Measuring the Effects of Using the FCAT Explorer on the 2002 FCAT Math Scores

Christopher B. Sullivan, Ph.D.
(sullivan@imageresearch.com)

and

Bahia Naime-Diefenbach, Ph.D.
(Bahia@fdt.net)

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Introduction

Computer-based materials are routinely used to prepare students for standardized tests such as the Florida Comprehensive Assessment Test (FCAT). Educators, who need their investment in software to work, keenly note the efficacy of each educational software program. This study focuses on the FCAT Explorer, a set of interactive software programs available across the Internet at no cost to Florida public schools. The software is provided by the Florida Department of Education. The FCAT Explorer offers multiple math and reading programs that enable students to practice the benchmarks and skills measured across several grade levels, from 4th to 10th grade. The programs included in this study are the 5th, 8th, and 10th grade math programs of the FCAT Explorer.

This study examines the effect of student use of the FCAT Explorer on their performance scores in the 2002 math FCATs, at a school level. The research model links program use to enhancing students' learning of the math benchmarks, their mastery of math skills and how FCAT Explorer's learning guidance assists their acquiring math strategies for solving math problems. The study posits that incremental learning steps, such as learning guidance feedback and explanation of correct answer, are carried over to the students' performance on the FCAT. Finally, the paper presents an analysis of how students' performance scores on the FCAT, as measured by mean school scores, are influenced by use of the FCAT Explorer.

Learning Mathematics in a Multimedia Environment

Educational technologies have evolved from the printed programmed instruction to computers driven by hypermedia. Research on the effectiveness of computer technologies has consistently revealed that, when used appropriately, computers make excellent learning tools (Snider, 1992; Herrington & Oliver, 1999). In the classroom, computer applications have varied from the provision of drill and practice for remediation to structured curriculum and instruction. Recent developments in multimedia present opportunities and challenges for educators who want to develop effective instructional programs. New software applications bring the promise of creating superior learning environments relative to the traditional classroom as well as delivering these learning experiences to a greater number of students and more diverse audiences.

In recent years, some curriculum designers have advocated using computer technology for knowledge exploration and construction. Innovative multimedia and online software provide opportunities for students to use the computer as a learning tool more often at school and at home. Studies show that students who receive appropriate, carefully chosen computer tutorials as homework assignments achieve better academic results than those who receive traditional textbook exercises as homework assignments (Sasser, 1990-91).

Mathematics educators are intuitively attracted to dynamic mathematical programs, sensing that powerful learning outcomes are possible (Goldenberg & Cuoco, 1996, Schifter, 1997; Russell, 1997). If the appropriate software is carefully chosen, it will have the flexibility to accommodate a variety of student learning styles (Hawkins, 1993; Schank, 1993). Some software can support complex learning in math (Nicaise, 1997) and teach problem solving to students who struggle with learning difficulties (Babbitt and Miller, 1996). By employing innovative, multimedia technology to teach mathematics, educators have the opportunity to improve learning. These multimedia-learning environments are ideal for a stimulating higher order of thinking (Schank, 1993; Paolucci, 1998).

Mathematics education promotes the view that mathematics should be taught and assessed in a variety of meaningful and authentic ways. When students are actively involved in an activity they are more likely to learn the mathematics content of the activity (Schoenfeld, 1992). Moreover, simulations of real-life situations, in which learners must rely on mathematical knowledge and skills to solve problems, help students incorporate mathematics reasoning as an important cognitive activity to arrive at a solution (Verzoni, 1997). By applying math skills and theories in real life situations, students establish connections between school learning and their interests outside school. This process enhances critical thinking and mathematics learning skills and improves the retention and transfer of learning. Therefore, students learn how to construct knowledge, conceptualize problems, and develop problem-solving skills (Goldenberg & Cuoco, 1996).

Considerable research has involved cognitive technologies and focused on students' learning traits. Identifying such learner traits as the learners' preference of teaching style and the amount of instruction could have critical developmental and implementation implications (Hannafin and Scott, 1998), and could have a considerable impact on students' success in such environments (Freitag and Sullivan, 1995; Hannafin and Sullivan, 1996).

