Reading is Fundamental in Predicting Math Achievement in 10th Graders

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Achieving proficiency in mathematics appears to be a particular area of challenge for students in the United States. The Trends in International Mathematics and Science Study (TIMSS) recently released results for 2003 testing, and revealed that eighth graders in the United States rank 15th among 46 participating countries (Snell, 2005). Although these results are a significant improvement from the 1995 performance, the United States students still rank near the bottom when compared to other students from industrialized nations. Research in the area of mathematics achievement has examined a number of explanations as to why some students will test proficient and many will not (e.g., Hyde, Fennema, & Lamon, 1990; Mason, & Scrivani, 2004; Mevarech, Silber, & Fine, 1991; Rangappa, 1993, 1994). Using data extracted from the Education Longitudinal Study (ELS, 2004), the present study investigated the impact of student reading ability, student math self-efficacy, teacher expectations, and the use of computers in the teaching of mathematics in predicting student math achievement. Findings reveal that 56% of the variance in student math achievement can be explained by students' reading ability. The results of the final regression model also revealed that higher levels of math-self-efficacy and higher levels of teachers' expectations were associated with higher math achievement scores. However, a negative association between computer-assisted instruction and student math achievement scores was found.

Keywords: high school mathematics, reading ability, mathematics self-efficacy

Achieving proficiency in the area of mathematics appears to be a particular area of challenge for students in the United States. The Trends in International Mathematics and Science Study (TIMSS) released results for 2003 testing, and revealed that eighth graders in the United States rank 15th among 46 participating countries (Snell, 2005). Although these results are a significant improvement from the 1995 performance, the United States students still rank near the bottom when compared to other students from industrialized nations. Research in the area of mathematics achievement has examined a number of explanations as to why some students will test proficient and many will not (e.g., Hyde, Fennema, & Lamon, 1990; Mason, & Scrivani, 2004; Mevarech, Silber, & Fine, 1991; Rangappa, 1993, 1994).

One variable, that historically has received considerable attention is the research in terms of its effects on math achievement and performance, is gender. Although the TIMSS found significant differences between males and females in math performance, with males significantly outperforming females, many of the researchers who have investigated the various explanations for differences in math achievement have also addressed the variable of gender, and generally have failed to find significant differences (e.g., Hyde, Fennema, & Lamon, 1990; Mason, & Scrivani, 2004; Mevarech, Silber, & Fine, 1991; Rangappa, 1993, 1994). Thus the question of gender differences in math achievement remains an issue that is not completely resolved at present.

Another variable that has been investigated as a potential contributor to success in mathematics is computer-assisted instruction (CAI). In a review of five different studies on

CAI, Schacter (1999), found that CAI facilitates differentiated instruction to each student's particular ability levels and learning speeds, provides visual imagery of difficult abstract concepts, and enables the instructor to more quickly and objectively identify students' areas of weakness. At the same time, the value that computer-assisted instruction can offer can be restricted by availability of equipment, instructor's mastery of technology, and the student's level of computer experience. Mevarech, Silber, and Fine (1991) investigated the use of computer-assisted instruction, for the purpose of drill and practice, in small groups and individually, with 149 junior high school math students. They found that compared to students who used computer-assisted instruction individually, CAI had a moderate positive impact on the achievement of small group participants, increasing their average student performance from the 50th percentile to the 73rd percentile. Mevarech et al. concluded that the small group instruction helped students to overcome some of the barriers to successfully learn mathematics with a computer. They also found that students in the small learning groups also reported improved attitudes about mathematics, and their ability in mathematics.

Student attitudes about math and their attitudes about their ability in math have been recognized as predictors of mathematics achievement. Rangappa (1994) posits that a student's view of their own abilities and willingness to accept responsibility in their learning can impact that student's achievement. In a study of data from 1000 students from rural and urban areas of Bangalore, India, Rangappa found significant differences in mathematics achievement for students with high, normal, and low self-concepts. Rangappa compared mean group differences, and found that significant differences existed between all three levels of students on the measure of self-concept. Rangappa concluded that students with high self-concepts performed better in mathematics than students with normal or low self-concepts.

