

Pre-service Teachers' Attitudes and Beliefs in Relation to Teaching Mathematics Equitably to all Students

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Abstract

This research investigated 203 pre-service teachers' attitudes and beliefs in relation to teaching mathematics equitably to all students. Survey ratings were analyzed as a whole and by gender, age, and race/ethnicity. Overall, participants thought that the environment for learning mathematics should be inviting and inclusive regardless of gender, race/ethnicity, home language or socioeconomic status. They believe that mathematics classrooms should provide practical experiences in ways of thinking that join the world of school to the real-world community. Participants believe that by including mathematical processes that have the potential for developing students' skills in solving problems in practical situations, students may gain confidence in themselves irrespective of their background. This study therefore, provides strong support for the argument that mathematics educators should make addressing pre-service teachers' attitudes and beliefs for teaching mathematics equitably a regular part of their pedagogy.

Keywords: Diversity, Equity, Critical Theory, Critical Multiculturalism, Social Justice, Differentiated Teaching, Real-world Connections

The purpose of this study was to investigate pre-service teachers' attitudes and beliefs in relation to teaching mathematics equitably to all students. Students bring to school not only varied racial and ethnic heritages, but also a wide range of histories, perspectives, experiences, expectations, and approaches to learning mathematics. Studies on diversity, equity, teacher education programs, and pre-service teacher preparation demonstrate the need for teachers who are prepared to work with diverse populations of children. Ball and McDiarmid (1990) assert that the increasingly diverse student population requires that teachers have a broader range of skills and knowledge to meet students' diverse needs. Studies show that while the number of linguistically and culturally diverse students is growing, the number of teachers with diverse backgrounds is not growing proportionally (Mercado, 2001; Nieto, 2004). Although many studies have identified specific factors that might influence how pre-service mathematics teachers are prepared, few studies have investigated pre-service teachers' attitudes and beliefs on teaching mathematics equitably to all students.

Theoretical Framework

For mathematics education research to contribute more fully to equity, it can no longer be bound within the traditional disciplines of mathematics but must build on the developments of other fields that have been traditionally the domain of the social sciences, such as critical theory (Gutstein et al., 2005). In order to provide a context for understanding, critical theory and critical multiculturalism provide the underlying theoretical framework for this study.

Critical Theory

The philosophical and theoretical perspectives of critical theory are as varied as the disciplines and scholars who have contributed to its development. Critical theorists such as Freire (2000), Giroux (2001), and McLaren (2000), suggest that the poor educational performance of most students from diverse backgrounds comes from the existing curriculum and pedagogical practices that do not meet the needs of all students.

They contend that an examination of systems of domination will bring about an awakening of consciousness and awareness of social injustices, motivating self-empowerment and social transformation. The concepts of self-empowerment and social transformation are recurring themes found in the scholarship of Paulo Freire (1985, 1998a, 1998b, 2000). It is his scholarship and his popularization of the concept of “learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality” (Freire, 2000, p. 35) that provides, to a certain extent, the foundation for critical pedagogy.

Based on the scholarship of critical theorists, the National Council of Teachers of Mathematics (NCTM) (1989, 2000) identified five clear sets of standards for teaching and assessing mathematics in all grade levels and provided mathematics educators with a solid base on which to build curriculum and instruction: (a) to understand and value mathematics, (b) to reason mathematically, (c) to communicate mathematics, (d) to solve problems, and (e) to make connections to real-world contexts and other academic subject areas. In 1991, the NCTM produced an accompanying document that makes recommendations for teacher professional standards, stating that teachers should: (a) select mathematical tasks to engage students’ intellect and interest, (b) provide opportunities to deepen students’ understanding of mathematics and its applications, (c) orchestrate classroom discourse in ways that promote the investigation and growth of mathematical ideas, (d) help students use technology and other tools to pursue mathematical investigations, (e) help students seek connections to previous and developing knowledge, and guide individual, small-group, and whole-class work. Careful attention to these actions can help mathematics educators teach more equitably.

Critical Multiculturalism

The term multiculturalism generally refers to a state of racial, cultural and ethnic diversity within the demographics of a specified place, such as a school, business, neighborhood, city or nation (Banks, 2010). Furthermore, Banks (2010) affirms that the concept of multiculturalism values the diverse perspective people develop and maintain through varied experiences and backgrounds stemming from racial, ethnic, gender, sexual orientation and/or class differences in society. It strives to uphold the ideals of equality, equity, and freedom, which include respect for individuals and groups as a principle, fundamental to the success and growth of any society.

