Change in Students' Mathematics Motivation and Behavior At the Transition to Junior High School

David Reuman, Douglas Mac Iver, Jacquelynne Eccles, and Allan Wigfield

The University of Michigan

Presented as part of a symposium on "Early Adolescence: School, Psychological, and Social Transitions" (Session 3.19) at the annual convention of the American Educational Research Association, Washington, D.C., April 20, 1987.

This research was made possible by grants from the National Institute of Mental Health (MH31724), the National Institute of Child Health and Human Development (HD17296), and the National Science Foundation (BNS-8510504). Address correspondence to: David Reuman, Room 5209, Institute for Social Research, The University of Michigan, Ann Arbor, MI 48106.

Change in Students' Mathematics Motivation and Behavior At the Transition to Junior High School

When students make the transition from elementary school to junior high school, they normatively experience abrupt organizational changes in their school environment. For instance, students typically shift from having a primary teacher and a single set of classmates in their elementary school to a departmentalized curriculum with several teachers and several sets of classmates in junior high school. Students often move from relatively small elementary schools near home to larger, more centralized, and impersonal junior high schools.

For many students, one important change involves assignment to separate junior high school classrooms on the basis of their past academic performance. Some students enter "high ability" classrooms, others enter "regular" classrooms, and still others enter "low ability" classrooms beginning in junior high school. Nationally, the incidence of between-classroom ability grouping doubles -- from 20 percent to 40 percent -- when students make the transition from elementary school to junior high school.

By examining patterns of change in students' achievement-related beliefs, values, and behavior at the transition to junior high school, and by linking these patterns of change to the new school environments that students encounter, we can begin to understand how school practices impact on early adolescents. Today we will illustrate the important effects of at least one environmental change: namely, how changes in ability grouping practices in mathematics at the transition to junior high school affect early adolescents' motivation.

Sample

During the 1983/84 and 1984/85 school years, students in 12 public school districts in southeastern Michigan took part in the Transitions in Early Adolescence project, a 4-wave panel study of the transition that students make from their last year of elementary school through their first year of junior high school. Here we will draw primarily on a longitudinal sample of 1490 students who completed questionnaires in the fall and spring of sixth grade (prior to their junior high school transition) and twice again in the seventh grade (after the school transition). Waves 1 and 3 refer to observations made in the fall (October/November) of each school-year; Waves 2 and 4 refer to observations made in the spring (late March/early April) of each school-year.

Student Measures.

We have measured differentiated components of students' mathematics motivation and behavior: the standards of excellence students use to evaluate themselves in mathematics (e.g., social comparison versus self-referenced standards); fear of failure in mathematics (e.g., worries, math test anxiety, and somatic signs of evaluation anxiety); components of achievement expectancies (e.g., self-concept of math ability, perceptions of math task difficulty, and expectancies of future success); components of achievement values and affect (e.g., utility value versus intrinsic value of mathematics; liking one's math teacher); and effort and performance in math. Examples of items used to measure each construct are shown in Table 1.

Based on evidence from confirmatory factor analyses, we aggregated certain sets of items into composites. Each composite shows moderate to

high internal consistency reliability (see Table 1) and discriminant validity from other composites. A few student self-report measures that did not show univocal factor-loadings will be analysed as single items.

In addition, we have measured students' talent, effort, and performance, based on ratings made by their math teachers. (See Table 1 for specific wording of these measures.)

Stability of Students' Experience.

The stabilities of students' achievement-related beliefs, values, and behavior in mathematics are displayed in Table 2. In general, the stability coefficients indicate a moderate degree of continuity for students across the transition to junior high school.

We particularly want to draw your attention to those variables that show greater instability between school-years than within either school-year (that is, those variables for which the Wave 2 - Wave 3 stability is lower than either of the other stability coefficients). Greater instability between school-years may direct us to those areas of students' experience that are affected by discrete changes in the classroom environment when students make the school transition. This pattern of differential instability is evident for students' math test anxiety, self-concept of math ability, expectancies for success in math, math intrinsic value, time spent on math homework, and subjective sense of doing well in math. The pattern of differential instability is strongest for several variables based on teacher ratings of students, and for student liking of their math teacher; for these variables, the substantial instability between school-years is an obvious consequence of the fact that students have different math teachers before and after the school transition.