Mason and Scrivani (2004) also investigated aspects of student's math self-concept. They specifically examined student's math attitudes and math self-evaluations in two innovative activity-based learning classrooms, relative to students in two traditional mathematics classrooms. Initial measures found that there were significant associations between student attitudes and self-evaluations regarding mathematics and their math problem solving abilities. Pre-tests revealed that no significant differences existed between groups on mathematics ability. However, post-tests revealed that students in the innovative classroom significantly outperformed students in the traditional learning sections on the post-test measure. Mason and Scrivani found that students in the innovative learning environment reported greater improvement in their mathematics attitudes and beliefs relative to students in the traditional sections, and thus concluded that mathematical beliefs contributed significantly to student achievement.

Teacher's evaluation of the student's ability can also be predictive of student achievement. In a study of 500 junior high and high school mathematics students, Smith, Jussim, and Eccles (1999) found that teachers' expectations were able to accurately predict student performance, although how well teachers' expectations predicted student performance decreased from the sixth grade through the twelfth grade. Interestingly, teachers' expectations were better predictors of tenth grader math performance than the tenth grade students' self-concept measures. Smith et al. suggest that teacher's expectations may be predictive of student achievement because of accuracy, rather than because of the effect of a self-fulfilling prophecy.

Relatively little research has examined the relationship between student's reading ability, as measured on short term or standardized reading assessments, and level of math achievement, as measured on standardized high stakes math achievement tests. In the standardized math assessments that are in use today, the questions are presented in a word problem format (U.S. Department of Education, 1996). Therefore, in practice, poor reading ability automatically undermines a student's likelihood of success on math achievement measures.

Research examining math problem-solving presented in a word problem format indicates that the cognitive processes involved in solving word problems are very complex. Kintsch and Greeno (1985) proposed that three different sets of knowledge structures can come into play when solving word problems. First, the written text of the problem must be represented conceptually by a set of "propositional frames" (p.111) in which the mathematical sentence is translated into a proposition. Secondly, Kintsch and Greeno posit that the student constructs a "problem model" (p. 111) in which the properties and relations in the problem are constructed into a general form of the math problem. Lastly, "action schemata" (p. 111), which contain the information and procedures needed to solve the math problem, are developed. According to Kintsch and Greeno, at this step any irrelevant information is excluded by the problem solver, and any information omitted from the original problem as stated may be inferred. The authors maintain that for any word problem, a version of these knowledge and action schemata are activated as the individual works to solve the problem. According to the research of Kintsch and Greeno, the linguistic part of understanding the text of a math problem is imperative to being able to successfully solve the problem. In light of these assertions, it seems plausible to predict that reading may play an important role in student mathematics achievement. The present study was designed to examine this relationship.

In a study of data from 1000 students from rural and urban areas of Bangalore, India, Rangappa (1993) found that reading ability had a direct bearing on student performance on standardized math achievement exams. Rangappa found that high ability readers performed significantly better on standardized math achievement exams relative to normal ability readers, and normal ability readers performed significantly better on standardized math achievement exams relative to low ability readers. In another study conducted with second grade students from India, Majumder (2003) concluded that reading comprehension was a strong predictor of student's ability to solve word problems. Majumder also suggest that issues with inhibited attention may also play a role in the difficulties with math word problems, however more research is necessary. In one other study on the relationship between math and reading achievement, Bull and Johnston (1997) found a significant correlation between these two factors with a group of seven year old children. These authors suggested that a speed of processing deficit that exists due to poor reading skills might explain why these same children struggle with math problems presented in a word-problem format.

