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# Nature of Mathematics Classroom Environments in Catholic High Schools

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*In an attempt to reveal the various types of learning environments present in 30 mathematics classrooms in five Catholic high schools, this replication study examined student (N = 602) perceptions of their classrooms using the Classroom Environment Scale. Student attitudes toward mathematics were assessed by the Estes Attitude Scale. Extending previous research conducted in public high schools, this study delineated two basic types of learning environments (teacher-centered and student-centered) in Catholic high schools. In contrast with students in public schools, students in these parochial schools reported positive attitudes toward mathematics regardless of the type of learning environment. Discussion of the findings and implications for practice, including the utility of the CES, are summarized.*

**Keywords**
Classroom environment, student attitude toward mathematics, Classroom Environment Scale, Estes Attitude Scale, cluster analysis, Catholic high school

In this age of school reform, educators, policymakers, and the media are heavily scrutinizing trends in public school student outcomes. Given the marketization of education, in which the schooling options for parents continue to expand, faith-based schools are also under pressure to offer evidence for higher student achievement (Viteritti, 2012). Social science research conducted in Catholic secondary schools in the 1980s and 1990s (e.g., Gamoran, 1996; Hoffer, Greeley, & Coleman, 1985) allegedly confirmed the previously undocumented assumption of the so-called "Catholic school advantage" (McDermott, 1997). This early research reported a benefit in both academic and lifetime accomplishments for Catholic high school students over their public school peers. Since then, much of this research has been challenged on methodological (e.g., selection bias) and modeling grounds; however, sociologist Andrew Greeley (2002; see also Greeley & Rossi, 2014) has vigorously

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defended these preliminary findings and those of other researchers. He has reasserted that Catholic high schools are especially successful with disadvantaged students, providing an academic advantage for minority students today, just as they did for the children of White ethnic immigrants in the previous century.

Other scholars have reported conflicting evidence for the value-added nature of Catholic secondary education. For example, after reviewing the findings from the Chicago School Study and the Chicago Catholic School Study, Hallinan and Kubitschek (2012) concluded that neither public nor Catholic middle schools offer a distinct, consistent advantage in terms of student achievement gains. They offered—as a possible contributing factor for this conclusion—that the positive school reforms instituted within both public and Catholic school systems since 1991 have reduced the achievement gap. Even so, these authors suggested that recent studies (e.g., Carbonaro & Covay, 2010) conducted on the added Catholic school benefit are methodologically stronger than past ones, offering more "evidence of a Catholic school advantage at the high school level" (p. 3).

To further confound the issue, Lubienski and Lubienski (2013) synthesized multiple studies examining student outcomes in a variety of school settings, both public and private. They concluded that public schools are largely superior to private schools in terms of student outcomes. Obviously, further rigorous empirical research is required to confirm or disprove the value-added benefits of a Catholic high school education. The study described here, in part, addresses this need by investigating the types of environments present in Catholic high school mathematics classrooms and whether students' attitudes toward mathematics differ based on the type of classroom environment. In short, the intent of this study was to determine what types of mathematics classroom environments exist in Catholic high schools, and how they may relate to students' mathematics attitudes.

To accomplish this aim, we drew on the work of Haladyna, Shaughnessy, and Shaughnessy (1983) regarding environmental determinants of student attitudes toward mathematics. Moreover, we used multivariate analyses as reflected in Fouts (1987, 1989) and Myers and Fouts (1992) when studying classroom environment and student attitude toward social studies and science. We extended these researchers' work primarily in two ways. First, survey data were collected in Catholic high schools rather than public high schools. Second, we explored how various types of classroom environments may relate to student attitudes toward mathematics. By assessing students with the same research instruments used in multiple earlier studies, we hypothesized that relatively clear patterns in the classroom environment data would emerge and different classroom environments would reflect different student attitudes toward mathematics. In the following section, we review the vast classroom environment literature, particularly as it concerns Catholic high school mathematics classrooms and student attitudes and achievement motivation associated with mathematics education.

## Classroom Environment Research

The influence of classroom environments on student achievement, attitude, and motivation has been under investigation since the mid-twentieth century (Dorman, 2009a, 2009b; Fraser, 2012). Starting in earnest with the work of Herbert Walberg, Barry Fraser, and Rudolf Moos in the 1960s and 1970s, several psychometrically sound measures were established to support this research agenda (e.g., Walberg's Learning Environment Inventory, Moos's Classroom Environment Scale, and Fraser's My Classroom Inventory; Fraser, 2012; Fraser, Anderson, & Walberg, 1982). Rooted in the pioneering theoretical work of Lewin (1936) and Murray (1938), the classroom is now understood as a social system comprised of a combination of specific characteristics (Getzels & Thelen, 1960), including, for instance, curriculum expectations, compulsory social interaction of the classroom participants, control of the classroom teacher, and out-of-class membership of groups and other influences on the students and the teacher. Students' backgrounds, personalities, and needs are also important qualities affecting the classroom milieu. Although this amalgam of factors produces a unique classroom environment, Getzels and Thelen (1960) have suggested that each group has a relatively predictable group behavior that can be studied.