Multimedia materials show promising effects on students' acquisition of knowledge and can enhance teaching and learning for today's diverse students (Torrez, 2000). An important feature of multimedia software applications is their interactivity with their user and their ability to provide important feedback. Some have also stressed the importance of creating more learner focused learning environments in which the learner is provided with varying amounts of help and support (Hannafin & Scott, 1998). Such learning environments enhance the learning of mathematical skills by providing the learner with interactivity, immediate feedback, control of the pace of instruction, and individualized learning (Hawkins, 1993). These capabilities could significantly improve learning (Naime-Diefenbach & Sullivan, 2001).

While feedback seems to be important in the enhancement of learning, research indicates that this is true only under certain conditions (Cooper, 1998; Khine, 1996). In a learning situation, feedback may be broadly defined as information obtained by students regarding the accuracy of their performance in a learning task. Different types of feedback can be categorized according to their functions and characteristics (Dempsey and Sales, 1993). Knowledge of results is the simplest level of feedback, which provides responses such as “right” or “wrong”, “correct” or “incorrect” without giving the correct answer. Elaborative feedback is a higher order of post-response information, which not only contains the result of a learner’s response, but also provides reasons for why the response was wrong and provides the correct answer. A third situation is where no feedback is provided. This forces the learners to proceed through the instructional sequence without receiving any post-response information on what the learner has attempted.

Studies have examined immediacy of feedback, the amount of information in feedback, the type of task involved, the importance of error analysis, and response certitude. Researchers agree that informative feedback does benefit learning and enhances performance for several types of learning tasks. The research suggests that feedback is more effective when it relates to the correct answer (Kulhavy and Wager, 1993; Khine, 1996).

Multimedia teaching technologies still have one main disadvantage: cost. Cost is a major factor affecting ownership and use of computers and other new technologies (Fahy, 2000). Teachers have little time to determine which CD or web-based program really works to prepare students, and the cost of such programs is high enough that a wrong choice also exhausts a scarce budget. Moreover, with appropriate guidance about the meaningful use of technology, teachers may rethink how students learn as well as develop working knowledge of mathematics concepts, and get feedback on student performance (Kim and Sharp, 2000).

The FCAT Explorer: 5th, 8th and 10th Grade Math Programs

The FCAT Explorer is an educational program provided to Florida public schools by the Florida Department of Education at no cost. The FCAT Explorer is an educational web site that provides innovative practice programs and instructional support tools to strengthen the skills students need for success on the FCAT, in the classroom, and in life. As a learning tool, the FCAT Explorer can be used in the classroom, at home, at the library or wherever there is a computer with Internet access.

The FCAT Explorer programs consist of an organized series of math practice items that the student answers online. In the FCAT Explorer**:** 5th Grade Math there are 148 items, in 8th Grade Math there are 139 items, and in 10th Grade Math there are 144 items. The set of math items in the program are written to the benchmarks at each grade math level, as specified in the Sunshine State Standards, so that a student who works all the way through the program will cover items pertaining to all the benchmarks included in the FCAT. The programs complement the educational curriculum by furnishing problem-solving opportunities that the students can access through the computer.

The FCAT Explorer was developed in partnership with expert math teachers, education specialists, instructional designers and testing professionals. The educational materials were designed using effective learning strategies, direct instruction procedures, principles of effective instructional design and cognitive learning theory (Bloom, 1956; Dick and Carey, 1990; Gagne, 1987).

Moreover, the instructional materials in the FCAT Explorer reflect critical thinking attributes, strategies for learning mathematics and solving problems, and contextual variables influencing the incorporation of motivational components such as the Keller's ARCS (Attention, Relevance, Confidence, Satisfaction) model (Keller, 1987, Naime-Diefenbach, 1991). The FCAT Explorer is an effective instructional tool, capturing and holding students' interest with a lively use of color graphics and a variety of subject matters (Attention). It measures and enhances the learning of the math skills and benchmarks using real-life situations (Relevance). It also builds the confidence of the learner by providing hints, immediate guiding feedback and the explanation of the correct answer (Confidence). Satisfaction is gained through acquiring tokens, playing instructional games, and through the FCAT Explorer student reports that show the student's progress and rate the student's performance (Satisfaction).