Aggregate Effects of School Year and Semester

Using repeated-measures MANOVAs, we have tested effects of school-year (i.e., sixth versus seventh grade), semester (i.e., fall versus spring), and the interaction of school year and semester for each measure of student motivation and behavior in mathematics. Student gender was included as a between-subjects factor in these MANOVAs. The results are summarized in Table 3.

Every outcome we have examined shows highly significant effects of school-year, semester, or both. In every case, the change we observe is a decline from sixth to seventh grade, or from the fall to the spring semester. The patterns of decline can be sorted into several categories: (a) a school-year decline but no semester decline; (b) a school-year decline that is greater than the semester decline; (c) a school-year decline that is as large as the semester decline; (d) a semester decline but no school-year decline; and (e) a semester decline that is greater than the school-year decline. We would interpret as school transition effects those measures of student motivation and behavior for which we observe (a) a school-year decline but no semester decline, or (b) a school-year decline that is larger than the semester declines.

Which aspects of student motivation and behavior show particular patterns of decline?

We see a school-year decline but no semester decline for: math test anxiety, somatic signs of evaluation anxiety, and teacher ratings of students' natural math talent, degree of effort, and performance to their capacity.

We see a school-year decline that is greater than the semester

decline for: the personal best standard of excellence, the utility value and intrinsic value students place on math, their free time spent on math games and activities, and their self-reported level of effort.

We see a school-year decline that is equal in magnitude to the semester decline for: math worries, students' self-concept of math ability, expectancies for success in math, sense that they do well on math tests after they have studied and will do well this year, and finally, how much they like their math teacher.

We see a semester decline but no school-year decline for: the perceived difficulty of math and teachers' ratings of students' performance compared to their classmates.

We see a semester decline that is greater than the school-year decline for: the social comparison and past performance standards, and time spent on math homework.

The different patterns of decline for different dependent variables argue against the inference that we are simply witnessing an effect of repeated measurement. Rather, we interpret these trends as substantive evidence that students are generally "turning off" to mathematics at the transition to junior high school. Not only do we see declines in factors that would tend to keep students invested in mathematics (for example, the standards of excellence against which they strive, the values they attach to math, and their confidence in their math skills), we also see declines in factors that might tend to make students withdraw from math activities (for example, their worries and anxieties about math, and their perception of math as a difficult subject). It seems as if students increasingly don't care about mathematics as an activity domain.

Links Between the Transition to Junior High School and Changes in Ability Grouping.

In order to illustrate the causal effects of a particular change in the classroom environment -- changes in ability grouping -- that occur at the transition to junior high school, we will focus first on students' self-concept of math ability, and then on students' math test anxiety. Each of these variables has shown higher instability between school-years than within either school-year.

Figure 1 shows students' self-concept of math ability across the transition to junior high school. Students are separated into four categories: Some students experience no grouping throughout the study ("No Grouping" students). Other students do not experience any ability grouping in sixth grade but enter either a high ability class in the seventh grade ("High Class Year 2"), a regular ability class in the seventh grade ("Regular Class Year 2"), or a low ability class in the seventh grade ("Low Class Year 2"). The trends are quite striking (and highly significant): Between-classroom grouping lowers the self-concept of high ability students and raises the self-concept of low ability students. (From other analyses, we know that social comparison behaviors of students and grading practices of teachers mediate this effect of ability grouping on students' self-concepts.)

The pattern also highlights an important issue in identifying effects of the transition to junior high school; namely, a change in classroom environments may impact on different students in opposite ways. If we had only paid attention to aggregate, mean changes in self-concept of math ability at the transition to junior high school, we might have mistakenly inferred that self-concept declines regularly and

that the decline within-school-years is as large as the decline between school-years.