### General Classroom Environment Factors

By the late 1970s, multiple studies had generated substantial evidence that certain learning environment variables can account for a modest portion (13% to 46%) of the variance in student achievement (Anderson, 1973; see also Fraser, 2012, for a review). In mathematics classrooms, O'Reilly (1975) optimistically reported that the learning environment explained 67% of the variance in class achievement scores.

More recent investigations have extended these initial findings, exploring other potential relationships among classroom milieus and an assortment of student variables (e.g., demographic, psychosocial, achievement, motivation to succeed, and attitude toward learning). Even though few studies have been conducted in Catholic high school classrooms, this research includes a wide spectrum of participant samples (e.g., students at risk for high school failure, students in single-gender schools, and those attending coeducational public, and coeducational private schools). For instance, Lamb and Fullarton's study (2002) of thousands of American and Australian eighth-grade student responses revealed that classroom differences explained about 33% and 25% variance in achievement, respectively.

Interestingly, one study explored students' achievement and perceptions of their algebra classroom environments in both online and traditional face-to-face learning contexts (Hughes, McLeod, Brown, Maeda, & Choi, 2007). Contrary to common beliefs about the quality of online learning environments, students situated in virtual learning experiences consistently outperformed their peers in traditional classroom settings on the Assessment of Algebraic Understanding (AAU) test. However, the latter group perceived the classroom environment as having greater cohesiveness, interpersonal involvement, and cooperation than those students studying online. Teacher support was seen as higher in the virtual setting than in the traditional classroom environment.

Subsequently, Dorman's (2009a, 2009b) analysis of Australian primary and secondary school data confirmed the importance of examining primary and secondary classroom environment on various student outcomes. Using a multilevel analysis of Australian Catholic high school data, he investigated the influence of student psychosocial and demographic variables on students' perception of their classroom environment (Dorman, 2009b). The most robust determinants of religious education and science classroom environments were student gender, grade level, and subject area, and school type. Females benefitted considerably more than boys from classrooms that fostered various psychosocial outcomes (e.g., student affiliation, cooperation, task orientation).

Together with Anderson and Walberg's (1974) early conclusion about the close connections between classroom environment and a wide range of student outcomes, the findings of numerous studies suggest that quality learning environments can serve as catalysts for the creation, maintenance, and support of at least short-term positive student outcomes, including academic achievement.

## Classroom Environment and Students' Attitudes Toward Mathematics

Although many secondary school investigations (Anderman, Andrzejewski, & Allen, 2011; Fouts, 1987; Myers & Fouts, 1992; Singh & McNeil, 2014) have explored the relationship between classroom environment and student attitudes across various subject areas (e.g., social science, science), there is a clear dearth of research conducted in Catholic secondary-level mathematics classrooms. Some of this public and private school research is sampled here. For instance, Shaughnessy, Shaughnessy, and Haladyna's (1983) study conducted in elementary and secondary public school mathematics classrooms is illustrative of how the classroom environment can connect with student attitudes. Their investigation had several aims: (a) to better understand the role student, teacher, and learning environment variables exert in student attitudes toward mathematics; (b) to determine data patterns across three different grade levels; and (c) to determine if these trends show any gender differences in the formation of math attitudes. The researchers suggested that poor math attitudes may explain (cause) low enrollment in advanced mathematics classes in high school and beyond, especially for females. In terms of results, they found that the learning environment itself was not a factor for children in grade four; however, as students reached grades seven and nine, these classroom influences were important in forming a positive attitude toward mathematics: enjoyment of classmates, class satisfaction, organization, materials usage, and attentiveness. Teacher variables such as teacher quality (based on student ratings of teacher support for individuals, reinforcement, and commitment to student learning and fairness) were also moderately correlated with mathematics attitude, especially in seventh- and ninth-grade students.

Later research supports some of Shaughnessy et al.'s (1983) conclusions (e.g., Taylor & Fraser, 2013; Tran, 2012). Tran (2012), for example, investigated whether Vietnamese lower secondary school students' perceptions of their learning environment might predict their self-esteem and attitude toward mathematics. Tran (2012) concluded that if students were satisfied with mathematics learning and perceived their classroom environment as more cohesive, they would exhibit positive self-esteem and attitude toward mathematics. Conversely, students who perceived mathematics as difficult and their classroom environment as competitive reported negative self-esteem and attitude. Taylor and Fraser (2013) predictably revealed that certain learning environments can foster negative attitudes and feelings (e.g., avoidance, anxiety) toward mathematics.

In general, then, public secondary school research has consistently reported significant correlations of at least low to moderate strength between different types of classroom environments and student attitudes toward learning, across several subject areas. Quality learning milieus can engender positive attitudes toward math, whereas unhealthy classrooms can cultivate negative attitudes and feelings. For Catholic high school mathematics classrooms, however, the connection between classroom environments and math attitudes is still not well understood.