Cognitive learning in the social and physical sciences is used to provide a rich, exploratory environment and to teach the students how to construct knowledge, conceptualize problems, and develop problem-solving skills. The FCAT Explorer makes mathematics learning more authentic by including real-life applications of math concepts. Through the informational items, students investigate mathematical problems embedded in a real-world scenario, enhancing the students' quality of communication about mathematical concepts. The FCAT Explorer provides its users with targeted resources that enable the overall environment of the student's learning. Administrators, teachers and mentors are given an array of utilities to manage enrollments, performance reports, messaging to students and maps linking each programs items to math benchmarks and skills. Parents are offered the Parent and Family guide in English, Spanish and Haitian-Kreyol, which provides an explanation of the FCATs and links to Sunshine State Standards as well as suggestions for how parents can work with their children to help them succeed in school. Students are given a variety of practice items and targeted guidance feedback, instructional games and a report on performance.

The items in the FCAT Explorer are formatted as multiple-choice problems or gridded response problems. Each item in the FCAT Explorer consists of a stem, four distracters (for multiple-choice items) or a grid (for gridded items), a colorful detailed illustration depicting a concrete, real-life situation, guidance feedback for incorrect answers, a hint to direct the student's thinking to understand and reason through the problem, a glossary of mathematical terms, and an explanation of the correct answer to reinforce and improve the student's skills. When students incorrectly respond to any item, they are presented with answer-specific feedback or skill-specific feedback and hints. Students will then be given another opportunity to answer the problem. If they respond incorrectly a second time, the FCAT Explorer provides the correct answer with an explanation of the correct answer. If students answer the item correctly, an explanation of the correct answer is provided reinforcing one or more correct solution techniques and math strategies.

The various components of the FCAT Explorer generate an instructional program that is designed to accommodate individual learner traits to improve learning. Moreover, it sharpens the students' skills to cultivate and develop their thinking. Improve learning efficiency and to address individual differences. It encourages students to use their thinking abilities to process learning at a higher level of complexity, and it teaches them how to organize content and knowledge to facilitate more complex processing.

The study was limited to usage data taken from database, and to the technology availability to students. The FCAT Explorer grants access to the feature for teachers to use the friendly print version and provide a printout of all items in any order the teachers chose. Many teachers informed the FCAT Explorer help desk that they are transcribing FCAT Explorer to paper and using it in classrooms. Therefore, the data related to those users is not included in our study.

Methodology for Analyzing the Effect of FCAT Explorer Math Programs

The research interest in this paper is to link the use of the FCAT Explorer math programs during the 2001-2002 school year with the performance of students on the math FCATs taken in March of 2002. The three math programs under investigation are the FCAT Explorer: 5th Grade Math, the FCAT Explorer: 8th Grade Math and the FCAT Explorer: 10th Grade Math. The student answer data for each program was used to test an effects model that links students' answer activity to their future performance on the FCAT. The statistical tests include difference of means tests and multiple regression.

The effects model employed in this study attempts to link students' activity on an educational software program to their performance on the FCATs. The same model is tested using the results from each of the programs. The model argues that use of educational software increases a student's exposure to benchmark-related information at his or her grade level. The increased exposure will positively impact the student's comprehension of the appropriate benchmark-related information. In turn, the student's improved knowledge of the benchmark-related material should be reflected in his or her FCAT scores (Naime-Diefenbach & Sullivan, 2001). Simply put, the more a student uses the FCAT Explorer to prepare for the FCATs, the better his or her expected FCAT score should be.

While the underlying research model posits that use of the FCAT Explorer will result in better performance on the FCATs, it is not possible to measure student performance on the FCATs directly. The Florida Department of Education does not publish the FCAT scores of students, but rather publishes the mean scale scores of schools for the different FCAT grade levels. This means that the research model cannot be directly tested, but must be inferred from data at the school level. Therefore this study compares the mean scale FCAT scores at a school level with the student performance data on the FCAT Explorer also aggregated to the school level.

