STUDENT ACADEMIC SELF-CONCEPT AND PERCEPTION OF CLASSROOM ENVIRONMENT IN SINGLE-SEX AND COEDUCATIONAL MIDDLE GRADES MATHEMATICS CLASSES

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In this paper we present findings from a study investigating the relationship between all girls' classes, all boys' classes and coeducational classes on student mathematics self-concept and student perception of classroom environment. Further, we compared responses of girls in all girls' classes to girls in coeducational classes and responses of boys in all boys' classes to boys in coeducational classes. Using the Mathematics Attitude Scale *and the* What is Happening in This Class *questionnaire, we found no significant differences in student responses on any of the subscales or domains for any of the subgroups, except for Math as a Male Domain. Our findings indicate that student mathematics self-concept and student perception of the classroom environment are similar regardless of whether students are in a single-sex or a coeducational class.*

FOCUS OF THE PAPER

In U.S. public schools, academic classes consisting of only girl students or only boy students became permissible in certain circumstances in October, 2006. Thus, in contrast to many other countries, single-sex classes in U.S. public schools are recent phenomena. Many schools and districts in the U.S. are implementing single-sex classrooms within coeducational schools, rather than separating boys and girls into different schools. This provides scholars with an opportunity to investigate the efficacy of single-sex classrooms in public schools. The authors are engaged in studies that seek to contribute to our understandings of to what extent, in what ways, by what means, and for which students, single-sex mathematics and science middle grades classrooms influence learning environments, classroom discourse, student academic self-concept, and student performance. In this paper, we present findings on student perception of classroom environment and student academic self-concept in single-sex and coeducational mathematics and science classrooms at the middle level. In particular, we focus on the following questions: To what extent and in what ways are student academic self-concept and student perception of classroom environment related to class type (all girls, all boys, or coeducational)? How do girls in all girls' mathematics classes compare to girls in coeducational (coed) classes in their academic self-concept and perception of classroom environment? How do boys in all boys' mathematics classes compare to boys in coed classes in their academic self-concept and perception of classroom environment?

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THEORETICAL FRAME AND RELATED LITERATURE

Marsh and Yeung (1997) discuss the importance of distinguishing between academic and non-academic components of self-concept. They also emphasize that, even within a notion of academic self-concept, domain-specific distinctions of academic self-concept make sense because, for instance, one's mathematics self-concept may not necessarily be correlated with one's English self-concept (Marsh & Yeung, 1997). Bong and Skaalvik (2003) concur with the utility of domain-specific self-concept constructs, as they discuss how "academic self-concept reflects an aggregated judgment or overall impression of one's competence in given academic domains" (p. 29). For this study, we consider mathematics self-concept to represent one's perspective of one's competence within the domain of mathematics. Our focus on middle school students is driven by our understanding of the middle grades—spanning approximately ages 10 to 15—as a critical juncture in the development of students' knowledge and attitudes towards mathematics. Ma & Kishor (1997) identify the middle grades as a crucial period in which students shape their attitudes toward mathematics.

While it can be illuminating to understand more about student academic self-concept in a variety of classroom settings, it is also meaningful to inquire about student perceptions of the learning environment, particularly when those learning environments are novel to the typical schooling contexts. The importance of student perception of classroom environment has become so clear that an entire field devoted to the study of learning environments is now well established. Dorman, Adams, and Ferguson (2003) report that several studies spanning three decades have linked the quality of the classroom environment to learning outcomes in mathematics. In addition, drawing on Fraser's (1998) study, they note the possibility that classroom environment could vary by school type (coeducational, boys' and girls' schools). In this study, we investigate whether and to what extent student perception of the mathematics classroom environment is related to classroom type (coeducational, all boys', and all girls') within coeducational public middle schools.