Figure 2 shows students' math test anxiety across the transition to junior high school. Once again, students are differentiated according to the type of ability grouping they experience in the seventh grade (none, or a high-, regular-, or low-ability math class). The longitudinal changes in students' test anxiety depend significantly on the nature of the change in ability grouping they experience: Students entering a low ability class show a substantial decline in math text anxiety, whereas students entering a high ability math class show a significant increase in test anxiety. Other students show a decline in test anxiety between school-years that is larger than whatever change occurs within either school-year. We speculate that school-year declines in test anxiety occur for several groups of students because the curriculum in junior high school often consists of considerable review. Students entering high ability classrooms, by contrast, may be receiving tests based on a more demanding curriculum than they have grown accustomed to in elementary school.

Of the measures of students' beliefs, values, and behavior in mathematics that we have examined, seven student self-report measures and all four teacher ratings have shown higher instability between school-years than within either school-year (refer to Table 2 and earlier discussion). The change in ability grouping that students experience at the transition to junior high school is a highly significant predictor of school-year differences for all but one of these measures. We believe that closer examination of systematic environmental changes -- such as these changes in ability grouping

-- that occur at the transition to junior high school will greatly improve our understanding of the effect that schools have on early adolescents' motivation and behavior in mathematics.

TABLE 1

MEASURES OF ACHIEVEMENT-RELATED BELIEFS, VALUES, AND BEHAVIORS IN MATHEMATICS

Social Comparison Standard of Excellence.
(5 items; $\alpha_{Females}$ = .77; α_{Males} = .76)
Doing better in math than other students in my classroom is important to me. [<1>Strongly disagree - <7>Strongly agree]

Past Performance Standard of Excellence.
(6 items; $\alpha_{Females}$ = .80; α_{Males} = .80)
Doing better in math than I have done before is important to me. [<1>Strongly disagree - <7>Strongly agree]

Personal Best Standard of Excellence.
(5 items; $\alpha_{Females}$ = .76; α_{Males} = .70)
Doing the best I can in math is important to me. [<1>Strongly disagree - <7>Strongly agree]

Math Worry.
(2 items; $\alpha_{Females}$ = .53; α_{Males} = .49)
If you are absent from school and you miss a math assignment, how much do you worry that you will be behind the other students when you come back to school? [<1>Not at all - <7>Very much]

Math Test Anxiety.
(3 items; $\alpha_{Females}$ = .89; α_{Males} = .87)
While you are taking a test in math, how nervous do you get? [<1>I'm not nervous at all - <7>I'm very nervous]

Somatic Signs of Anxiety.
(3 items; $\alpha_{Females}$ = .82; α_{Males} = .79)
Does the hand you write with shake when you are taking a test? [<1>Not at all - <7>It shakes a lot]

Self-Concept of Math Ability.
(3 items; $\alpha_{Females}$ = .81; α_{Males} = .79)
How good at math are you? [<1>Not at all good - <7>Very good]

Expectancies for Success in Math.
(2 items; $\alpha_{Females}$ = .76; α_{Males} = .79)
How successful do you think you'd be in a career that required math ability? [<1>Not very successful - <7>Very successful]

Perceived Difficulty of Math.
(3 items; $\alpha_{Females}$ = .63; α_{Males} = .63)
In general, how hard is math for you? [<1>Very easy - <7>Very hard]

Math Utility Value.
(5 items; $\alpha_{Females}$ = .82; α_{Males} = .77)
In general, how useful is what you learn in math? [<1>Not at all useful - <7>Very useful]

Intrinsic Value of Math/Positive Math Affect.
(4 items; $\alpha_{Females}$ = .76; α_{Males} = .74)
In general, I find working on math assignments [<1>Very boring - <7>Very interesting]

Free Time Spent on Math Activities.
(2 items; $\alpha_{Females}$ = .58; α_{Males} = .58)
Outside of the time you spend at school or doing school work, how often do you do math games or activities just because you want to? [<1>Never - <7>Very often]