The research interest in this paper is to determine whether students' use of the 5^{th}, 8^{th} and 10^{th} grade FCAT Explorer programs, with their rich set of supportive math resources, has any impact on their 2002 FCAT scores. The research focuses on a comparison of three FCAT Explorer usage measures on the mean school score of the 2002 Math FCAT. The three variables of interest are Answers per Student, Percent Correct and Correct Answers per Student. Answers per Student, or student use of the program are indicated by the number of answers per active student for each school in the sample. It is calculated by dividing the total number of answers by the number of active students. Answers per Student represents the interactivity of the FCAT Explorer program, as it tracks student progress through the items and guidance feedback. It is closely related with the sustained use the program by students without regard to the outcome of any item.

The second variable of interest is Percent Correct, measured by the percent of correct answers per school. It is calculated by dividing the total number of correct answers both on first and second attempt into the total number of answers per school. Percent Correct is related to the activity of the students in answering each question correctly, either on first attempt or following the guidance feedback on second attempt at the item. This construct represents the proportion of correct answers with regard for the number of items answered.

The third variable of interest, Correct Answers per Student, is an indicator of both student performance and activity as measured by the percentage of correct answers per student in each school. It is calculated by dividing the total number of correct answers by the total number of active students in a school. Correct Answers per Student is a variable that combines the total correct performance per school with the total number of active students in each school that used the FCAT Explorer. As such it suggests that usage must be combined with correct performance to have an impact on FCAT scores.

The two arch questions in this study point to the crux of the problem in linking software usage and FCAT performance. These research questions are:

1. Is there a significant relationship between use of the FCAT Explorer and subsequent FCAT performance?
2. Which factor explains the influence of the FCAT Explorer on FCAT performance:
    a. Answers per Student,
    b. Percent Correct,
    c. Correct Answers per Student?

The following analysis discusses the process of aggregating scores into a school level sample and then explains the testing of the aggregate usage scores against the 2002 mean school FCAT scores. The first research question is tested using a simple difference of means test for each grade-level program. The second research question is tested using multiple regression to compare the effects of each usage variable on the 2002 mean school FCAT scores.

Development of Aggregate FCAT Explorer Usage Measures

The first step in constructing aggregate FCAT Explorer usage measures was to create total answer tables covering the span of student activity during the 2001-2002 school year for each of the three programs. The FCAT Explorer 5th and 8th Grade Programs were available at the start of the school year; the 10th Grade Program was introduced in November 2001, so high school students did not have an equal amount of time to use it. In addition, schools at all levels used math programs at other levels; for example, of the 2,424 schools included in this study sample, 554 used the program at a different grade level than the students. Table 1 shows frequency of school using the three math programs as well as the number of schools that did not use the FCAT Explorer. Table 2 reports the total number of active students in each grade-level program and the total number of answers made during the school year.

Table 1. Number of Schools Using FCAT Explorer Programs and Activity Measures of Each Program

School Type	No Usage	5GM Activity	8GM Activity	10GM Activity	Total Included in Sample
Combination	78	31	39	22	0
Elementary	**542**	**1,040**	121	72	1,582
Middle	**227**	194	**276**	44	503
High	**136**	22	101	**203**	339
Total	983	1,287	537	297	2,424

Table 2. Activity Measures for Each FCAT Explorer Program Used in the Analysis

School Type	No Usage	5GM Activity	8GM Activity	10GM Activity	Total Included in Sample
Total Active Students	0	70,671	33,502	12,709	104,666
Total Answers	0	4,286,056	1,118,938	408,626	5,069,624

The first step in aggregating usage scores for the school sample was to eliminate program usage that was not at grade level. This step was accomplished by eliminating answers to non-grade-level programs at the student answer level. Thus, only answers to the 5th grade program were allowed for elementary schools, only answers to the 8th grade program were accepted for middle schools and answers to the 10th grade programs were restricted to high schools. Because combination schools included students at different grade levels, making it impossible to isolate appropriate grade-level use, combination schools were also eliminated from the sample. Thus, in the final research sample, student usage was restricted to the grade level programs appropriate for elementary, middle and high schools. The second step in building the analysis data set was to eliminate all answers that were completed on a second or more try. This left only the first and second attempt at an answer on the first try, which maintains equivalence across students.