Given this mix of theoretical propositions and research evidence (albeit limited) suggesting a relationship between reading ability and student mathematics achievement, the goal of the present investigation is to assess the role of reading ability as a predictor of mathematics achievement relative to a number of other variables that have also been shown to be related to the prediction of mathematics achievement. Specifically, this study will investigate the additive predictability of the amount of computer-assisted instruction used in mathematics instruction, level of student math self-efficacy, and teacher's expectations of students—along with reading ability-- to see if these variables are also significantly predictive of 10th grade student's mathematics achievement, as measured on a standardized math assessment. This study will also attempt to validate previous findings that gender is not predictive of math achievement. Therefore, this project will test the following research hypotheses:

1. Is there a difference between the male and female students with respect to their math achievement?
2. Do the students' reading abilities predict their math achievement?
3. Do the variables of computer-assisted instruction, student math self-efficacy, and teacher evaluation of the students improve prediction of math achievement over and above reading ability?

Methods

Data and Sample

The data set used for this study was extracted from the Education Longitudinal Study: 2002 (ELS, 2004). This is an ongoing longitudinal study designed to monitor the transition of a national sample of adolescents as they progress from the 10th grade through high school, and on through their post secondary education, vocational education, or early work experiences. The ELS-2002 project acquired information from the students, the student's school records, and the student's parents, teachers, and school administrators. One of the primary focal points of the ELS-2002 initiative is to follow students across a six year period of time in order to assess the student's academic growth in mathematics, and examine how well the student has been prepared in his/her mathematics education for post-secondary educational experiences and the job force. This data set was made available to the researcher through a university-based license for the use of the data set. The data set is available for public use through the National Center for Educational Statistics (NCES) at nces.gov.

Participants in ELS-2002 were chosen through a two stage selection process. Initially, 27,000 schools were randomly selected from the nation's schools. Schools were selected from the 27,000 whose school population reflects national ethnicity distributions, resulting in 752 participating schools in the study. These schools were asked to provide their enrollment list of 10th grade students, and 26 tenth grade students were selected by means of stratified systematic sampling from each of the schools. This was done in an effort to ensure that the sample distribution of students' ethnicities was reflective of the nation's population. Of the selected students, 87.3 percent participated by completing the student questionnaire. There were some cases in which the students completed the questionnaire but did not complete the academic assessments. Additionally, there were cases where teachers did not complete the teaching faculty inventories. These assessments and inventories were released to the school districts, and their administration was overseen by the school appointed survey administrators. A detailed discussion of the data collection process is available in the ELS-2002 codebook (Education Longitudinal Study, 2004).

Table 1

Summary of exploratory factor analysis using maximum likelihood estimation (n=442)

Item	Computer-Assisted Instruction	Mathematics Self-Efficacy	Teacher Expectations
How often uses computers to solve math problems	**0.807**	-0.013	0.035
How often uses computers to practice math drills	**0.774**	0.025	-0.021
How often uses computers to analyze data in math class	**0.759**	0.094	-0.029
How often uses computers to apply learning in math class	**0.704**	0.023	0.116
How often uses computers for graphing in math class	**0.669**	0.084	-0.048
How often math teacher uses computer to instruct one-on-one	**0.632**	0.057	-0.071
How often uses computers to review math work	**0.598**	0.006	0.016
How often math teacher uses computer to show new topics	**0.530**	0.102	0.016
Can understand difficult math class	0.029	**0.878**	0.042
Can master math class skills	0.016	**0.855**	0.068
Can understand difficult math texts	0.056	**0.847**	0.026
Can do excellent job on math tests	0.030	**0.804**	0.177
Think math is fun	0.100	**0.525**	0.110
Math is important	0.030	**0.493**	0.051
How often totally absorbed in math	0.060	**0.396**	0.065
How often student completes homework (math)	-0.017	0.129	**0.867**
Student usually works hard for good grades (math)	-0.027	0.166	**0.698**
How often student is attentive in class (math)	-0.044	0.182	**0.687**
Student relates well to others (math)	0.032	-0.004	**0.306**
Eigenvalues	3.831	3.650	1.886
% of variance	20.161	19.208	9.928

Note: Factor loadings above .30 appear in bold.