METHODS

Context of the Study

A total of 215 students enrolled in one of the three class types (all boys, all girls and coeducational classrooms) in two rural middle schools (grades 6-8) from one school district in the southeastern region of the United States participated in the study. Specifically, 85 participants were enrolled in all-boys classes, 66 in all-girls classes, and 64 in coeducational classes (40 boys and 24 girls). Thus, there were a total of 125 boys and 90 girls participating in the survey. The students completed an electronic survey and responded to subscales from two survey instruments – the *Fenemma-Sherman Mathematics Attitudes Scales* and the *What Is Happening In this Classroom* (WIHIC) questionnaire. The former scale addresses the research questions related to student mathematics self-concept and the latter scale addresses the research questions related to student perceptions of the classroom learning environment. Both instruments are discussed in more detail below.

Instruments and Analysis

The *Fenemma-Sherman Mathematics Attitudes Scales* (MAS) (Fenemma-Sherman, 1976) have long been used to investigate students' attitudes and beliefs towards mathematics across all levels of schooling. For the purposes of this study, we focus on four of the nine domains of the MAS; the Math as a Male Domain Scale, the Confidence in Learning Mathematics Scale, the Mathematics Usefulness Scale, and the Teacher Scale. The MAS is organized as a 5-point Likert scale from strongly disagree to strongly agree. Prior to analysis, we reverse coded negatively-worded items from the subscales. For the subscale Mathematics as a Male Domain, we coded items so that a high rating reflected rejection of the notion that mathematics is a male domain. Thus, a score higher than neutral (higher than 3 on the 5-point scale) represents disagreement with the idea that mathematics is a male domain, whereas scores lower than neutral represent agreement with the idea that mathematics is a male domain. Fennema and Sherman (1976) obtained split-half reliabilities ranging from 0.87 to 0.93 for these scales.

The *What is Happening in this Classroom* (WIHIC) questionnaire was developed by Fraser, Fisher, and McRobbie (1996) as an instrument to assess student perceptions of their classroom learning environments. By incorporating scales that have been shown to be important predictors of learning outcomes, this instrument reflects recent cognitive views of learning in mathematics and science (Kim, Fisher, & Fraser, 2000). The WIHIC contains seven scales or subsets, each consisting of ten items on a Likert scale: (1) Student Cohesiveness, (2) Teacher Support, (3) Involvement, (4) Investigation, (5) Task Orientation, (6) Cooperation, and (7) Equity. Fraser (1998) notes that it is important to separate variations of a survey that asks about students' perceptions of the classroom environment as a whole from variations of that survey that ask about that particular student's experiences in the classroom; he advocates for extricating these perspectives into separate class and personal forms. In this study, we use the personal form because we are interested in sub-group analysis (Fraser, 1998). Fraser (1998) reports alpha reliabilities of more than .80 for each subscale for the WIHIC instrument.

A non-experimental one-way analysis of variance (ANOVA) of student responses was conducted for each research question. For the ANOVA, the dependent variables were the student responses to items on each scale. The independent variables were class type, more specifically an all-girl, an all-boy, and a coeducational class setting, and students' sex. For ANOVA in which a significant difference ($\alpha = .05$) among the means was concluded, Tukey's Pairwise Comparison post hoc test was utilized. When significant differences were found for subscales, Bonferroni adjustments were made for subsequent ANOVA analyses of individual items in that subscale. All statistical calculations were performed using the software program JMP Pro 10.

RESULTS

The research questions for this study are: To what extent and in what ways are student academic self-concept and student perception of classroom environment related to class type (all girls, all boys, or coeducational)? How do girls in all girls' mathematics classes compare to girls in coeducational (coed) classes in their academic self-concept and perception of classroom environment? How do boys in all boys' mathematics classes compare to boys in coed classes in their academic self-concept and perception of classroom environment? In presenting our findings, we address the research questions relating to mathematics self-concept first, followed by our findings addressing student perception of classroom environment.

Findings from the Fenemma-Sherman Mathematics Attitudes Scales

We began our analysis of mathematics self-concept by investigating student responses across the three class types (all girls, all boys, and coed). We found no significant differences in the responses of students in all-boys, all-girls and coed classrooms for three of the four MAS scales: Mathematics Usefulness, Confidence in Learning Mathematics, and Teacher scales. The Mathematics as a Male Domain scale, however, indicated significant differences, with all-girls' and coed classes scoring differently from all-boys' classes. Further analysis indicated that responses from students in all girls' classes differed significantly from responses from students in all boys' classes on four items of the scale. Table 1 shows the results of the analysis of mathematics self-concept by classroom type.