Tables 3, 4 and 5 show the total number of schools included in the elementary, middle and high school samples, both those that used the FCAT Explorer and those that did not. It also provides summary statistics for the 2002 FCAT mean school scores, Answers per Student, Percent Correct and Correct Answers per Student.

Table 3. Number of Schools Included in the 5th Grade Math Research Sample and Summary Statistics of Aggregated Scores

		5th Grade Math FCAT 2002 School Score	Answers per Student	Percent Correct	Correct Answers per Student
Schools that Used FCAT Explorer: 5th Grade Math	N of Schools	1,038	1,040	1,040	1,040
	Mean	318.26	44.86	0.72	29.29
	Std. Deviation	21.31	39.82	0.12	30.65
Schools that Did Not Use FCAT Explorer: 5th Grade Math	N of Schools	534	542	542	542
	Mean	312.58	0	0	0
	Std. Deviation	24.37	0	0	0

Table 3 shows that there were about three times as many elementary schools that used the FCAT Explorer as schools that did not use it. On average, students answered slightly more than a third of the items, or 44.86 items per school, and were correct 72% of the time. The averaged mean school math FCAT score for schools that used the FCAT Explorer was 5.7 points greater than the average score of schools that did not use the program.

Table 4. Number of Schools Included in the 8th Grade Math Research Sample and Summary Statistics of Aggregated Scores

		8th Grade Math FCAT 2002 School Score	Answers per Student	Percent Correct	Correct Answers per Student
Schools that Used FCAT Explorer: 8th Grade Math	N of Schools	319	319	319	319
	Mean	308.69	18.28	0.64	11.88
	Std. Deviation	20.22	21.76	0.20	14.47
Schools that Did Not Use FCAT Explorer: 8th Grade Math	N of Schools	183	184	184	184
	Mean	301.95	0	0	0
	Std. Deviation	22.37	0	0	0

Table 4 shows that there were only twice as many middle schools that used the FCAT Explorer as schools that did not use it. On average, students answered about one eighth of the items, or 18.28 items per school, and were correct only 64% of the time. The averaged mean school math FCAT scores for schools that used the FCAT Explorer were 6.7 points higher than the average score of schools that did not use the program. While usage of the 8th grade math program was much lower than school usage of the 5th grade program, there still appears to be an interesting difference in the FCAT scores of both groups.

Table 5. Number of Schools Included in the 10th Grade Math Research Sample and Summary Statistics of Aggregated Scores

		10th Grade Math FCAT 2002 School Score	Answers per Student	Percent Correct	Correct Answers per Student
Schools that Used FCAT Explorer: 10th Grade Math	N of Schools	203	203	203	203
	Mean	321.48	10.46	0.63	8.19
	Std. Deviation	16.48	27.61	0.19	70.91
Schools that Did Not Use FCAT Explorer: 10th Grade Math	N of Schools	135	136	136	136
	Mean	317.17	0	0	0
	Std. Deviation	18.57	0	0	0

In Table 5 the number of high schools that used the FCAT Explorer is only 1.5 times larger than schools that did not use it. Students answered only 10.46 items per school, and were correct 63% of the time. The averaged mean school math FCAT scores for schools that used the FCAT Explorer were only 4.3 points higher than the average score of schools that did not use the program. While usage of the 10th grade math program was much lower than school usage of ether the 5th or 8th grade programs, there is still a difference in the FCAT scores of both groups that could be attributable to use of the FCAT Explorer.