Many researchers (e.g., Bensimon, 1994; McLaren, 2000) favor a version of multiculturalism that seeks social transformation based on diverse cultures and identities. This version of multiculturalism has been described as critical multiculturalism because it combines the conditions of cultural diversity with the emancipatory vision of critical educational practice borrowing from critical theory. Critical multiculturalism struggles against cultural homogeneity, advocating instead a cultural heterogeneity uniting people of different classes, ethnicities, and genders (McLaren & Farahmandpur, 2005). Critical multicultural education recognizes both the contributions of marginalized groups and the importance of their participation in the production of social and cultural meaning (McLaren & Farahmandpur, 2005). Critical multiculturalism does not see diversity itself as a goal but rather a commitment to cultural pluralism and social justice. This commitment to social justice, Grant and Sachs (2000) insist, increases the possibility of emancipatory teaching for students from a variety of ethnic and cultural backgrounds.

Research Question

This study was guided by the research question: What attitudes and beliefs do pre-service teachers report in relation to teaching mathematics equitably to all students? To answer this question, responses from following survey items S1-S5 were analyzed:

S1: Student demographics in my classroom, such as gender and race/ethnicity, should influence the way I teach mathematics.

S2: Student gender is a factor to consider in planning and carrying out mathematics instruction.

S3: Student race/ethnicity is a factor to consider in planning and carrying out mathematics instruction.

S4: Whether English is the first or a secondary language for students is a factor to consider in planning and carrying out mathematics instruction.

S5: Student socioeconomic status is a factor to consider in planning and carrying out mathematics instruction.

Methodology

A mixed-method approach was used for this study. This approach integrates both quantitative and qualitative research methods (Gay & Airasian, 2003). According to Hanson, Creswell, Plano-Clark, Petska, and Creswell (2005), "Using both forms of data allows researchers to simultaneously generalize results from a sample to a population and to gain a deeper understanding of the phenomena of interest" (p. 224). Thus, in this study the aim was to find patterns among the participants that provide a rich description of pre-service teachers' attitudes and beliefs in relation to teaching mathematics equitably to all students.

Participants and Data Collection

Participants in this study were undergraduate pre-service teachers in a teacher education program at a major research university. Of a possible 212 students, 203 (96%) participated in the survey. The modal age group in years of the sample was the age category

18-25 ($n = 165$; 77.8%). Twenty-three of the sample were in the age group 26-34 (10.8%),

9 were in the age group 35-45 (4.2%), and 6 were over 45 years old (2.8%). Five out of six racial/ethnic groups classified in the survey were represented in this study: American Indian or Alaskan Native, Asian, Black not of Hispanic origin, Hispanic, and White not of Hispanic origin. No Native Hawaiian or Pacific Islander was a study participant. Thus, this study included a reasonably substantial number of both male (28) and female (175) participants despite unequal proportions by gender. The highest proportion of participants was in the 18-25 age category (77.8%), and the majority of the students were White (85.1%).

Data Analysis

Survey ratings were analyzed using SPSS statistical software to calculate descriptive statistics, frequencies, and percents. The dependent variables represented survey items that utilized a five-point Likert scale that included "Strongly Disagree" (1), "Disagree" (2), "Unsure" (3), "Agree" (4), and "Strongly Agree" (5). Because 5 (SA) was the most supportive or favorable result and 1 (SD) was the least supportive or least favorable response, 3 (U) was considered the midpoint. The data for the content analysis was taken from the comments that students provided for each survey item. Data were analyzed as a whole and disaggregated by three categories: gender, age, and race/ethnicity. The number of participants in age group category 18-25 was large compared to the age groups 26-34 ($n = 23$), 35-45 ($n = 9$), and over 45 years ($n = 6$), so the latter three groups were collapsed into one group (over 25 years) for analysis. Also, the numbers of non-White participants: American Native or Alaskan Native ($n = 3$), Black, not of Hispanic origin ($n = 3$), Hispanic ($n = 15$), Asian ($n = 9$), and Native Hawaiian or Pacific Islander ($n = 0$) were small compared to White participants ($n = 172$), so race/ethnicity was put into two groups, non-White ($n = 30$) and White ($n = 172$), in order to analyze the data.