Single Items

Effort - Time on Homework.
How much time do you spend on math homework? [<1>Less than 15 minutes a day, <2>15 to 30 minutes a day, <3>30 minutes to an hour a day, <4>an hour or more a day]

Effort - Try Hard.
How hard do you work in math? [<1>A little - <7>A lot]

Do Well After Studying.
When taking a math test I have studied for, I do [<1>Very poorly - <7>Very well]

Do Well This Year.
How have you been doing in math this year? [<1>Very poorly - <7>Very well]

Like Teacher.
How much do you like your math teacher? [<1>Not very much - <7>Very much]

Single-Item Teacher Ratings

Natural Math Talent.
How much natural mathematical talent does this student have? [<1>Very little math talent - <7>A lot of math talent]

Effort - Try Hard.
How hard does this student try in math? [<1>Does not try at all - <7>Tries very hard]

Perform to Ability.

How well is this student performing in math this year compared to how well you believe he or she could do? [<1>Far below his/her ability, <2>Somewhat below his/her ability, <3>Almost to the maximum of his/her ability, <4>To the maximum of his/her ability]

Perform Compared to Others.

Compared to other students in this class, how well is this student performing in math? [<1>Near the bottom of the class, <2>Below the middle of the class, <3>In the middle of the class, <4>Above the middle of the class, <5>One of the best in the class]

TABLE 2

STABILITIES OF ACHIEVEMENT-RELATED BELIEFS, VALUES, AND BEHAVIORS IN MATHEMATICS

Construct	Stability		
	Wave 1 - Wave 2	Wave 2 - Wave 3	Wave 3 - Wave 4
Composites:			
Social Comparison Standard	.47	.49	.61
Past Performance Standard	.42	.52	.52
Personal Best Standard	.50	.55	.57
Worry	.48	.45	.49
Test Anxiety	.56	.50	.61
Somatic Signs of Anxiety	.56	.56	.59
Self-Concept	.66	.54	.62
Expectancies for Success	.60	.51	.62
Difficulty	.56	.51	.55
Utility Value	.50	.54	.63
Intrinsic Value	.64	.59	.68
Free Time	.39	.39	.49
Single Items:			
Effort - Time on Homework	.45	.33	.54
Effort - Try Hard	.33	.39	.47
Do Well After Studying	.46	.43	.50
Do Well This Year	.54	.39	.54
Like Teacher	.48	.17	.54
Single-Item Teacher Ratings:			
Natural Math Talent	.73	.48	.65
Effort - Try Hard	.59	.35	.58
Perform to Ability	.53	.26	.52
Perform Compared to Others	.71	.39	.62

Note. Analyses of composites are based on 1490 students making the transition from 6th to 7th grade. Analyses of single items are based on 1300 of these students. The Pearson *r* is used to estimate stability.

TABLE 3

EFFECTS OF STUDENT GENDER, SCHOOL YEAR, AND SEMESTER

ON ACHIEVEMENT-RELATED BELIEFS, VALUES, AND BEHAVIOR IN MATHEMATICS

Dependent Variable	Gender (G)	Within-Subjects Effects					
		Year (Y)	Y x G	Sem (S)	S x G	Y x S	Y x S x G
Social Comparison Standard	M>F 13.18***	Y1>Y2 32.74***	1.77	Fa>Sp 64.77***	1.12	Y1Δ>Y2Δ 28.34***	.03
Past Performance Standard	F>M 11.97***	Y1>Y2 89.90***	1.43	Fa>Sp 130.77***	.84	2.97	.01
Personal Best Standard	F>M 13.99***	Y1>Y2 147.34***	*a* 8.78**	Fa>Sp 59.66***	.21	.02	.12
Worry	F>M 57.22***	Y1>Y2 16.02***	*a* 4.32*	Fa>Sp 9.81**	.64	.05	.04
Test Anxiety	F>M 75.55***	Y1>Y2 83.34***	*a* 19.94***	1.88	*b* 4.80*	.12	.24
Somatic Signs of Anxiety	F>M 22.62***	Y1>Y2 121.47***	*a* 7.40**	1.42	3.66	.32	.03