For the purpose of the present investigation, participant data was included if all necessary data needed for the variables for this investigation was provided for the participant. These included: math achievement test scores, reading achievement tests results, a completed self-report student survey, and a mathematics teacher evaluation of the tenth grade student for the 2002/2003 school year. This resulted in an initial sample size of 554. According to the codebook for the ELS-2002 data set, many schools were not able to complete all teacher surveys due to time constraints, and many students were not able to participate in the academic assessments, that were administered by their respective schools, because of learning disabilities or time constraints, thereby creating a large amount of missing data for the items of interest for this investigation. After the listwise deletion of missing cases, when performing an exploratory factor analysis, the final sample size for this investigation included data for 442 tenth grade participants from different schools.

A content-based analysis of variables in the data set revealed eight items that described the use of computer-assisted instruction, seven items that describe student's feelings regarding mathematics, and seven items in which mathematics teachers described their evaluations of a specific participant. Although these sets of items intuitively describe three different composite items, an exploratory factor analysis was used to verify that the items initially identified as measuring the same constructs did indeed empirically cluster together as expected. An exploratory factor analysis, using maximum likelihood estimation with a varimax rotation, was performed through SPSS 15.0.1 on 22 variables from the ELS-2002 data set. The maximum likelihood rotation method of exploratory factor analysis was selected because of the robustness of the technique and because of the large sample of participants in this data set. Varimax rotation was selected in an effort to develop factors that were not highly correlated, and thus appropriate for multiple regression analysis procedures. The exploratory factor analysis revealed that three factors were extracted which contained 19 of the 22 variables. The values for each of the three factors were summated from the variables associated each factor. As indicated in Table 1, rotated factors are well-defined by this factor solution.

The loading of variables on factors, as well as the respective eigenvalues and percent of variance explained, are shown in Table 1. The interpretive labels of computer-assisted instruction, student math self-efficacy, and teacher's expectancy have been appropriately assigned to each factor.

Student Math Self-Efficacy Factor and CAI Factor

Student questionnaires asked students to respond to a number of questions regarding their background, family life, peer relationships, school experiences, and future plans. Some of the student information was cross-validated using records provided by the student's schools, as well as information provided through the parent questionnaires. Exploratory factor analysis revealed that all of the student questionnaire items regarding student's attitudes and beliefs about math clustered together empirically, therefore confirming the decision to construct a composite index of the self-reported student math-self efficacy for these items. Three items were recoded, prior to the factor analysis: math is fun, math is important, and how often totally absorbed in math. Student items were compiled into a Student's Math Self-Efficacy Factor which included student responses to items specifically in reference to mathematics, including: can understand difficult math class, can understand difficult math texts, can master math class skills, can do excellent job on math tests, math is fun, math is important, and how often totally absorbed in math.

Student responses were also used to develop a computer-assisted instruction in mathematics factor as a predictor of math success in high school mathematics. Eight of eight questionnaire items, in which students responded concerning the level of computer use in math classes, compiled together empirically through exploratory factor analysis. The Computer-assisted instruction in mathematics factor included student responses to the following items: how often uses computer to solve math problems, how often uses computer to apply learning in math classes, how often use computers to analyze data in math classes, how often uses computers to practice math drills, how often teacher uses computers to instruct one-to-one, how often uses computers for graphing in math classes, how often uses computer to review math work, and how often uses computers to show new topics.

