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ABSTRACT

Hierarchical linear modeling was used to examine the effects of individual and classroom level factors on reported value of mathematics for students (n=557) in grades three, four, and six. Data for this study came from the "Childhood and Beyond" study. Results indicated that the use of computers and computer efficacy were both positively related to students' valuing of mathematics. A negative relationship was found between teachers giving parents positive feedback and students' levels of valuing math in classrooms. This is in contrast to prior studies that suggest parents' ratings of students' abilities in math are related to students' interest in math. It was determined that grade level is not a significant predictor of valuing mathematics, but that attending a middle level school has detrimental effects on students' valuing of mathematics. The results of the study suggest that teachers do make a difference and that, after controlling for various student characteristics, classroom-level variables still have important effects on students' valuing of mathematics. (SYB)

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Running head: LEARNING TO VALUE MATHEMATICS

# Learning to Value Mathematics: Individual Differences and Classroom Effects

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## Abstract

We used student and teacher data in a sample of 577 students in grades three, four, and six to examine the effects of individual and classroom level factors on students' reported valuing of mathematics. We used hierarchical linear modeling to examine the unique effects of individual and classroom factors. Results suggest that students who spend free time engaged in math-related activities, students who have a high self-concept of ability in mathematics, students who worry about math performance, and students whose parents help them with math homework value math more than other students. However, students who attend middle schools value math less than other students. Using teacher-reported classroom level data, we found that students value mathematics more when they are in classrooms where teachers use computers in math instruction, and where teachers report feeling efficacious at using computers. Students appear to value math less when their teachers report positive feedback to parents about student performance.

Learning to Value Mathematics: Individual Differences and Classroom Effects

Motivational researchers espouse the view that students' self-perceptions of ability and students' subjective task values are predictive of motivation to engage in various activities (Eccles et al., 1983; Wigfield & Eccles, 1992). Prior studies suggest that self-perceptions of ability and task-values can be measured successfully in elementary school children (Eccles, Wigfield, Harold, & Blumenfeld, 1993a; Harter, 1982).

Nevertheless, research to date has not examined the specific effects of being in a particular classroom on students' valuing of academic subjects. Do teachers have an impact on values? Do different instructional practices influence task values? The purpose of the present study is to examine the effects of classroom environments on the valuing of mathematics.

Why do Some Children Value Mathematics While Others Don't?

Prior research suggests that several student characteristics are important predictors of valuing mathematics. For example, prior studies suggest that younger children value mathematics more than older children (Eccles et al., 1993a). In addition, studies suggest that some student value mathematics less after the transition to junior high school than before (Eccles & Midgley, 1989). Gender has emerged as an important mediating factor in students' choices of whether or not to enroll in advanced mathematics courses (Eccles, Adler, & Meece, 1984). Finally, several studies suggest that anxiety has a negative impact on most educational outcomes (see Covington & Omelich, 1987).

In addition, parents may play an important role in students' sense of well being, intrinsic motivation, and performance in school. For example, Flanagan (1989) found that adolescents who report being involved in family decision making processes also higher self-esteem and intrinsic motivation. It is indeed possible and plausible that the relationships between home events and motivation may have its roots in practices exhibited during the elementary school years.

Classroom Characteristics

Studies to date have not examined the unique effect of classroom characteristics on students' valuing of mathematics. Educational and psychological research of student achievement, cognition, performance, and motivation only recently have begun to embrace appropriate statistical techniques to examine nested designs (cf., Bryk & Raudenbush, 1992). Therefore, in the present study, using data from teachers, we chose to examine the effects of several classroom-level variables on the valuing of mathematics.

There are numerous classroom level predictors which may be related to students' reported valuing of academic subjects. Research suggests that classroom level factors may have an impact on student motivation (e.g., Ames, 1992; Anderman & Young, 1994). Although many schools are obtaining sophisticated computers and technology (e.g., O'Connor & Brie, 1994), little research to date has examined the motivational effects of computers and technology on motivation. Nevertheless, it is plausible that the use of technology will be related to a greater sense of valuing mathematics and motivation to study mathematics in the future (cf., Kozma, 1991).