**Classroom Environment and Motivation in Mathematics**

Because of the reciprocal relationship between the classroom environment and students' achievement motivation, which in turn is associated with their attitudes toward mathematics, this literature is briefly reviewed. Even as there are multiple operational definitions of motivation and ways to measure it, many researchers (e.g., Eccles et al., 1993; Lee, Winfield, & Wilson, 1991; Turner & Meyer, 2004; Uguroglu & Walberg, 1986; Wang & Eccles, 2012) have reported that achievement and motivation are positively correlated, and that the influence of attitude on motivation increases with grade level (e.g., Haladyna et al., 1983). These variables and other related ones are influenced by the classroom milieu (Gilbert et al., 2014).

Several studies have been conducted in middle school classrooms. Eccles et al. (1993), for instance, analyzed student motivational data drawn from mathematics classrooms, suggesting that environmental changes that are the most adverse to early adolescent motivation tend to occur first in mathematics classes. They further indicated that changes in motivation are most likely to occur at a time of transition, especially from elementary school to middle school (i.e., sixth to seventh grade). Ryan and Patrick (2001) also studied a middle school population and found that whereas some student-held beliefs (e.g., doing well comes from innate ability rather than effort) undermined motivation, a collaborative, supportive learning environment encouraged students to be more motivated and engaged in their mathematics classroom. Similarly, Gilbert et al.'s (2014) structural equation modeling study of nearly 1,000 early adolescents' perceptions of their mathematics classrooms to various motivational variables and achievement found that certain teacher behaviors (e.g., expectations, support, and use of innovative mathematic pedagogy) significantly mediated various student motivational outcomes (e.g., mastery, performance, goal orientations, and mathematics utility).

Research conducted in high school classrooms generally supports the middle school findings. Bempechat, Boulay, Piergross, and Wenk's (2008) qualitative investigation, for instance, focused on the motivational advantage associated with Catholic education in the United States. By analyzing individual student interviews in two urban Catholic high schools, researchers found that certain themes emerged. Among other beliefs, the adolescents largely perceived their schools as caring environments in which teachers take a deep interest in both their academic and psychosocial well-being. Opolot-Okurut (2010) quantitatively assessed Ugandan secondary student perceptions of their classrooms using a modified What Is Happening In this Class (WIHIC) questionnaire. Results showed that student perceptions on some of the scales were significantly and positively associated with student motivation variables. The author concluded that teachers wishing to improve student motivation toward mathematics, in general, should emphasize the environment dimensions assessed by the WIHIC. Similarly, Dhillon and Bhardwaj (2014) reported significant correlations between various dimensions of classroom environment and high school students' achievement motivation.

As reviewed above, decades of classroom environmental research provides generous evidence that educators can proactively create milieus that support enhanced learning in mathematics courses. However, the findings are largely derived from public school studies. As such, this investigation further explores mathematics classroom environments in Catholic high schools. In particular, we posed these research questions: (a) Using the dimensions of the Classroom Environment Scale, are there different types of mathematics classroom environments in Catholic high schools? and (b) Do different classroom environments reflect different student attitudes toward mathematics?

## Methods

To reiterate, this study attempted to estimate the types of mathematics classrooms in several Catholic high schools and compared classroom dimensions with students' attitudes toward mathematics within clusters of classrooms.

### Participants and Sampling

A stratified random sample of 30 high school mathematics classrooms was drawn from five Catholic high schools in the Northwest region of Washington state. Two of these high schools were urban, and three were suburban. Two were single-gender schools (one all-female, one all-male); the other three were coeducational. The participants were largely representative of the Washington state high school students attending private schools (i.e., predominantly White, lower middle–class to upper middle–class families). In addition, the sample was drawn from a variety of mathematics classes, including mandatory, honors, and elective courses.

Department chairs identified classroom mathematics teachers whom they thought might want to take part in the study then approached these potential participants to determine interest. Of the five schools, only a handful of teachers opted out. Participating teachers ($N = 30$) then solicited volunteer student respondents from their classes. Parental consent was obtained. Thirty high school classrooms were involved in the study—six from each school. Student respondents ($N = 602$; 255 [42.4%] female, 347 [57.6%] male) were principally drawn from the ninth through 10th grades (187 freshmen, 258 sophomores, 105 juniors, and 52 seniors). The frequency of students from each school ranged from 91 students (from an all-girls school) to 148 students (from an all-boys school). The majority of the teachers were male (55%), with a range of teaching experience from one year to 37 years ($M = 13.49$, $SD = 11.13$). Approximately three-fourths of the adult participants were trained to teach mathematics, with the remainder of the instructors reporting that they were untrained. Although ethnicity data were not collected, traditionally students and teachers in the participating private Catholic schools are largely European American (White).

### Instrumentation

In an attempt to replicate and extend previous classroom environment research (e.g., Fouts, 1987, 1989; Fraser, 2012; Myers & Fouts, 1992), the authors assessed participants on two widely used psychometrically sound instruments.

**Classroom Environment Scale (CES)**. Devised by Moos and Trickett (1974), the CES is a multi-scale self-report instrument for use with secondary-school-age respondents. The CES focuses on student-to-student and teacher-to-student relationships and on the classroom's organizational structure. These three main dimensions of the classroom environment are appraised: relationship, personal growth, and system maintenance and change. The relationship scale is estimated by involvement, affiliation, and teacher support subscales. Personal growth is comprised of task orientation and competition subscales. System maintenance and change scale are measured by order and organization, rule clarity, teacher control, and innovation subscales. Students answer 10 true/false questions for each of the nine subscales. Therefore, subscale scores could range from zero to 10.