Teacher Expectation Factor

Teacher evaluations were conducted, via mailed questionnaires, in order to assess the teacher's perceptions of the student's motivation and performance. Teachers were asked to rate various aspects of the student, such as how hard the student works for good grades in their particular class, whether or not homework assignments were generally turned in on time and completed, and items regarding student attendance, attentiveness, and willingness to engage in the classroom experience. Exploratory factor analysis revealed that four of the seven student questionnaire items regarding teacher's evaluation and expectations of each student, clustered together empirically, therefore confirming the decision to construct a composite of the teacher expectancy for these items. Teacher items included in the exploratory factor analysis included: how often student completes homework assignments, how often the student is attentive in class, how well the student relates well to others, and how hard student works for grades.

Assessment Measures

The dependent variable for this study is the participant's score on a standardized math assessment containing items in arithmetic, algebra, geometry, data analysis, probability, and advanced topics, which was developed from the National Education Longitudinal Study of 1988 (NELS, 88) and the National Assessment of Educational Progress (NEAP) test forms. The assessment was divided into categories of skills and knowledge, understanding and comprehension, and problem solving. Ninety percent of the math assessment was presented in a multiple choice format with the remaining ten percent presented as open ended questions that were scored as either correct or incorrect. No partial credit was given.

Student reading ability was measured with a thirty-item reading assessment that was developed from the Program for International Student Assessment (PISA. 2000) reading assessment. The items focused on reading applications, including diagrams and graphs, and included literary pieces, as well as topics of natural science and social science. The reading assessment was administered in two stages. Students were initially given one reading passage followed by six questions. School appointed survey administrators conducted the two stage reading ability test, which was developed from a selection of questions used in the PISA (A sample of the PISA-2000 questions can be found at http://www.oecd.org.). These assessments were administered as paper and pencil inventories. The first stage reading assessment answer sheets were scored by survey administrators who then used that score to assign the students to a low, middle or high difficulty second stage form of the reading assessment, depending on the student's number of correct answers in the first stage of the assessment. The second stage of the assessment included skill-level appropriate multiple choice items and free response items. The second stage of the reading assessment was scored according to the number of correct responses.

According to the ELS-2002 codebook (p.21), the goal of using the two-stage procedure was designed to maximize the accuracy of measurement that could be achieved in a limited amount of testing time, while minimizing floor and ceiling effects. The psychometric properties of these instruments were not presented in the ELS-2002 codebook. However, according to the ELS-2002 codebook (p.19) the scores used to describe student performance on mathematics and reading are based on Item Response Theory, and take into account the student's ability, question difficulty, omitted answers, and guessing.

Results

An independent samples t-test was performed to see if significant differences exist between the 240 female (M=42.14, SD=11.77) and 202 male (M=44.32, SD=12.52) participants in this data set, on the dependent variable of mathematics achievement. No significant differences were revealed, p = .061. Descriptive statistics for each of the three factors, the independent variable reading achievement, as well as mean differences across gender, are presented in Table 2.

Table 2

Descriptive statistics for factors across gender (n = 442)

	Male (N = 202)		*Female (N = 240)*		
	M	*SD*	*M*	*SD*	*t*
Reading Achievement	561	91.9	570	85.1	-1.16
CAI	-0.02	0.099	0.017	0.90	-0.39
Student Math Self-Efficacy	0.203	0.95	-0.177	0.93	4.18*
Teacher Expectations	-0.177	0.95	0.15	0.85	-0.38*

Note: * p <.01, CAI: Computer-assisted instruction. [A score of 672 is highest level of proficiency on the Reading Achievement measure; CAI, Student Math Self-Efficacy, and Teacher Expectations are weighted factor scores that range from -1.0 to 1.0.]

Descriptive statistics indicated that all variables are normally distributed. Cronbach's α, a measure of internal consistency was estimated for each of the predictor variables, indicated that reliabilities were acceptable high (Reading Achievement, α=0.81; CAI, α=0.83; Student Math Self-Efficacy, α=0.82; Teacher Expectations, α=0.91). Bivariate correlational analyses reveal that mathematics achievement is significantly correlated (p<.001) with each of the four predictor variables. Small significant correlations exist between four of the predictor variables. This potentially is the result of the large sample size included in these analyses. Tolerance statistics were computed to investigate if multicollinearity exists between the predictor variables. These statistics indicate that all tolerance levels for the four predictor variables exceed .866, indicating that multicollinearity is not a concern (see Pedhazur, 1997). Bivariate correlations are presented in Table 3.

