal that improvement in evaluate scores did not differ significantly across conditions, $F(1, 113) = .18$, $p = .674$, partial $\eta^2 = .002$. Rather, evaluate scores improved across time, regardless of condition, $F(1, 113) = 2036.52$, $p < .001$, partial $\eta^2 = .947$.

Table 14 Mixed ANOVA Results for Evaluate Scores (N = 115)

Source	df	MS	F		Partial η^2
Between subjects					
Condition	1	.79	.66		.006
Error	113	1.21			
Within subjects					
Time	1	1693.78	2036.52	***	.947
Condition x time	1	.15	.18		.002
Error	113	.83			

*** p < .05. ** p < .01. *** p < .001.**

Discussion

The objective of the study was to determine whether the software program, Fractions v2.0, when used as a supplement to traditional math instruction would help fourth grade students understand fraction concepts more easily. A second objective was to determine whether there were differences in the understanding of fraction concepts between male and female students when using the software program, Fractions v2.0, as a supplement to traditional math instruction. In line with these objectives, male and female students were assigned to one of two groups (i.e., traditional math instruction only vs. traditional math instruction with supplemental use of Fractions v2.0) and tested prior to and after instruction on fractions. Their performance was measured in terms of three lower-order thinking skills (i.e., knowledge, comprehension, and application) and three higher-order thinking skills (i.e., analyzing, creating, and evaluating).

Interpretation of Findings

Type of instruction method. Contrary to expectations, improvement in performance did not differ as a function of type of instruction method. The possible explanations for this finding fall under three broad umbrellas: theoretical, methodological, and statistical.

One theoretical explanation is the possibility that the cognitive processes underlying fraction learning were not mapped onto the Fractions v2.0 program. As noted in the literature review, students have to get a conceptual understanding of fractions first (Bogen, 2008). They must also be taught how to determine the size of a fraction. Whether these concepts were integrated into the Fractions v2.0 program is unclear. A second theoretical explanation, buttressed by the three-way interaction between time, gender, and instruction method, is that the effects of the Fractions v2.0 program were more complex than anticipated. As the findings on the Application scores reveal, the Fractions v2.0 program was effective across time for female students but not for male students.

One methodological explanation is that the implementation period for the Fractions v2.0 program was not long enough for lower- and higher-order learning to take place. Another methodological explanation is that the Fractions v2.0 program may not have been implemented correctly. For instance, it is unclear whether the program was implemented prior to, in conjunction with, or after the traditional instructional method. A third methodological explanation is that the Fractions v2.0 program may not have provided a hands-on experience; therefore, students may have remained uninterested and uninvolved in the learning process.

Gender. The effect of Fractions v2.0 on Application scores was moderated by gender; there was an improvement in learning for female – but not male – students who were exposed to the Fractions v2.0 program. The effect size of .34 indicates a moderate effect, one of practical importance. Why the Fractions v2.0 program led to an improvement for female but not male students is unclear. One possible theoretical explanation is that the Fractions v2.0 program was more involving for females than for males.

Regardless of teaching method, gender moderated the improvement of Lower-Order Thinking scores. One explanation for this finding is that female students were more persistent in learning about fractions; thus, they improved across time.

Limitations of the Study

Theoretical. As noted above, it was unclear whether the pertinent cognitive processes underlying fraction learning were mapped onto the Fractions v2.0 program. Prior to implementing any program (software or otherwise), it is necessary to do a thorough instructional design program; this way, it becomes clear which cognitive processes are being targeted by the specific procedures of the program.

Methodological. It was unclear whether the implementation period was long enough for the effects of the Fractions v2.0 program to take effect. In addition, whether or not the teacher(s) implemented the program correctly is not known. Finally, whether the Fractions v2.0 program allowed for a hands-on experience was not ascertained. If the goal was to have students more engaged in the learning process, students should have been asked prior to the study whether or not the Fractions v2.0 program was truly engaging.

Future Recommendations

It is important that, in future studies, the cognitive processes underlying the learning of fractions be clearly spelled out. These processes must then be mapped onto the instruction method. In addition, the period of implementation should be long enough such that the effects are noticed, especially if the effects are anticipated to be relatively small. Finally, given that implementing a new program is cost-prohibitive, it is important that the teachers be thoroughly trained in its execution.

References:

- Aql, M. M. (2011). Effect of Computer Integrated Instruction on Student Achievement in Eighth Grade Mathematics Retrieved from http://www.bakeru.edu/images/pdf/SOE/EdD_Theses/aql_mofeed_m.pdf
- Bogen, M. (2008). When 1/2 + 1/3 = 2/5. Harvard Education Letter, 1(5), 11-14.
- Brown, G. & Quinn, R. J. (2006). Algebra students' difficulty with fractions: An error analysis. Australian Mathematics Teacher, 62(4), 28-40.
- Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research. Chicago: Rand McNally.
- Clarke, D., Roche, A., & Mitchell, A. (2008). Ten practical tips for making fractions come alive and make sense. Mathematics Teaching in the Middle School, 13(7), 372-379.
- Core Learning. (n.d.). Fractions step by step. Retrieved from http://www.core-learning.com/courseinfo/fractions/fractions.htm
- Empson, S. (2003). Low performing students and teaching fractions for understanding: An interactional analysis. Journal for Research in Mathematics Education, 34(4), 305-343.