The measure's reliability and construct validity have been affirmed by multiple research-oriented publications (e.g., Fraser, 1987; Fraser & Fisher, 1982; Saudargas, 1989; Smith, 1989). In support of this statement, Smith concluded that there is now solid evidence for the CES's construct validity with a variety of respondent groups (e.g., adolescents and adults), showing strong CES subscale associations with classroom observational and teacher interview data.

**Estes Attitude Scales (EAS).** In the early 1970s, Estes (1975) developed the EAS (with versions for elementary- and secondary-level children and youth) as a measure of respondent attitudes toward one or more school subjects (Estes, Estes, Richards, & Roettger, 1981). Initially, the EAS was used to assess student attitudes toward reading (Dulin & Chester, 1974). Survey-takers respond to 15 items using a 5-point Likert scale (*I strongly agree* to *I strongly disagree*). Negatively worded items are reverse-coded (scored). Total scores can range from 15 to 75, with higher scores suggesting a stronger positive attitude toward a subject area. In this study, the secondary school scale was used to estimate participants' attitudes toward mathematics.

Across a variety of student populations, the reliability and criterion-related validity of the EAS has been confirmed (e.g., Dulin & Chester, 1974; Richards & Bear, 1987; Summers, 1980). Moreover, supporting the EAS's construct validity, both grade-level versions demonstrated factorial validity (Richards & Clark, 1983) as well as convergent and discriminant validity over several subject areas (Miller, 1985).

### Statistical Analyses

Based on previous work by Fouts (1987, 1989; Myers & Fouts, 1992), this study utilized three related multivariate statistical methods as described in Tabachnick and Fidell (2013): cluster analysis (CA), principal factor analysis (PFA), and discriminant function analysis (DFA). As it is beyond the scope of this article to summarize each of these procedures, only CA—perhaps the least-known procedure—is briefly described. Essentially, CA is akin to EFA (exploratory factor analysis), in which the researcher begins with one large, undifferentiated group of cases (e.g., student survey ratings) and forms subgroups (clusters) that differ on selected variables (see Everitt, Landau, Leese, & Stahl, 2011; Garson, 2014, for extensive overviews). Put differently, one has a large number of cases and seeks to quantitatively subdivide (cluster) them into relatively homogeneous groupings. For this study, a *k*-means CA (a partitional clustering approach) was used, where the number of clusters is chosen a priori, based on previous research (Everitt et al., 2011); that is, the procedure assigns cases to a fixed number of groups (clusters) whose features are yet to be delineated, but are based on a set of specified variables. *K*-means iteratively estimates the cluster centroids (i.e., mean of the points in the cluster) and ascribes each case to a particular cluster, for which its Euclidian distance to the cluster centroid is the smallest. For this study, membership in the clusters was based on the similarity or difference between classroom means for each dimension and was measured in terms of the distance between each pair of classrooms. The class mean was selected as the unit of analysis based on the research of Haladyna and Shaughnessy (1981) and Haladyna et al. (1983), suggesting that instructional changes have a more pervasive effect on a class of students than they do on the individuals who compose the class.

## Results

Prior to computing the multivariate analyses, the CES and EAS data set was screened for problematic elements (e.g., missing scores, data entry errors) and examined for significant departures from normality (see Field, 2013, for details). Descriptive statistics for the CES subscales are shown in Table 1. The total EAS mean for the 602 respondents was 50.33 ($SD$ = 11.58; skew = -0.30, $SE$ skew = .10; kurtosis = -0.41, $SE$ kurtosis = .19). In the main, score distributions for CES subscales and EAS generated skewness and kurtosis indices well within acceptable range of ±1.0. Following the recommendations of Field (2013) and Tabachnick and Fidell (2013), additional commonly used normality analyses (e.g., Levene's test of homogeneity and Box's M test of homogeneity of covariance matrices, analysis of residuals) were examined. The findings largely supported the parametric assumptions underlying the statistical procedures.

### Research Question 1

To respond to the first question (Using the dimensions of the CES, are there different types of mathematics classroom environments in Catholic high schools?), various multivariate analyses were computed on CES data.

**Cluster analyses**. A *k*-means cluster analysis was computed on the CES data set (Aldenderfer & Blashfield, 1984). Three clusters were chosen a priori

Table 1

*Initial Descriptive Statistics for CES Subscales*

| CES Subscales | *M* | *SD* | Skew | Kurtosis |
|---|---|---|---|---|
| Involvement | 5.16 | 2.97 | -.12 | -1.19 |
| Affiliation | 7.40 | 2.28 | -.86 | -.03 |
| Teacher Support | 7.06 | 2.39 | -1.03 | .56 |
| Task Orientation | 7.15 | 2.37 | -.88 | .16 |
| Competition | 5.68 | 1.99 | -.21 | -.31 |
| Order & Organization | 5.64 | 2.55 | -.19 | -.82 |
| Rule Clarity | 6.65 | 2.37 | -.52 | -.61 |
| Teacher Control | 4.58 | 2.65 | .22 | -.91 |
| Innovation | 3.91 | 2.23 | .22 | -.69 |