Teachers may have different practices of communication with parents. Since research documents that parents' perceptions of students' ability are related to students interest in math (cf., Eccles et al., 1993b), it is indeed plausible that different patterns of



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teacher-parent communication about student performance may have an impact on students' valuing of mathematics.

Consequently, in the present study, we use hierarchical linear modeling (cf., Bryk & Raudenbush, 1994) to examine the unique effects of student characteristics and classroom contexts on students' reported valuing of mathematics. We utilize both student and teacher data to characterize the students' characteristics and the classroom environments.

## Procedure

### Sample

Data for this study come from the fourth year of data from the "Childhood and Beyond" study. This study was designed to investigate the development of children's self- and task-perceptions and values during middle childhood and early adolescence. The student sample consists of 577 students from thirteen schools. The students are about equally divided by gender (52% female, 48% male). Twenty-seven percent of the students are in the third grade, 27% are in the fourth grade, and 45% are in the sixth grade. In addition, 65% of the students are in elementary schools, and 35% are in middle level schools.

The teacher sample consists of a total of 55 teachers. The mean number of years of experience teaching for the sample is 16.6 years (s.d. = 9.34). In addition, 44 of the teachers are female, while 11 are male.

Measures

Two of the measures are scales. These scales are based on extensive factor analysis and construct validation (for details, see Eccles et al., 1993a). The mathematics value scale has an alpha of .75, while the mathematics self-concept of ability scale has an alpha of .72. All other measures were dummy coded for analyses.

## Results

Relationships Between Student and Teacher Variables

We ran bivariate correlations between student characteristics and students' reported valuing of mathematics. Results are presented in Table 1.

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Insert Table 1 About Here

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Students who value mathematics also report a high self-concept of ability in math ($r = .55$, $p<.001$), and they report spending more free-time doing math related activities ($r = .38$, $p<.001$). Students in higher grades report valuing math less ($r = -.20$, $p<.001$), and students who attend a middle school value math less than do other students ($r = -.14$, $p<.001$). Interestingly, there is no relationship between IQ and valuing math. Finally, there is a weak positive relationship between worrying about math and valuing math ($r = .12$, $p<.01$).



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Relationships Between Teacher Variables

Using the teacher sample, we calculated bivariate correlations between several teacher measures. Results are presented in Table 2.

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Insert Table 2 About Here

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One of the more intriguing results is that teachers who report feeling efficacious at using computers for instruction do not tend to actually report using computers much in their classrooms ($r = .16$). Teachers who report giving parents positive feedback also report high levels of giving parents negative feedback about children ($r = .66$). The use of ability grouping in math is not related to any of the other variables.

Determining The Amount of Between-Classroom Variance in Math Value

We used hierarchical linear modeling (HLM; Bryk & Raudenbush, 1992) to estimate the amount of variance in math value that lies between classrooms. We standardized all measures (except for dummy variables) to z-scores for all HLM analyses. Using the HLM program, we determined that 15.95% of the variance lies between classrooms (tau = 0.083, sigma-squared = .90, reliability = .486).[1]

The Full HLM Model

We first tested an HLM model using the following independent variables: free-time spent in math activities, whether or not parents help students with math assignments, math self-concept of ability, the amount the student reports worrying about math, whether

[1] The variance between classrooms was adjusted for the reliability of the measure.

or not the student attends a middle level school, grade level[2], gender, and IQ. Since gender, grade in school and IQ were not significant predictors, we eliminated them from the analysis.

We also modeled several teacher (classroom) level variables on the intercept in order to examine the effects of classroom level factors on average levels of students' valuing of mathematics. We tested classroom level variables such as years of teaching experience, whether or not the teacher puts an extra emphasis on math instruction, type of motivation emphasized (intrinsic or extrinsic), whether or not the teacher feels efficacious at using computers, whether or not math is taught in ability groups, whether or not the teacher uses computers in the classroom, and the type of feedback that teachers report to parents. The only significant predictors involved computer efficacy and usage, and feedback to parents. Results of the full hierarchical linear model are presented in Table 3.