Before running any tests on the variables, Levene's Test of Equality of Error Variance was calculated for each variable to ensure that the assumption of homogeneity of variance was tenable and that a One-Way Analysis of Variance (ANOVA) was an appropriate statistical test because the number of participants was unequal for the data groups. Where ANOVA was inappropriate, the Kruskal-Wallis test or the Mann-Whitney U test was used to determine the existence of differences within different subgroups by gender, age, and race/ethnicity for each dependent variable of the survey. The test for significance was set at a 0.05 alpha level. When an ANOVA found a significant main effect, Eta square, η^2 , was used to determine the strength of a significant result. Using Cohen's (1988) conventions, an effect was considered small, medium, or large if Eta square, η^2 , was 0.01, 0.06, or 0.14, respectively.

Participant comments were placed into conceptual categories, and themes across the categories were developed using qualitative content analysis. Holsti (1969) defined content analysis as "any technique for making inferences by objectively and systematically identifying specified characteristics of message" (p.14). Although content analysis can be rigidly quantified, forms of content analysis have been developed to allow the mapping of patterns within quantitative data in a way that avoids reducing meaning simply to the number of times a particular textual term occurs within the texts being analyzed (David & Sutton, 2004).

Findings

Quantitative Analyses

The discussions that follow are the findings of this study.

Table 1 shows the descriptive statistics, frequency distributions, and percents for responses to survey items S1-S5. The ratings show that participants tended to agree that student demographics should influence how they teach mathematics. However, responses differed by participant demographic groups.

Table 1: Descriptive Statistics and Frequency Table for Survey Items S1-S5

Survey Item	Mean	<i>SD</i>	Strongly Disagree (1)	Disagree (2)	Unsure (3)	Agree (4)	Strongly Agree (5)	Total
S1	3.1	1.3	32 (15.8%)	47 (23.2%)	27 (13.3%)	66 (32.5%)	31 (15.3%)	203 (100%)
S2	2.3	1.1	58 (28.6%)	69 (34.0%)	37 (18.2%)	34 (16.7%)	5 (2.5%)	203 (100%)
S3	3.0	1.3	32 (15.8%)	49 (24.1%)	33 (16.3%)	57 (28.1%)	31 (15.3%)	202 (100%)
S4	4.0	1.0	6 (3.0%)	12 (5.9%)	24 (11.8%)	93 (45.8%)	68 (33.5%)	203 (100%)
S5	3.2	1.2	23 (11.3%)	45 (22.2%)	37 (18.2%)	70 (34.5%)	28 (13.8%)	203 (100%)

Participants most strongly agreed that students having English as a second language should influence their mathematics instruction and tended to agree that student socioeconomic status should also be considered. Participant responses were fairly evenly split in regard to student race/ethnicity, and participants tended to disagree that gender should be a factor in planning and carrying out mathematics instruction.

Gender. Table 2 shows the means and standard deviations of survey items S1-S5 by gender. Mean scores between gender groups were relatively close and therefore mirrored the results of the total sample. For example, for S1, males had a mean score of 3.0 and females had a mean score of 3.1.

Table 2: Means and Standard Deviations for Survey Items S1-S5 by Gender

Survey item	Male (<i>n</i> = 28)		Female (<i>n</i> = 175)		Total (<i>n</i> = 203)	
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>
S1	3.0	1.4	3.1	1.3	3.1	1.3
S2	2.1	1.1	2.3	1.1	2.3	1.1
S3	2.9	1.4	3.0	1.3	3.0	1.3
S4	3.9	1.1	4.0	1.0	4.0	1.0
S5	3.2	1.3	3.2	1.2	3.2	1.2

In analyzing the data by gender, the Levene’s test revealed that there was homogeneity of variance for S1 ($p = 0.560$), S2 ($p = 0.686$), S3 ($p = 0.525$), S4 ($p = 0.350$) and S5 ($p = 0.916$). A one-way analysis of variance (ANOVA) was used to determine whether there were significant differences between males and females for S1, S2, S3, S4 and S5. The results revealed no significant differences between males and females for survey items S1 ($F(1, 201) = 0.041$,

$p = 0.839$), S2 ($F(1, 201) = 0.673$, $p = 0.413$), S3 ($F(1, 200) = 0.186$, $p = 0.667$), S4 ($F(1, 201) = 0.788$, $p = 0.376$), and S5 ($F(1, 201) = 0.037$, $p = 0.849$).