Table 3
Inter-correlations for Math Achievement and four predictor variables

Measure	1	2	3	4	5
1) Math Achievement	--				
2) Reading Ability	.749**	--			
3) Computer-Assisted Instruction	-.260**	.262**	--		
4) Student Math Self-Efficacy	.316**	.096*	.113*	--	
5) Teacher Expectations	.293**	.217**	-0.012	.242**	--

Note: *p<.05, **p<.01

Table 4
Summary of regression analyses for variables predicting math achievement (n = 442)

Variable	*Model 1*			*Model 2*		
	B	*SE B*	*Β*	*B*	*SE B*	*β*
Reading Ability	.104	.004	.749***	.094	.004	.679***
CAI				-.184	.051	-.108***
Math self-efficacy				.614	.076	.242***
Teacher expectations				.574	.204	.085**
Intercept		-15.549			-23.967	
R^2 (adjusted R^2)		.561(.560)			.638(.635)	
Fchange		562.143			31.021	
F		562.143			192.56***	

Note: ** p < .01, *** p <.001

After verifying that all assumptions for multiple regression analyses were tenable, a hierarchical linear regression analysis was conducted in an effort to investigate whether reading ability, as measured on a 30 item reading assessment, was predictive of student math achievement, as measured on a standardized math assessment. This initial model accounted for 56.1% of the variance in the student's level of math achievement, R^2=.561, adjusted R^2=.560, $F(1,440)=562.143$, $p<.001$. The results indicate that reading achievement is a significant predictor of the student's level of mathematics achievement ($\beta = .749$, $p <.001$). A second model was tested in order to investigate whether the addition of the independent variables, computer-assisted instruction use in mathematics education, student's math self-efficacy, and teacher's expectations of the student, would significantly add to the prediction of student math achievement. Together, the four independent variables accounted for 63.8% of the variance of the student's level of math achievement in the final model, R^2=.638, adjusted R^2=.635, $F(4,437)=192.56$, $p<.001$. The addition of the three factors in the second (final) model significantly improved the model fit, *Fchange* (3, 437)=31.02, $p<.001$. The results of the final regression model reveals that higher levels of math-self efficacy (β =.242, $p<.001$), and higher levels of teachers expectations (β=.085, $p<.01$), were associated with higher math achievement scores. These results also revealed a negative association between the level of computer-assisted instruction used (β=-.108, $p<.001$) and student math achievement scores. Interaction effects, between gender and student math self-efficacy and gender and teacher's expectations, were analyzed in the regression model with the four independent variables. This analysis was conducted because the independent *t* tests indicated that significant differences exist for males relative to females for the variables of student math self-efficacy and teacher's expectations. These interaction effects were not statistically significant. The results of the regression analyses are shown in Table 4.

Discussion

In a research report in *Psychological Science,* Johns, Schmander, and Martens (2005) discussed the prevalence of gender stereotypes in the area of mathematics achievement, and how the persistence of these stereotypes serve to hinder females' performance in mathematics. At the same time, many researchers (e.g., Hyde, Fennema, & Lamon, 1990; Mason, & Scrivani, 2004; Mevarech, Silber, & Fine, 1991; Rangappa, 1993, 1994) investigating the predictors of math achievement have found that females do not perform significantly different from their male counterparts. Interestingly, although the data analyses in the present study also did not reveal any significant gender-based differences in math achievement, significant differences in student's math self-efficacy and teacher expectations across gender do exist in the present data. While researchers such as Johns et al. (2005) suggest that math stereotypes are problematic for female students, the data in the present study revealed that teachers' expectations of female students were significantly *higher* relative to their expectations of male students. This sort of discrepancy suggests the need for additional research investigating the pervasiveness and potency of math-related gender stereotypes today.