Analysis of the School Sample of FCAT Explorer Usage and 2002 FCAT Scores

In the summaries of the school sample data, the FCAT scores of schools that used the FCAT Explorer were consistently higher than the FCAT scores of schools that did not use the program. The next step in the analysis is to determine if these differences are statistically significant. To this end, difference of means tests on the mean school Math FCAT scores were run for each of the grade level programs, comparing schools that used the program and those that did not. Table

6 shows the results of the difference of means test for elementary schools using the FCAT Explorer: 5th Grade Math.

Table 6. Difference of Means Comparison of 2002 5th Grade Math FCAT Scores for Schools that Used the FCAT Explorer and Schools That Did Not Use the Program

Summary Statistics for 5th Grade Comparison

	Whether School Answered FCAT Explorer Items	N	Mean	Std. Deviation	Std. Error Mean
FCAT5M02	1 Yes	1038	318.26	21.306	.661
	2. No	534	312.58	24.368	1.054

Difference of Means Test Comparing 2002 FCAT Scores of Schools that Used FCAT Explorer: 5th Grade Math Versus Schools That Did Not Use It

		Levene's Test for Equality of Variances		t-test for Equality of						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2002 5th Grade Math FCAT	Equal variances assumed	7.503	.006	4.764	1570	.000	5.68	1.192	3.341	8.020
	Equal variances not assumed			4.564	958.49	.000	5.68	1.245	3.238	8.123

In this table it is clear that the difference between the 5th Grade FCAT scores is significantly different, at p = .000. Schools that used the FCAT Explorer: 5th Grade Math, to whatever extent, thus tended to score better on the 2002 Math FCAT than schools that did not use the program. This difference is seen again in the difference of means test for 8th Grade Math, as shown in Table 7. The difference in 2002 Math FCAT scores is again statistically significant for schools that used the program, at p = .001. This implies that use of the program, even at a lower level than 5th Grade Math, has a positive influence in student performance on the FCATs.

Table 7. Difference of Means Comparison of 2002 8th Grade Math FCAT Scores for Schools that Used the FCAT Explorer and Schools That Did Not Use the Program

Summary Statistics for 8th Grade Comparison

	Whether School Answered FCAT Explorer Items	N	Mean	Std. Deviation	Std. Error Mean
FCAT8M02	1 Yes	319	308.69	20.219	1.132
	2 No	183	301.95	22.367	1.653

Difference of Means Test Comparing 2002 FCAT Scores of Schools that Used FCAT Explorer: 8th Grade Math Versus Schools That Did Not Use It

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2002 8th Grade Math FCAT	Equal variances assumed	3.643	.057	3.461	500	.001	6.75	1.950	2.917	10.57
	Equal variances not assumed			3.367	348.7	.001	6.75	2.004	2.806	10.68

Table 8 shows the results of the difference of means test for the 10th Grade Math FCATs. Once again, schools that used the FCAT Explorer scored significantly higher on the FCATs than schools that did not use the program, at p = .029. This result is only borderline significant, and may be so low due to the low frequency of usage for this program. Nonetheless, the differences in mean school FCAT scores for schools that used the program and for schools that did not use it are consistently significant, indicating the FCAT Explorer plays a role in school and hopefully, students' performance on the Math FCATs. While the difference of means tests are simple tests for a complicated model, they do indicate that there is an effect that runs consistently across grade levels and programs.

Table 8. Difference of Means Comparison of 2002 10th Grade Math FCAT Scores for Schools that Used the FCAT Explorer and Schools That Did Not Use the Program

Summary Statistics for 10th Grade Comparison

	Whether School Answered FCAT Explorer Items	N	Mean	Std. Deviation	Std. Error Mean
FCAT10M	1 Yes	203	321.48	16.478	1.157
	2 No	136	317.17	18.569	1.592

Difference of Means Test Comparing 2002 FCAT Scores of Schools that Used FCAT Explorer: 10th Grade Math Versus Schools That Did Not Use It

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2002 10th Grade Math FCAT	Equal variances assumed	1.580	.210	2.244	337	.025	4.31	1.922	.533	8.094
	Equal variances not assumed			2.192	265.62	.029	4.31	1.968	.439	8.188