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Insert Table 3 About Here

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Since all variables were standardized using z-scores, the gamma coefficients represent effect sizes (standard deviations).

Several student-level variables have significant effects on individual students' reported valuing of math. Students who report spending free-time engaged in math-related activities report valuing math more (gamma = 0.17, $p<.001$). Other positive predictors of valuing math include having a high self-concept of ability in math (gamma = .52, $p<.001$), having parents who help with math assignments (gamma = .07, $p<.05$), and

[2] Grade level and attending a middle-level school were tested independently in these models.



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worrying about math (gamma = .15, $p < .001$). Attending a middle school has a negative effect on valuing math (gamma = -.24, $p < .01$).

The strongest classroom-level effect on the intercept is the use of computers in classroom instruction (gamma = .26, $p < .01$). In addition, when students study math from teachers who report feeling efficacious at using computers, the students value math more (gamma = .10, $p < .05$). Interestingly, when teachers report positive feedback to parents, students value math less (gamma = -.17, $p < .001$).

For the final HLM model, $\chi 2 = 48.61$ (df = 45), p = .330. Since the chi square statistic is no longer significant, the model has explained all of the significant between classroom variance in valuing mathematics.

## Discussion

The use of hierarchical linear modeling in the present study reveals that classroom practices, as reported by teachers, have unique effects on students' self-reported valuing of mathematics. The use of computers and computer efficacy are both positively related to students' valuing of mathematics. Future studies should investigate the specific activities within classrooms that possibly mediate these effects. For example, do these teachers use computers as games? Do they incorporate computer-activities with other types of math lessons?

The negative relationship between teachers giving parents positive feedback and the mean levels of valuing math in classrooms is a surprising yet intriguing finding. Prior studies suggest that parents' ratings of students' abilities in math are related to students' interest in math (see Eccles et al., 1993b). It is possible that excessive positive



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information about student performance may be problematic and troublesome for some children, thus causing them to feel unable to live up to their parents' expectations; consequently, these children may come to value math less than others. Future studies should investigate this phenomenon.

The fact that grade level is not a significant predictor of valuing mathematics, while attending a middle school is a significant predictor, is an intriguing finding. Prior research suggests that the environments in many middle level schools are antithetical to the needs of early adolescents (Eccles et al., 1993c; Eccles & Midgley, 1989; Simmons & Blyth, 1987). Results of the present study corroborate these findings, and suggest that attending a middle level school has detrimental effects on students' valuing of mathematics.

Results of the present study suggest that classroom factors have an independent and important effects on students' valuing of mathematics. Indeed, teachers do make a difference! After controlling for various student characteristics, classroom-level variables still have important effects on students' valuing of mathematics.

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*Table 1. Correlations Between Student Characteristics and Math Value*

| Variable | r |
|---|---|
| Parents Help With Math | .05 |
| Math Self-Concept of Ability | .55*** |
| Worries About Math | .12** |
| Attends Middle School | -.14** |
| Grade in School | -.20*** |
| IQ | -.04 |
| Free Time Math Activities | .38*** |
| Gender | -.08* |

*Middle school is coded 1 = attends middle school, 0 = does not attend middle school; gender is coded 1 = female, 0 = male. All other items and scales have been standardized using z-scores. All other measures are single items originally coded on a seven point Likert scale, except math value ( alpha = .75) and self-concept of ability (alpha = .72), which are scales computed from the mean of several items..*

*Table 2. Correlations Between Teacher Variables*

| | Computer Efficacy | Computer Usage | Negative Parent Feedback | Positive Parent Feedback | Ability Grouping |
|---|---|---|---|---|---|
| Computer Efficacy | 1.00 | | | | |
| Computer Usage | .16 | 1.00 | | | |
| Negative Feedback | .18 | -.01 | 1.00 | | |
| Positive Feedback | .35* | .31* | .66** | 1.00 | |
| Ability Grouping | -.06 | -.20 | .20 | .01 | 1.00 |

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



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