	All Girls		All Boys		Coed		
Subscales	Mean	SD	Mean	SD	Mean	SD	*p*
Confidence in Learning Math	3.60	0.92	3.63	0.87	3.52	0.86	.7580
Mathematics Usefulness	3.93	0.71	3.87	0.69	3.74	0.75	.3223
Teacher Perceptions	3.48	0.68	3.46	0.72	3.51	0.73	.9096
Math as a Male Domain	4.08[a]	0.52	3.63[b]	0.61	3.85[a]	0.54	<.0001*
When a woman has to solve a math problem, she should ask a man for help.	4.13[a]	1.19	3.41[b]	1.18	3.82	1.02	.0012
Women who enjoy studying math are a little strange.	4.22[a]	1.14	3.58[b]	1.13	3.94	1.05	.0023
Women certainly are smart enough to do well in math.	4.56[a]	0.76	4.07[b]	0.87	4.33	0.91	.0036
I would have more faith in the answer for a math problem solved by a man than a woman.	4.13[a]	1.19	3.41[b]	1.18	3.82	1.02	.0008
OVERALL	3.76	0.51	3.65	0.56	3.65	0.54	0.3789

Table 1: MAS by class type

Note. * indicates significant difference based on F-test with $p < .05$. Item means with a different letter superscript indicate significant difference based on F-test with $p<.0046$.

Our second layer of analysis of mathematics self-concept was to investigate whether girls in all girls' classes responded differently from girls in coed classes, and how responses from boys in all boys' classes compared with those from coed classes. There were no statistically significant differences on any of the four subscales for girls in single-sex classes and girls in coed classes, and the same situation holds for boys in single-sex classes and boys in coed classes (see Tables 2 and 3). There were two individual items on which girls in single-sex classes and girls in coed classes differed significantly; those items are included in Table 2. Likewise, there was one item on which boys in single-sex classes differed significantly from boys in coed classes; this item is included in Table 3.

	Female Coed		Female Single-Sex		
Subscales	Mean	SD	Mean	SD	*p*
Confidence in Learning Math	3.54	0.77	3.62	0.92	0.7186
Mathematics Usefulness	3.71	0.79	3.93	0.72	0.2270
I will use mathematics in many ways as an adult.	3.50	1.02	4.05	0.93	0.0192
Teacher Perceptions	3.63	0.58	3.50	0.67	0.3924
Math as a Male Domain	4.01	0.45	4.12	0.44	0.2960
Studying math is just as good for women as for men.	4.17	0.82	4.53	0.67	0.0346
OVERALL	3.76	0.49	3.63	0.57	0.0708

Table 2: MAS Female Coed by Female Single-Sex comparison

	Male Coed		Male Single-Sex		
Subscales	Mean	SD	Mean	SD	*p*
Confidence in Learning Math	3.52	0.92	3.62	0.88	0.5429
Mathematics Usefulness	3.76	0.74	3.87	0.69	0.4181
Math is not important for my life.	3.40	1.43	3.89	1.06	0.0340
Teacher Perceptions	3.43	0.80	3.44	0.73	0.9551
Math as a Male Domain	3.76	0.57	3.61	0.64	0.2077
OVERALL	3.61	0.58	3.64	0.57	0.8367

Table 3: MAS Male Coed by Male Single-Sex comparison

Findings from the What Is Happening In this Classroom Questionnaire

To address our research question regarding student perception of classroom environment in single-sex and coed classes, we first compared responses to the WIHIC survey across the three class types (all boys, all girls, and coed). We found no significant differences across the three class types for any of the subscales or individual items on the survey. The results for this analysis at the subscale level are presented in Table 4.