*Note.* $N$ = 602; SE skewness = 0.10; SE kurtosis = 0.20.

based on research documented earlier. After four iterations, three final clusters were formed with different cluster centers representing three different groups or categories: high (most "desirable," cluster 1), medium (moderately "desirable," cluster 2), and low (least "desirable," cluster 3) classroom environments (see Table 2). The nine cluster centers and means were significantly different ($F$s [$df$ 2, 599] ranged from 40.22 to 375.37, $p < .001$), with classrooms in the same cluster more alike than those from different clusters. Specifically, the 30 classrooms were distributed as follows: 15 classrooms in cluster 1, nine classrooms in cluster 2, and six classrooms in cluster 3. Minimum distances between final cluster centers were computed (cluster 1 to 2 = 5.62, 1 to 3 = 6.65, and 2 to 3 = 5.90).

Tentative cluster profiles emerged when patterns in CES cluster means were further compared. Although cluster 1 reflects characteristics associated with student- and teacher-centered classrooms (see McCombs & Vakili, 2005, for detailed information), the overall pattern in mean cluster scores reflects more of a student-centered learning environment. For instance, mean cluster scores for affiliation, teacher support, and innovation were the highest on cluster 1. Moreover, the cluster 1 mean for the involvement subscale (i.e., what students are willing to invest in the class) is nearly twice the magnitude of the other two clusters' means. Bolstering this conclusion, the cluster 1 mean for teacher control was lowest across all clusters. However, to reiterate, characteristics more associated with teacher-centered classrooms were present as well (e.g., task orientation, competition, order and organization, rule clarity).

The pattern in cluster 2 means tentatively suggested a learning environment in which students may feel less involved (i.e., they bring very little to the environment personally), affiliated with their peers, and supported by their teacher. Teacher control and rule clarity had the highest mean cluster scores, and innovation had the lowest mean. Generally, then, the CES subscales that were reflected in cluster 2 were associated with a teacher-centered classroom. However, in comparison to the first two clusters, cluster 3 means were lower across all the CES subscale variables. Only the means for affiliation and teacher support subscales were noticeable.

As a whole, the CA computed on the CES data yielded modest evidence for two different types of learning environments in Catholic high school mathematics classes. Cluster 1 more likely represents a student-oriented learning environment, and cluster 2 reflects a teacher-focused classroom. The data pattern represented in the third cluster was too indistinct to suggest an additional type of learning environment.

Table 2

*Final Clusters Based on Nine CES Subscales' Mean Scores*

| CES Scale | Student-Oriented Cluster 1 | Teacher-Oriented Cluster 2 | Cluster 3 |
|---|---|---|---|
| Involvement | 6.70 | 3.98 | 3.11 |
| Affiliation | 8.12 | 6.57 | 6.93 |
| Teacher Support | 8.33 | 5.73 | 6.33 |
| Task Orientation | 7.51 | 7.96 | 4.65 |
| Competition | 6.06 | 5.65 | 4.71 |
| Order, Organization | 6.52 | 5.95 | 3.01 |
| Rule Clarity | 6.75 | 7.24 | 5.15 |
| Teacher Control | 3.53 | 6.40 | 3.82 |
| Innovation | 4.92 | 2.49 | 3.93 |

**Factor analyses**. To further explore whether there were different types of classroom environments (or dimensions) underlying the nine CES subscales and the EAS data, Tabachnick and Fidell (2013) indicated that results from varimax and oblimin rotations could be compared, particularly if the intercorrelations between factors were negligible (less than .30). Factors were liberally marked by factor loadings over .30. Assumptions for factor analysis were tested using the Kaiser-Meyer-Olkin measure of sampling adequacy (.75) and Bartlett's test of sphericity ($F$ [45] = 1751.56, $p$ = .001). These results suggest that the intercorrelation matrix was factorable. Given the correlation between factors was .12, oblimin rotation was not needed.

To determine the number of factors to retain, the following criteria were used: (a) Eigenvalues greater 1.0 and (b) percentage of variance accounted for by each factor. In addition, the results from the scree plot and parallel analyses suggested a 2-factor solution. The most interpretable simple structure was achieved with varimax rotation, yielding two interpretable dimensions. These accounted for 42.55% of the variance in the correlation matrix (see Table 3). Rule clarity, task orientation, order and organization, teacher control, and competition subscales marked factor 1, which was labeled teacher-centered classroom. The second dimension (named student-centered classroom) was comprised of teacher support, involvement, innovation, and affiliation variables. EAS loaded weakly on factor 1 (.13) and factor 2 (.23), suggesting that, overall, student attitude toward mathematics does not assist in differentiating between the two types of classrooms. In sum, the derived factors further elucidated the findings from the CA, where two primary types of learning environments appear to exist in Catholic mathematics classrooms.

**Discriminant function analyses**. Drawing upon the PFA findings, two DFAs were performed using a subset of CES subscales as the predictor variables and cluster membership as the criterion variable. Table 4 shows the descriptive statistics for the three CES clusters by CES subscales. The first DFA was computed using those predictor variables comprising the teacher-centered classroom factor (i.e., competition, order and organization, rule clarity, and teacher control).