The next step in the analysis is to determine whether any or all of the aggregate usage variables stands out as an explanatory factor in the difference of FCAT scores. The method used to determine the explanatory factors is multiple regression. Each of the aggregated FCAT Explorer usage variables, Answers per Student, Percentage Correct and Correct Answers per Student, is entered into the model to explain the difference in FCAT scores among the schools that used the FCAT Explorer. In Table 9 the multiple regression results are depicted in three tables to test the model for 5th Grade Math: the model summary, an ANOVA test of the entire model and the multiple regression coefficients. The R^2 result is 0.089, indicating that the total explained variance in the model is low. However, the ANOVA indicates that the model as a whole explains a significant amount of change in the 2002 FCAT scores, with p = .000. The multiple regression coefficients show that, of the three usage factors, only the Percentage Correct explains the change in 2002 FCAT scores, with p = .000. Neither of the other two factors explains any significant change in the model.

Table 9. Multiple Regression of FCAT Explorer Usage Indicators for FCAT Explorer: 5th Grade Math on 2002 5th Grade Math FCAT Scores

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.296[a]	.088	.085	20.442

a. Predictors: (Constant), AVGCORCT, PCORCT, ANSS

ANOVA of Effects Model for FCAT Explorer: 5th Grade Math on 2002 Math FCAT Scores[b]

Mode		Sum Square	df	Mean	F	Sig.
1	Regression	42319.58	3	14106.52	33.75	.000[a]
	Residual	441273.	1056	417.87		
	Total	483592.	1059			

a. Predictors: (Constant), AVGCORCT,

b. Dependent Variable:

Coefficients of Effects Model for FCAT Explorer: 5th Grade Math on 2002 Math FCAT Scores[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	280.032	3.918		71.478	.000
	ANSS	3.529E-02	.019	.066	1.839	.066
	PCORCT	49.086	5.203	.280	9.435	.000
	AVGCORCT	3.651E-02	.025	.052	1.447	.148

a. Dependent Variable: FCAT2002

In Table 10 the multiple regression results are again depicted in three tables to test the model for 8th Grade Math: the model summary, an ANOVA test of the entire model and the multiple regression coefficients. The R^2 result is 0.082, again indicating that the total explained variance in this 8th grade model is also low. Once again, though, the ANOVA indicates that the model as a whole explains a significant amount of change in the 2002 FCAT scores, with p = .000. The multiple regression coefficients once again show that only the Percentage Correct explains the change in 2002 FCAT scores, with p = .000. Neither of the other two factors explains any significant change in the model. Again we see that the total percentage of correct answers from the first and second attempts has a positive, significant effect on the 2002 FCAT school scores.

Table 10. Multiple Regression of FCAT Explorer Usage Indicators for FCAT Explorer: 8th Grade Math on 2002 8^{th} Grade Math FCAT scores

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.261[a]	.068	.059	19.556

a. Predictors: (Constant), AVGCORCT, PCORCT, ANSS

ANOVA of Effects Model for FCAT Explorer: 8th Grade Math on 2002 Math FCAT Scores[b]

Mode		Sum Square	df	Mean	F	Sig.
1	Regression	8671.82	3	2890.60	7.559	.000[a]
	Residual	118170.	309	382.42		
	Total	126842.	312			

a. Predictors: (Constant), AVGCORCT,

b. Dependent Variable:

Coefficients of Effects Model for FCAT Explorer: 8th Grade Math on 2002 Math FCAT Scores[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	291.389	4.262		68.364	.000
	ANSS	-3.28E-02	.079	-.039	-.414	.680
	PCORCT	26.266	6.562	.226	4.003	.000
	AVGCORCT	.164	.130	.122	1.264	.207

a. Dependent Variable: FCAT2002

Table 11 once again presents the multiple regression results to test the model for 10^{th} Grade Math. The R^2 result in this test is 0.102, somewhat higher than the 5^{th} and 8^{th} grade models, but still fairly low. One again, though, the ANOVA indicates that the model as a whole explains a significant amount of change in the 2002 FCAT scores, with p = .000. One more time the multiple regression coefficients show that only the Percentage Correct significantly explains the change in 2002 FCAT scores, with p = .000. Neither of the other two factors explains any significant change in the model. With this 10th Grade model, we see that the total percentage of correct answers from the first and second attempts has a positive, significant effect on the 2002 FCAT school scores.