Table 3 (continued)

Dependent Variable	Gender (G)	Within-Subjects Effects					
		Year (Y)	Y x G	Sem (S)	S x G	Y x S	Y x S x G
Self-concept	M>F 24.85***	Y1>Y2 17.82***	.49	Fa>Sp 22.35***	1.48	Y2Δ>Y1Δ 8.47**	.11
Expectancies for Success	M>F 8.78**	Y1>Y2 51.77***	.01	Fa>Sp 60.36***	.89	Y2Δ>Y1Δ 27.75***	.13
Difficulty	F>M 13.42***	3.76	2.00	Fa>Sp 11.88***	.05	Y1Δ>Y2Δ 3.88*	.22
Utility Value	1.94	Y1>Y2 157.34***	1.40	Fa>Sp 41.04***	.13	Y2Δ>Y1Δ 6.58**	2.49
Intrinsic Value	1.79	Y1>Y2 89.47***	.83	Fa>Sp 41.97***	1.62	Y2Δ>Y1Δ 15.09***	.12
Free Time	F>M 4.36*	Y1>Y2 119.00***	.15	Fa>Sp 16.98***	3.15	.21	1.04

Table 3 (continued)

Dependent Variable	Gender (G)	Within-Subjects Effects					
		Year (Y)	Y x G	Sem (S)	S x G	Y x S	Y x S x G
Single Items:							
Effort - Time on Homework	F>M 10.55***	Y1>Y2 6.24*	2.31	Fa>Sp 59.52***	c 4.88*	.00	.28
Effort - Try Hard	.00	Y1>Y2 224.89***	.05	Fa>Sp 66.00***	.54	.41	1.00
Do Well After Studying	2.92	Y1>Y2 10.09**	.31	Fa>Sp 18.00***	.42	Y2Δ>Y1Δ 9.10**	.56
Do Well This Year	.23	Y1>Y2 42.17***	.25	Fa>Sp 33.43***	3.20	Y2Δ>Y1Δ 11.72***	.39
Like Teacher	.00	Y1>Y2 181.48***	.23	Fa>Sp 213.95***	.08	2.80	.54