Table 3

*Final PFA Varimax Rotated Factor Matrix with CES and EAS Data*

| | Factor | |
|---|---|---|
| Variables | Teacher-Centered | Student-Centered |
| Rule clarity | .70 | .07 |
| Task orientation | .69 | .06 |
| Order & organization | .69 | .24 |
| Teacher control | .60 | -.52 |
| Competition | .35 | .09 |
| Teacher support | .04 | .73 |
| Involvement | .49 | .70 |
| Innovation | -.08 | .59 |
| Affiliation | .18 | .51 |
| Estes Attitude Scale | .13 | .23 |
| Eigenvalue | 2.24 | 2.03 |
| % of Explained Variance | 22.24 | 20.31 |

*Note.* Loadings are standardized; factors 1 and 2 were labeled teacher-centered and student-centered classrooms, respectively; loadings marking a specific factor are bolded.

Table 4

*Means (SDs) for CES Clusters and Teacher-Centered and Student-Centered Classroom types*

| | Teacher-Centered | | | | Student-Centered | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cluster | Comp. | Order | Rule Clarity | Teacher Control | Involv. | Affil. | Teacher Support | Task Orient. | Innov. |
| 1 | 6.14<br>(1.19) | 6.45<br>(2.10) | 6.78<br>(2.28) | 3.56<br>(2.24) | 6.79<br>(2.44) | 8.13<br>(1.93) | 8.30<br>(1.46) | 7.61<br>(1.10) | 4.91<br>(2.04) |
| 2 | 5.62<br>(1.70) | 5.95<br>(2.44) | 7.29<br>(2.13) | 6.46<br>(2.40) | 3.99<br>(2.74) | 6.62<br>(2.36) | 5.71<br>(2.63) | 7.95<br>(1.73) | 2.49<br>(1.71) |
| 3 | 4.64<br>(2.28) | 3.07<br>(2.09) | 5.19<br>(2.43) | 3.77<br>(2.21) | 3.21<br>(2.37) | 7.00<br>(2.37) | 6.38<br>(2.24) | 4.58<br>(2.50) | 3.95<br>(2.14) |

*Note.* Comp. = Competition; Involve. = Involvement; Affil. = Affiliation; Task Orient. = Task Orientation; Innov. = Innovation; *n*s for clusters 1, 2, and 3 = 285, 203, and 113, respectively.

To test the assumption of homogeneity of covariance matrices, Box's M test was computed. Not surprisingly, with a very large sample size, a significant result was found, M = 56.33, $F_{approx.}(20, 513691.30)$, $p < .00$. Next, an $F$-test of the equality of teacher-centered group means was conducted to determine which predictor variables (competition, order and organization, rule clarity, and teacher control) significantly differed on the three clusters (criterion variable). All extracted subscales were significant ($p < .001$), showing that at least one of the cluster means was different from the others. The significant Wilks' Lambdas were: competition = .93; order and organization = .76; rule clarity = .90; and teacher control = .74. $F$ tests (*df*s 2, 599) ranged from 24.10 (competition) to 103.65 (teacher control). The $I$-index (see Huberty & Lowman, 2000), an effect size (a measure of practical significance) estimating the accuracy of classification, was found to be substantial ($I = .56$).

Of particular interest was the correct classification statistics derived from the DFA. Overall, 70.1% of the originally grouped cases were correctly classified to their particular cluster. Cluster 1 generated the highest correct classification percentage (78.6%). For clusters 2 and 3, the correct classification percentages (65% and 57.9%, respectively) were somewhat better than chance (i.e., 50%).

The second DFA was computed using the student-centered variables (involvement, affiliation, teacher support, task orientation, and innovation). Again, the criterion or grouping variable was cluster membership. Due to the large sample size, Box's M test was again significant (M = 167.03, $F_{approx.}[30, 465233.5]$, $p < .001$). $F$-tests of the equality of student-centered group means were computed to ascertain whether the predictors significantly differed on the three clusters. The five student-centered CES subscales were significant ($p < .001$). $F$s (*df* 2, 599) ranged from 31.17 (affiliation) to 115.80 (task orientation). The correct classification percentage for cluster 1 was the strongest (80.7%). For clusters 2 and 3, the correct classification percentages were somewhat better than chance (cluster 2 = 62.6% and cluster 3 = 54.4%). Overall, 69.6% of original grouped cases were correctly classified. The student-centered I index (.55) was a noteworthy effect size.

To review, the overall DFA cross-validation analyses affirmed that the CES predictor variables comprising teacher- and student-centered classroom environments, respectively, could be correctly classified across the three clusters (approximately 70% and far better than chance). Coupled with the CA and PFA findings, the DFAs and the resulting large effect sizes provided further evidence that at least two different types of learning environments exist in Catholic high school mathematics classrooms. Lastly, whereas the PFA findings indicated that the CES subscale task orientation loaded strongly on the teacher-centered factor, the CA results suggested that this variable was associated with both types of learning environments. Perhaps task orientation is an environmental characteristic present in many of the classrooms.