Table 11. Multiple Regression of FCAT Explorer Usage Indicators for FCAT Explorer: 10th Grade Math on 2002 10th Grade Math FCAT scores

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.321[a]	.103	.088	16.801

a. Predictors: (Constant), AVGCORCT, PCORCT, ANSS

ANOVA of Effects Model for FCAT Explorer: 10th Grade Math on 2002 Math FCAT [b]

Mode		Sum Square	df	Mean	F	Sig.
1	Regression	5738.72	3	1912.91	6.777	.000[a]
	Residual	49961.47	177	282.26		
	Total	55700.19	180			

a. Predictors: (Constant), AVGCORCT,

b. Dependent Variable:

oefficients of Effects Model for FCAT Explorer: 10th Grade Math on 2002 Math FCA Scores [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	303.993	3.943		77.103	.000
	ANSS	-4.38E-02	.077	-.041	-.567	.572
	PCORCT	27.167	6.087	.321	4.463	.000
	AVGCORCT	-1.06E-02	.017	-.045	-.632	.528

a. Dependent Variable: FCAT2002

With remarkable consistency, the results of the difference of means and multiple regression tests indicate that FCAT Explorer is plays a significant role in the 2002 mean school math FCAT scores of elementary, middle and high schools. The remarkable thing about the findings is that the total amount of usage is not an important as the actual fact of usage. The factor that explains the most change in FCAT scores appears to be the result of answering the practice items correctly, either at first attempt of after reading through the guidance feedback and answering the item in second attempt. There does appear to be an impact related to usage, in that as usage scores decrease, the significance of the findings also decreases. However, across the board, use of the FCAT Explorer appears to play a significant role in schools' (and students) success on the 2002 math FCATs.

Conclusions

The results of this study demonstrate that using interactive, Internet-based programs like the FCAT Explorer for practicing the math benchmarks and skills does enhance learning. This positive effect on math learning is reflected in student performance on the FCAT. The findings of this study clearly show that schools can benefit from online resources such as the FCAT Explorer.

In this report there were two statistical tests of the efficacy of the FCAT Explorer. The first test focused on whether the difference in 2002 mean school FCAT scores for math were significantly different for schools that used the program and schools that did not use the program. The study had to use school level scores rather than student scores because the latter are not made available by the Florida Department of Education. In this first set of tests, the differences in 2002 mean school FCAT scores in math was statistically significant for elementary, middle and high school students. This indicates that use of the FCAT Explorer math programs has a significant effect on a school's performance on the FCAT . We would infer that the same effect holds true for individual students; use of the FCAT Explorer math program helps student performance on the FCAT.

The second statistical test was intended to determine which usage factor related to the FCAT Explorer did a better job of explaining the difference in FCAT scores. The three factors were: student activity, student performance on items and a construct joining activity and performance. For each of the FCAT Explorer programs, the percent of correct answers achieved by a school had the most significant predictive value for FCAT performance. This finding is consistent with the argument that the design of the program, using graphics, concrete examples and guidance feedback helps the students master the math skills at their grade level. In the program, students have two attempts to answer an item correctly; the percent correct variable is a summary indicator of these two attempts. We conclude, therefore, that the additional students who are able to answer an item correctly after receiving the guidance feedback and making a second attempt in the FCAT Explorer increases both student performance and school level performance on the FCAT.

This research constitutes a first step in a research agenda to link the use of educational software with performance on standardized tests. As such, the research offers a broad analysis of the impact of student use of the FCAT Explorer on FCAT scores by comparing aggregate data at the school level to infer effects at the student level. Because the results of the study show that aggregated student usage of the FCAT Explorer has a measurable effect on mean school FCAT scores, further detailed investigation is required.

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