Research in the area of CAI in mathematics has suggested that computers can have a small but significant impact on student achievement in mathematics. Unfortunately, the research examining the impact of CAI in mathematics is minimal and spotty. This makes it difficult to determine if CAI is presently having an impact on student learning as students become more acclimated to using computers as a medium for communication and learning, or if computer-assisted instruction's may have a negligible impact because significant numbers of teachers continue to report that they are not "reasonably familiar and comfortable using computers" and that computer technology is not sufficiently available in their classrooms, as found in a recent study (U.S. Department of Education, 2005). The ELS-2002 data set is the first of many national data sets to include measures of the use of computer-assisted instruction, providing researchers with the opportunity to examine whether or not there is an association between level of computer use in mathematics and students' level of math achievement. The results of the present study indicate that the use of CAI did add significantly to the explanation of variance in 10^{th} grade student's math achievement scores. However, the findings of this present investigation indicate that there is a negative relationship between the use of computer-assisted instruction and mathematics achievement scores rather than evidence that CAI improves achievement in mathematics.

Although prior studies (e.g., Mevarech, 1985; Mevarech et al., 1991) have indicated that computer-assisted instruction, implemented with activity based learning and/or cooperative learning groups, can produce a small to moderate impact on student mathematics achievement, Mevarech, et al. also reported that computer-assisted instruction, used on an individual basis, has been found to negatively impact student achievement in mathematics (p.234). Interestingly, Mevarech et al.'s research also reported a strong association between computer-assisted instruction and math self-concept. They found that CAI had a significantly higher positive impact on the mathematics self-concept level of low achievers, relative to high achievers. Thus, the effect of computer-assisted instruction on student math achievement in the presently available research is equivocal and additional research delineating the potential moderating and/or mediating variables that may be involved is needed. These findings might suggest that more professional development on the use of technology in the mathematics classroom might be needed.

For the present study, student math self-efficacy significantly contributed to the predictions of student math achievement. This finding is consistent with earlier conclusions of Mason and Scrivani (2004), Mevarech et al. (1991), and Rangappa (1994) who found a strong association between math self-concept and mathematics achievement. Interestingly, teacher expectations of the students did not correlate with students' math self-efficacies in the present study, but did also contribute significantly to the variance accounted for in the regression model. These outcomes seem to indicate that while there is a significant association between student math self-efficacy and math achievement, and teacher's expectations and math achievement, it is possible that the small correlation between student math self-efficacy and teacher's expectations indicates, as suggested by Jussim (1989), that teacher's expectations are highly predictive of student performance because they are accurate, and not because they create self-fulfilling prophecies in students as has often been surmised (e.g., Eden & Shani, 1982; Rosenthal & Jacobson, 1968; Snyder, Tanke, & Berscheid,1977).

Reading ability, as measured with the ELS-2002 reading assessment, significantly contributed to the prediction of student math achievement scores in both the first and final model of the regression analyses. The addition the computer-assisted instruction factor, the student's math-self efficacy factor, and the teacher's expectations factor to the final model significantly improved the model fit of the prediction equation. There were no significant differences found when comparing the mean reading achievement scores for females, relative to males, and the correlation of reading to math achievement was very strong. These findings are consistent with the conclusions of Rangappa (1993), Bull and Johnston (1997), and Majumder (2003) which maintain that reading ability has a direct impact on student mathematics achievement.