### Research Question 2

With respect to the second question (Do different classroom environments reflect different student attitudes toward mathematics?), a DFA was conducted on the EAS data. The criterion variable was cluster scores, and the predictor variable was EAS. The mean scores for the EAS across the three clusters were as follows: clusters 1, 2, and 3 were 54.20 ($SD$ = 10.87, $n$ = 285), 48.66 ($SD$ = 11.14, $n$ = 203), and 43.66 ($SD$ = 11.74, $n$ = 114), respectively. Box's M test for the equality of covariance matrices was nonsignificant (M = .98, $F$ = .49, $p < .62$). The test of equality of group means yielded a significant difference between group means. This finding indicates that there are different types of classrooms based on attitude, Wilks's lambda = .88, $F$ (2, 599) = 40.01. However, only 46.2% of the original grouped classrooms were correctly classified. The overall effect size was considered weak, $I$ = .23. In all likelihood, then, the significant $F$-test for equality of group means was due to the very large sample size ($N$ = 602).

In short, different mathematics classroom environments were not correctly grouped or classified by student attitudes toward mathematics. The DFA cross-validation analysis indicated that group classification based on student attitude was worse than chance. These results, along with earlier-reported PFA results—where the EAS variable failed to sufficiently load on either the teacher- or student-centered factor—indicated that there was little evidence for a plausible link between varying classroom environments and student attitude in the sampled Catholic classrooms.

## Discussion

This study extended previous research conducted in public high schools to Catholic high schools. The findings here are compared to previous studies of high school mathematics classrooms, particularly as they relate to each research question. We close with implications for practice and research limitations.

**Question 1: Types of Learning Environments in Mathematics Classrooms**

Although rigorous comparison studies remain sparse, previous research indicated that in many ways, public and private schools, including Catholic secondary schools, seem to be more alike than different (e.g., Choy, 1998; Hallinan & Kubitschek, 2012; Lunenburg, 1991; Peterson & Llaudet, 2007). For instance, as a whole, investigations across most subject areas—regardless of pedagogical approach—showed that student achievement remained fairly equivalent for Catholic and public schools. Other differences do exist, however. Trickett, Trickett, Castro, and Schaffner (1982) suggested, for example, that private and public schools diverge mainly on authority structure in the classroom and the qualitative aspect of inter-student relationships. Discipline was found to be stricter in Catholic and in other private schools, and the parents tended to expect orderly classrooms and firm discipline.

Some 50 years ago, Getzels and Thelen (1960) proposed a model of the classroom that mirrors a social system, one in which the stability and the needed flexibility of the group is largely contingent on student perceptions of belongingness or affiliation within the group. They posited that the key factor found in positive classroom environments was the teacher's behavior toward students, including characteristics loosely represented by the teacher-centered (TC) and the student-centered (SC) classrooms (Peters, 2013). Our findings with regard to classroom environment types support these conclusions. In particular, we tentatively showed that Catholic high school mathematics classrooms reflect at least two relatively different types of learning milieus. Classrooms, however, should not be categorized as merely one type or the other. More accurately, most mathematics classroom teachers will vary their pedagogy, and the classroom climate will fluctuate accordingly—ranging from highly teacher-focused to highly personalized environments. Peters (2013) delineated TC environments by suggesting that they (a) deploy a transmissive approach to achieving instructional goals, (b) exhibit substantial teacher control over the learning enterprise, (c) have less emphasis on individual student needs, and (d) focus on direct instruction and the appraisal of behavioral objectives through course content and delivery. Student-centered classrooms are characterized by an instructional inclination or teaching style focused more on attending to students' personal qualities and needs and the process and interpersonal dynamics of learning. Moreover, this type of "classroom climate places students at the center of the learning process and provides them with support and guidance, positive feedback and encouragement, empathy, and mutual trust and respect" (Peters, 2013, p. 462).

In general, the evidence collected from the participating Catholic high schools indicated that TC mathematics classrooms were slightly more discernible than SC environments. This finding was not altogether unexpected. Although this trend is gradually changing, teacher-directed classrooms remain common in many public and private secondary and postsecondary classroom environments, including mathematics and science classrooms (e.g., Cuban, 1982; Peters, 2013; Sidlik & Piburn, 1993). Research on teacher effectiveness has also identified some of these same characteristics. For instance, in examining the classroom of an effective inner-city seventh-grade teacher who taught at-risk students, Pierce (1994) identified four important elements that coincided with the teacher's beliefs about teaching: (a) the classroom had structure and organization with a high standard of behavior, as well as sensitivity to others; (b) the instructor took on a variety of roles to support the students' self-esteem; (c) the teacher believed her students could learn; and (d) the teacher was obviously enthusiastic about her students. A similar theme emerged from a survey of a diverse group of 90 teachers about the characteristics of effective and ineffective teachers (Walls, Nardi, von Minden, & Hoffman, 2002). Participants wrote about effective teachers as having very little difficulty with classroom control or management. These teachers were also considered warm and caring while maintaining high standards for behavior and work, with clear and fair grading policies.