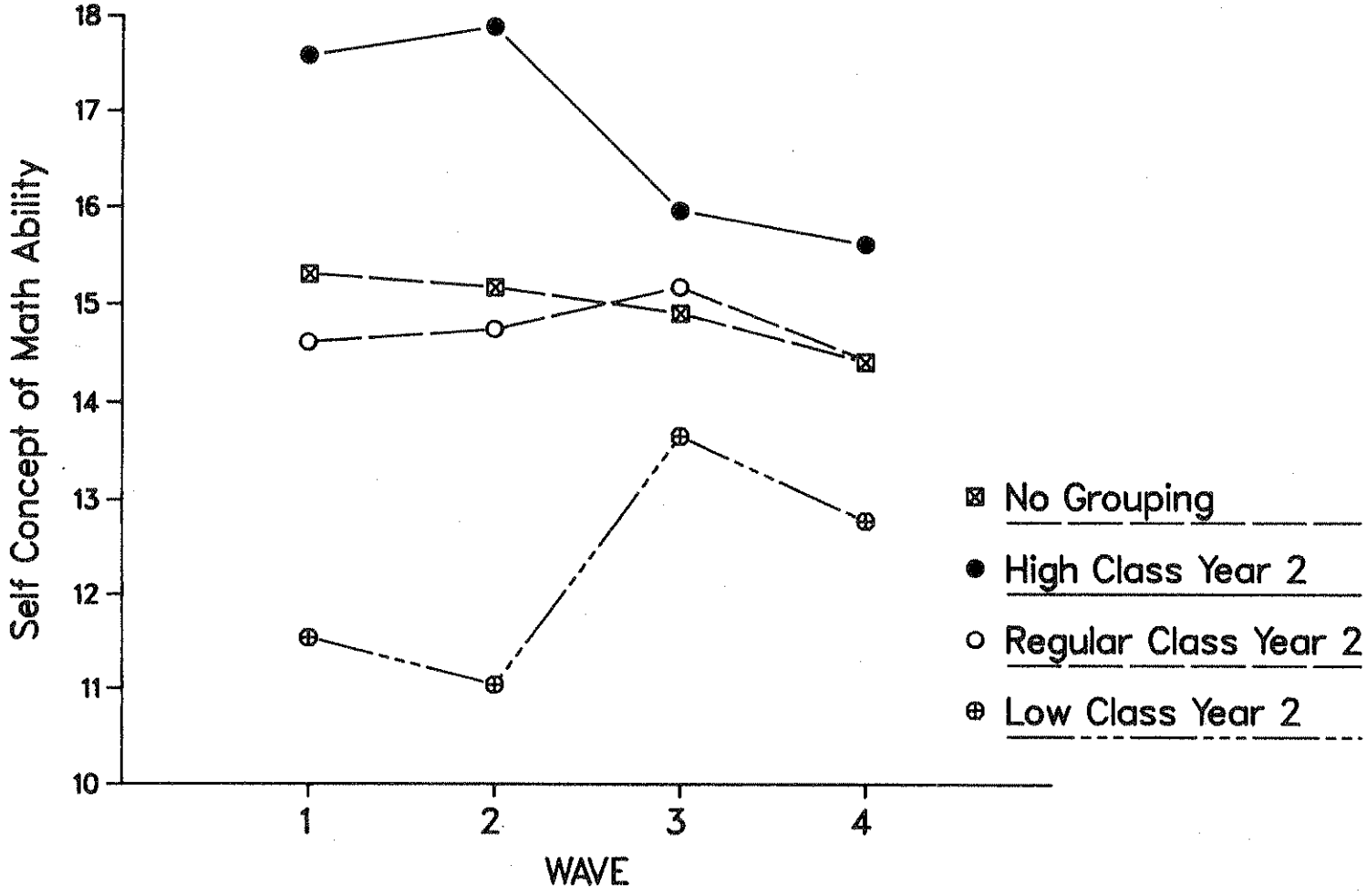
Table 3 (continued)

Dependent Variable	Gender (G)	Within-Subjects Effects					
		Year (Y)	Y x G	Sem (S)	S x G	Y x S	Y x S x G
Single-Item Teacher Ratings:							
Natural Math Talent	1.94	Y1>Y2 12.45***	.64	.09	1.11	.28	1.83
Effort - Try Hard	F>M 35.53***	Y1>Y2 44.14***	2.41	2.26	*d* 7.78**	.77	.13
Perform to Ability	F>M 32.58***	Y1>Y2 18.53***	1.66	1.11	*b* 7.10**	1.03	.11
Perform Compared to Others	F>M 6.97**	3.01	1.85	Fa>Sp 9.01**	2.72	.10	1.35

Note. Analyses of composites are based on 1490 students making the transition from 6th to 7th grade. Analyses of single items are based on 1300 of these students. Cells display *F*-tests based on repeated-measures MANOVAs. One-, two-, or three asterisks indicate the effect is significant at or below .05, .01, or .001, respectively. The nature of significant effects are described using the following abbreviations: F = female, M = male; Y1 = Year 1 (6th grade), Y2 = Year 2 (7th grade); Fa = fall semester, Sp = spring semester.

a means the decline from Year 1 to Year 2 is larger for females than for males.
b means females decline from the Fall to the Spring semester; males increase.
c means the decline from the Fall to the Spring semester is larger for males.
d means females decline from the Fall to the Spring semester; there is no change for males.

SELF CONCEPT OF MATH ABILITY
FOR STUDENTS EXPERIENCING NO GROUPING YEAR 1
AND BETWEEN–CLASSROOM GROUPING YEAR 2



MATH TEST ANXIETY
FOR STUDENTS EXPERIENCING NO GROUPING YEAR 1
AND BETWEEN–CLASSROOM GROUPING YEAR 2