The current investigation contributes appreciably to the limited research examining the link between reading ability and mathematics achievement. First, this study provides confirmation of the prior findings linking these two variables. Unlike prior research studies, the data for the current investigation includes 442 students each from different schools, in different school districts, from different regions of the United States. This dynamic provides valuable information about the stability of these findings without the basic violation of independence that often afflicts social science research. Violations of independence occur when data is drawn from existing classrooms of students, or existing groups of individuals, as was the case in the earlier studies. These violations can result in meaningless correlations that occur because environmental factors will affect the members of a classroom the same way, and inflate the likelihood of Type One errors in study's conclusions (Myers & Well, 2003, p.

87). Therefore, not only does the present study provide confirmation of earlier research, it does so with a stronger research design by using independent data through a systematic standardized collection process.

Second, this study is distinct in that it examines the potential of a reading ability math achievement link relative to other variables that have been considered instrumental in student's math achievement in prior research. This is the first study investigating reading ability relative to computer assisted instruction, student's mathematics self-efficacy, and teacher expectations about math achievement. Interestingly, the findings presented here suggest that reading ability is the strongest predictor of math achievement, followed by student's mathematics self-efficacy, computer assisted instruction, and teacher's expectations.

Last, the current investigation is unique in that it examines the reading ability mathematics achievement link specifically with tenth grade high school age students. Previous research focused exclusively on elementary school age children. This is noteworthy in that the current findings suggest that the linkage that is found in elementary school age children is sustained through the high school years. Specifically, these results suggest that weak reading ability issues that are not addressed in younger children may plague their mathematics achievement as they advance to high school and beyond.

Conclusion

Kintsch and Greeno (1985) maintain that solving word problems in mathematics involves a high level of cognitive complexity, and this fact may offer some insight as to why reading and math achievement are so strongly associated. Standardized mathematics assessment questions are predominantly written in word problem format (U.S. Department of Education, 1996). Therefore, the student must be able to read the word problem at the most basic level of word recognition, and must be able to comprehend the words well enough for them to be transformed into a conceptual understanding of the text. Once this is accomplished, the student must be able to move this conceptual understanding into the construction of a problem model. Only then is the student able to proceed to calculating the solution, based on the rules of arithmetic. For the student who is a low-ability reader, advancing beyond word recognition and comprehension may be a difficult-to-impossible task. The findings of this investigation suggest that even the gifted mathematician who is not proficient in reading will be challenged beyond his or her ability to succeed when participating in achievement testing written in the word-problem format.

The purpose of academic testing is to establish the students', the school districts', and the state board of educations' level of proficiency across the primary academic areas of math, reading, writing, citizenship, and science. The goal of research in the area of education is to assist states, school districts, and teachers in providing proven educational programs for its students, so that *no child* is left behind. If research in the area of mathematics achievement is going to be able to provide educators with explanations as to why some students will test proficient and many will not, and with solutions which can help to ensure that more students will be successful on the mandatory mathematics assessments, the findings of this present study suggest that reading ability, specifically the ability to read and comprehend word-problems, should be a focal point of future research.

Mel Levine (2002) has worked individually with students struggling in reading and found that individual brains are often wired differently causing some students to struggle in all areas of academic coursework. “There are 44 sounds in the English language. Some children's minds have problems differentiating sounds and have problems reading, writing, and spelling words” (p. 42). This does not necessarily mean that these children possess low intelligence scores; however, based upon the manner in which we assess students in the United States which is heavily favored to reading ability, other areas of assessment, such as mathematics, will result in lower scores. Similar challenges exist for non-native English speaking students trying to complete standardized assessments in algebra coursework (Macgregor & Price, 1999). These authors suggest that mathematics coursework should be postponed until these students have developed the appropriate linguistic and subsequently, reading skills, to support the processing of word problems.

Further research is needed which addresses the problem of how to test students in a manner that is truly valid of that particular subject area without the necessity that depends heavily on another content area. The current investigation also suggests that nationally, strides in mathematics might be best achieved by first addressing the continuing problem of the low reading abilities of the students in our nation’s schools. Only then will students be able to successfully perform on standardized mathematics exams constructed overwhelmingly of word problems.

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