Age. Table 3 shows the means and standard deviations of survey items S1-S5 by age. Although mean ratings tended to be higher for the older group, the ratings were relatively close for S1, S2, S3, and S4. Therefore, the role of student gender, race/ethnicity, and language in relation to mathematics instruction were viewed by the two age groups similar to that of the sample at large. A difference in mean values appears between age group 18-25 ($M = 3.1$) and

26-plus years ($M = 3.6$) for survey item S5, which relates to student socioeconomic status. This means that the older age group was more likely to agree that student socioeconomic status should be considered in planning and carrying out mathematics instruction.

Table 3: Means and Standard Deviations for Survey Items S1-S5 by Age

Survey item	18-25 ($n = 165$)		26 and older ($n = 38$)		Total ($n = 203$)	
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>
S1	3.0	1.3	3.4	1.4	3.1	1.3
S2	2.3	1.1	2.3	1.3	2.3	1.1
S3	3.0	1.3	3.3	1.3	3.0	1.3
S4	4.0	1.0	4.2	1.0	4.0	1.0
S5	3.1	1.2	3.6	1.2	3.2	1.2

In analyzing the data by age, the Levene’s test revealed that there was homogeneity of variance for S1 ($p = 0.519$), S2 ($p = 0.097$), S3 ($p = 0.522$), S4 ($p = 0.348$), and S5 ($p = 0.284$). A one-way analysis of variance was used to determine whether there were significant differences between age groups. Table 4 presents the results. The results revealed that there was a significant difference between age groups for the survey item S5 ($F(1, 201) = 5.788$, $p = 0.017$, $\eta^2 = 0.028$).

Table 4: Analysis of Variance (ANOVA) for Survey Items S1-S5 by Age

Survey Item	Source of Variation	Sum Squares	of df	MS	F	p
S1	Between Groups	4.522	1	4.522	2.531	0.113
	Within Groups	359.055	201	1.786		
	Total	363.576	202			
S2	Between Groups	0.063	1	0.063	0.049	0.825
	Within Groups	257.001	201	1.279		
	Total	257.064	202			
S3	Between Groups	3.158	1	3.158	1.781	0.184
	Within Groups	354.663	201	1.773		
	Total	357.822	202			
S4	Between Groups	1.421	1	1.421	1.484	0.225
	Within Groups	192.559	201	0.958		
	Total	193.980	202			
S5	Between Groups	8.759	1	8.759	5.788	0.017*
	Within Groups	304.206	201	1.513		
	Total	312.966	202			

* $p < 0.05$

Race/Ethnicity. Table 5 shows the means and standard deviations of survey items S1-S5 by race/ethnicity. Mean scores between non-White and White students were relatively close for S1, S2, S3, S4, and S5 and thus approximated the sample at large. For example, for S3, non-White and White students had mean scores of 3.3 and 3.0 respectively.

Table 5: Means and Standard Deviations for Survey Items S1-S5 by Race/Ethnicity

	Non-White ($n = 30$)		White ($n = 172$)		Total ($n = 202$)	
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>
S1	3.0	1.2	3.1	1.4	3.1	1.3
S2	2.1	1.0	2.4	1.1	2.3	1.1
S3	3.3	1.4	3.0	1.3	3.0	1.3
S4	4.3	0.8	4.0	1.0	4.0	1.0
S5	3.2	1.1	3.2	1.3	3.2	1.2

The Levene's test revealed that there was homogeneity of variance for S1 ($p = 0.490$), S3 ($p = 0.229$), S4 ($p = 0.688$), and S5 ($p = 0.376$), but not for S2 ($p = 0.019$), the question that relates to gender. Therefore, a one-way analysis of variance was performed to determine whether there were significant differences between non-White and White students for S1, S3, S4, and S5. The results revealed no significant differences between the two groups for survey items

S1 ($F(1, 200) = 0.319, p = 0.573$), S3 ($F(1, 199) = 1.568, p = 0.212$), S4 ($F(1, 200) = 2.533,$

$p = 0.113$), and S5 ($F(1, 200) = 0.000, p = 0.987$). Using the Mann-Whitney U test, S2 was examined for significance. The result showed no significant difference between non-White and White students for S2 ($z = -1.192, p = 0.233$).

Qualitative Analysis

The qualitative analysis of the data involved reading and rereading participants' written responses from survey items S1-S5 multiple times. Consistencies were noted in individual words, phrases, and ideas. These consistent themes were identified from each survey item. Five dominant themes, each described below, appeared across students' written comments: children's learning differences, differentiated teaching, real-world connections, importance of students' prior knowledge, resources and supplies.