	All Girls		All Boys		Coeducational		
Subscales	Mean	SD	Mean	SD	Mean	SD	*p*
Social Cohesiveness	3.05	0.09	3.02	0.08	3.07	0.09	0.9264
Teacher Support	2.48	0.10	2.55	0.10	2.43	0.10	0.7099
Involvement	2.55	0.10	2.58	0.10	2.51	0.10	0.8725
Investigation	2.34	0.11	2.45	0.10	2.32	0.11	0.6322
Task Orientation	3.14	0.10	2.94	0.09	3.06	0.10	0.3610
Cooperation	2.96	0.10	2.76	0.09	2.90	0.10	0.3160
Equity	2.66	0.11	2.79	0.10	2.85	0.11	0.4812

Table 4: WIHIC by Class Type

Table 5 shows the results of our analysis of girls' responses in coed classes and girls' responses in all girls' classes. None of the subscales indicated significant differences in the responses, although two individual items showed significance. Those items are included in Table 5.

	Female Coed		Female Single-Sex		
Subscales	Mean	SD	Mean	SD	*p*
Social Cohesiveness	3.01	0.15	3.07	0.09	0.7382
Teacher Support	2.46	0.17	2.50	0.1	0.8350
Involvement	2.36	0.17	2.58	0.1	0.2860
Investigation	2.05	0.17	2.37	0.11	0.1174
I solve problems by using information obtained from my own investigations.	1.83	0.21	2.42	0.13	0.0218
Task Orientation	3.16	0.16	3.18	0.1	0.9109
Cooperation	2.91	0.17	2.99	0.11	0.697
Equity	3.00	0.19	2.68	0.11	0.1398
I get the same amount of help from the teacher as do other students.	3.04	0.21	2.56	0.13	0.0503
OVERALL	2.71	0.13	2.76	0.08	0.7525

Table 5: WIHIC Female Coed by Female Single-Sex comparison

Similarly, results of our analysis of boys' responses in coed classes compared to boys' responses in all boys' classes are presented in Table 6. None of the subscales indicated significant differences, although one item showed significant differences. That item is included in Table 6.

	Male Coed		Male Single-Sex		
Subscales	Mean	SD	Mean	SD	*p*
Social Cohesiveness	3.11	0.11	3.01	0.08	0.4595
Teacher Support	2.41	0.13	2.53	0.10	0.4548
Involvement	2.60	0.12	2.55	0.09	0.7591
Investigation	2.49	0.13	2.42	0.10	0.6508
Task Orientation	3.00	0.13	2.92	0.10	0.629
Cooperation	2.90	0.12	2.73	0.09	0.2624
When I work in groups in this class, there is teamwork.	3.05	0.15	2.67	0.11	0.0463
Equity	2.75	0.14	2.78	0.10	0.8810
OVERALL	2.75	0.11	2.70	0.08	0.6902

Table 6: WIHIC Male Coed by Male Single-Sex comparison

DISCUSSION

Our findings at the subscale level of the WIHIC survey suggest that class type, whether coeducational, all boys, or all girls, did not influence student perception of the classroom environment. Student self-concept, assessed through the Mathematics Attitude Scales, was not significantly different for the subscales Confidence in Learning Math, Mathematics Usefulness, or Teacher Perceptions. The only subscale that showed statistically significant differences between single-sex classes was Math as a Male Domain. Our findings indicate that, while both boys and girls rejected the notion that mathematics is a male domain, girls tended to do so more strongly.

Our comparisons of girls in coed to girls in single-sex classes and boys in coed to boys in single-sex classes indicate that, on the subscale or domain level, single-sex education does not significantly influence student mathematics self-concept or student perception of the classroom environment. That is to say, we have not found that girls in all girls' classes (or boys in all boys' classes) have significantly different views of their classrooms or themselves as mathematics learners than girls and boys in coeducational classes. However, we realize that the presence or absence of a relationship between class type, academic self-concept, and student perception of classroom environment is not the sole rationale for instituting single-sex education. For this reason, our research team continues to investigate classroom discourse, student performance, and student engagement in single-sex and coeducational classrooms in addition to self-concept and perception of classroom environment.

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