**Question 2: Classroom Environment and Student Attitude**

The conclusion reached by previous researchers (e.g., Fouts, 1987, 1989; Haladyna et al., 1983; Myers & Fouts, 1992; Shaughnessy et al., 1983)—that the type of learning environment was correlated with student attitude—was not replicated in the sampled Catholic high schools. This study revealed that regardless of the type of classroom environment, student attitudes toward mathematics were generally positive. Given that there are so few empirical research studies addressing attitudinal and motivational issues in Catholic high school mathematics classrooms, the explanation for this discrepancy in findings is only speculative. The study did not address the issue of possible selection bias, so it is not known whether admissions guidelines for the sampled high schools created a restriction in range effect in these mathematics classrooms. It is possible, however, that the affiliation mean scores, which were relatively high in all three clusters, indicate what previous researchers discovered (for example, Lee et al., 1991), that is, that in the Catholic school setting, students—even minority students from the inner city—feel a sense of belonging to their environment and largely possess better attitudes toward learning.

## Implications for Practice

The most salient implications for educational practice are reviewed in this section.

### Use of CES to Estimate Classroom Environment Factors

To summarize, the study provided additional evidence for the usefulness of the CES to estimate the relative importance of nine characteristics of classroom environments, whether they are viewed as TC, SC, or a combination thereof. Administering the CES periodically to students may yield valuable insights into what environmental factors are more prominent in one's classroom. Although the type of learning environment appears to be less influential to overall student mathematics achievement, for certain mathematical topics (e.g., math facts and computation skills), high school teachers may want to use a pedagogy more aligned with TC. Similarly, certain math concepts and processes (e.g., games-based mathematics education) might be better facilitated through an SC approach that emphasizes such dimensions as student affiliation and teacher support of student learning (e.g., Afari, Aldridge, Fraser, & Khine, 2013).

Moreover, teachers armed with student CES ratings could draw upon pedagogical and curricular changes to address any environmental areas that they deem lacking. For example, students might perceive their learning environment as having too little involvement, high competition, and limited order and organization. Assuming that at least moderate levels of student interaction, active engagement, and teacher organization are priorities for optimal learning, instructors can restructure their lessons to include more cooperative learning activities, thereby lowering negative classroom competitiveness, and increasing teacher preparedness (order and organization; e.g., handing back papers and tests in a timely manner, maintaining a clean and neat classroom, and having familiar classroom routines). In addition, CES ratings, for example, could (a) assist teachers with revising how they give directions and determine student expectations in the class (rule clarity), (b) increase teacher collaboration around effective and positive classroom management strategies (teacher control), and (c) provide useful data regarding their perceived level of classroom creativity and originality in planning daily lessons (innovation).

Administrators ought to appreciate that the quality of the classroom environment influences student learning (Eccles et al., 1993; Fraser, 2012; Ryan & Patrick, 2001). As suggested previously, Lee et al. (1991) concluded that the high-achieving early adolescents who attended primarily Catholic schools with rich curricula tended to work more diligently and invested more of themselves in the educational process. Catholic school administrators could use the CES, for instance, to assess whether students believe they are receiving in-depth and engaging mathematics curricula and quality instruction. The measure could also be adapted for use with parents and others. Trends in aggregated classroom environment data could be shared with stakeholders as a way to provide basic accountability information.

### Research Limitations and Suggestions for Future Investigations

Because the study draws only on student samples from Catholic high schools in one region of the Northwest, subsequent research should be conducted in Catholic schools in other regions, states, and even internationally. Another caveat relates to the investigation's single academic subject focus. Although complicated to carry out, as a way of comparison, new research should simultaneously include a variety of academic subjects in Catholic high schools. Moreover, correlational designs cannot determine causality, and self-report questionnaires can be problematic where the social desirability factor may influence respondents' ratings of their classrooms. At least quasi-experimental designs and causal modeling analyses conducted in faith-based and public schools would add to the existing corpus of classroom environment literature.

Subsequent research should also investigate student and environmental variables both inside and outside the classroom environment that might influence Catholic students' attitudes toward mathematics and other subject areas. For example, factors that may merit further exploration are the authority structure of the classroom, parental involvement, student work ethic, student desire to succeed, and student view of the importance of mathematics to future success.

## Conclusion

Bearing in mind the research limitations, this investigation—conducted in multiple Catholic high school mathematics classrooms—generated some relevant findings with modest implications for educational practice. In part, it replicated and expanded on previous studies of secondary-school classroom environments. Similar to public school classroom research, teacher-centered and student-centered learning environments seemed to emerge from the Catholic student data. These learning environments had overlapping characteristics (e.g, task orientation), but Catholic mathematics learning environments were more likely to be teacher-directed.  Contrary to public high school findings, the results here indicate that students in Catholic mathematics classrooms reported a more positive attitude to learning the subject matter. For this reason, the study may be useful to researchers seeking to identify variables in Catholic high school classroom culture that seem to make a difference in student outcomes. These results, however, should be reexamined and confirmed in subsequent causal-oriented studies comparing parochial and public school classrooms across different subject areas. Finally, the study showed that the CES has some utility in differentiating secondary school-learning environments.

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