- Gall, M. D., Gall, J. P., & Borg, W. R. (2006). Educational research: An introduction (8th ed.). Boston: Allyn and Bacon.
- Hannula, M. S. (2003). Locating fraction on a number line. International Group for the Psychology of Mathematics Education, 3, 17-24.
- Huang, K.H., & Kellsohn, C. (2009). Integrating computer games with mathematics instruction in elementary school: An analysis of motivation, achievement, and pupil-teacher interactions. International Journal of Science and Human Sciences, 3, 1409-1411.
- Kline, R.B. (2011). Principles and practice of structural equation modeling, 3rd edition. New York: The Guilford Press.
- Lamon, S. (2007). Rational numbers and proportional reasoning: Towards a theoretical framework for research. In F. Lester (Ed.), Second handbook of research on mathematics teaching and learning (pp. 629-667). Reston, VA: NCTM.
- Learning Points. (2007). Quick key 3 - Understanding the No Child Left Behind Act of 2001: Technology integration. Retrieved from http://www.learningpt.org/pdfs/qkey3.pdf
- Mills, J. (2011). Body fractions: A physical approach to fraction learning. Australian Primary Mathematics Classroom, 16(2). 17-22.
- Ministry of Education (2013). Schools' database. Retrieved from https://www.moe.gov.sa/Arabic/EServices/Public/Pages/SchoolProfile.aspx?qsId=47255
- National Council of Teachers of Mathematics. (2000). Principles and Standards for School Mathematics. Retrieved from http://www.nctm.org/standards/content.aspx?id=16909
- Nieme, D. (1996). Assessing conceptual understanding in mathematics: Representations, problem solutions, justifications, and explanations. The Journal of Educational Research, 96(6), 351-363.
- Roblyer, M. D. & Doering, A. (2009). Integrating education technology into teaching. Needham Heights, MA: Allyn & Bacon.
- Smith, J. P. (2002). The development of students' knowledge of fractions and ratios. In B. Litwiller & G. Bright (Eds), Making Sense of Fractions, Ratios, and Proportions: 2002 Yearbook. (pp. 3-17). Reston, VA: NCTM.
- Tabachnick, B.G. & Fidell, L.S. (2007). Using multivariate statistics, 5th edition. San Francisco: Pearson, Inc.
- Tanner, K. (2008). Working with students to help them understand fractions. Australian Primary Mathematics Classroom, 13(3), 28-31.
- Tienken, C. & Wilson, M. (2007). The impact of computer assisted instruction on seventh-grade students' mathematics achievement. Planning and Changing, 38(3&4), 181-190.

- Traynor, P. (2003). The effects of computer-assisted instruction on different learners. Journal of Instructional Psychology. 30(2), 137-151.
- U.S. Department of Education. (n.d.). The facts about ... mathematics achievement [On-line]. Retrieved from http://www2.ed.gov/nclb/methods/math/math.pdf
- Van De Walle, J. A. (2007). Elementary and Middle School Mathematics Teaching Developmentally. Boston, MA: Pearson Education, Inc.
- Verschaffel, L., Greer, B. & Torbeyns, J. (2006). Numerical thinking. In A. Gutierrez & P. Boerno (Eds), Handbook of research on the psychology of mathematics education: Past, present, and future (pp. 51-82). Rotterdam, The Netherlands: Sense Publishers.
- Wu, H. (2001). How to prepare students for Algebra. Retrieved from http://math.berkeley.edu/~wu/AE3.pdf

فعالية برنامج (Fractions v2.0) في تعزيز فهم الكسور

الملخص: هدفت هذه الدراسة البحثية شبه التجريبية إلى تحديد فعالية برنامج حاسوبي (برنامج الكسور v2.0) في تعزيز فهم الكسور عند استخدامه كأداة تكميلية للتعليم التقليدي للرياضيات مقارنة باستخدام التعليم التقليدي فقط لطلاب الصف الرابع في المرحلة الابتدائية. شارك في هذه الدراسة 115 طالباً وطالبة، وقد استغرق إجراء الدراسة أربعة أسابيع في ثمان مدارس ابتدائية عامة في مدينة أبها، جنوب المملكة العربية السعودية.

استخدمت الدراسة الاختبارات القبلية والبعدية في جمع البيانات. وقد أظهرت نتائج الدراسة أن استخدام برنامج (الكسور v2.0) كمكمل للتعليم التقليدي للرياضيات يؤدي إلى تحسن النتائج في جميع مستويات المعرفة: التذكر والفهم والتطبيق والتحليل والتركيب والتقويم. كما أظهرت نتائج الدراسة تحسناً في مهارات التفكير الدنيا مع مرور الوقت $F(1, 113) = 4044.61, p < .001$ ، وأظهرت كذلك تحسناً في نتائج مهارات التفكير العليا مع مرور الوقت $F(1, 113) = 2831.83, p < .001$.

الكلمات المفتاحية: برنامج الكسور v2.0 ، فهم الكسور ، مهارات التفكير الدنيا ، مهارات التفكير العليا.