Children's learning differences. As noted earlier, the survey ratings show that 47.8% of the participants tended to believe that student demographic in the classroom should influence the way they teach. Written comments indicate that participants believe children have different learning styles (some children are visual learners, some auditory learners, and others are kinesthetic/tactual learners). Typical student responses were:

- Students that come from different backgrounds have different ways of learning. Teachers should incorporate these differences into their lesson plans so that all students will benefit.
- Like every subject, all children, no matter their gender or race/ethnicity learn things in different ways and it is important to teach them in ways that meet their needs.
- Students from different ethnicities may have grown up learning in different ways than I am accustomed to so I need to consider these differences.

Differentiated teaching. In their commentary, participants thought that teachers ought to be flexible and should not stick to one way of teaching. Participants contend that there is no one best way of teaching and that teaching and learning should accommodate the level of students' potential, different learning styles, background and experiences, and gender. Some participants assert that the teacher must use a mixture and variety of teaching methods and strategies that will ensure all students are reached out to. Typical student responses were:

- Students with varying backgrounds will also have different expectations and prior knowledge to bring to my classroom. In order to best reach those students, my methods will need to be ever changing.
- I think that capable teachers should be flexible and be able to use various methods to meet the needs of the diverse students they encounter. However, race/ethnicity alone should not necessarily require change, but language barriers might.

Real-world connections. In general, participants thought that the environment for learning mathematics should be inviting and inclusive for all students regardless of gender, race/ethnicity, home language or socioeconomic status. They believe that the mathematics classrooms should provide practical experiences in ways of thinking that join the world of school to the real-world community. Participants believe that by including mathematical processes that have the potential for developing students' skills in solving problems in practical situations, students may gain confidence in themselves. Sample participant comments are:

- The classroom needs to represent a real-world community. Everyone needs to have relations to their own beliefs, culture, and customs.
- Each child, irrespective of gender, race/ethnicity, and other demographics deserves to be represented in the classroom curriculum.
- All students deserve equal and equitable mathematics education. We need to break down stereotypes. I feel the way I teach should be constructed and portrayed by the students I have in my classroom. I feel that student demographics should be acknowledged as a benefit of diversity. The way I intend to teach mathematics is to link with the real-world that will benefit all students regardless of demographics.

Importance of students' prior knowledge. In general, participants contend that prior knowledge influences how the teacher and students interact during the teaching and learning process. One way to do this, according to some participants, is for teachers to use class discussions to activate and illustrate students' prior knowledge because such dialoging encourages students to think about their thinking, raising their thought process to a conscious level. By tapping into students' prior knowledge in mathematics, participants assert that teachers can plan lessons that will clarify incomplete or erroneous prior knowledge, determine the extent of instruction necessary in a particular topic area, and discern necessary adjustments to planned independent activities and assessment materials. Participants said that teachers can use prior knowledge to make instruction more meaningful by incorporating parallels between a student's cultural background and the curriculum's design. Some typical participant comments include:

- The ideas that students bring into the classroom should help you understand them and teach them better. Gender and race/ethnicity, in some ways, do influence a student's background knowledge.
- Some students may not show sufficient background knowledge for a specific topic that would make math concepts easier to understand so teachers need to help students bring out those background experiences needed for the lesson in their classes.

Resources and supplies. Some participants expressed a belief that schools serving relatively disadvantaged populations of students receive fewer resources. They contend that schools with particularly disadvantaged students are likely to have less-educated and less-experienced teachers. They argued that by funneling considerable additional resources into schools in disadvantaged areas, students who already are classified as having low socioeconomic status may have reasonable opportunities to improve their performance. Further, they stated that some students may not be able to afford the tools and supplies needed for school. Sample comments follow:

- Socioeconomic status is a huge factor in a student's individuality, which should be addressed.
- Not every student will be able to buy school supplies. Not every student will show up in class everyday because of family reasons. These need to be taken into thought.
- This is very important in assigning projects or assignments. Teachers have to know available resources for all the students. For example, if a teacher assigns a project where a student has to use technology (computer) outside of class and the student's socioeconomic status is very low, there is going to be a problem because most likely the student will not have the resources necessary to complete the assignment.

Closing Discussions

This study has addressed the issue of pre-service teachers' attitudes and beliefs in relation to teaching mathematics equitably to all students. In addition to looking at participants' attitudes and beliefs as a whole, emphasis was placed on how gender, age, and race/ethnicity might play a role in shaping those attitudes and beliefs.

In general the quantitative analyses of this study show that participants perceive students' home language, race/ethnicity, and socioeconomic status in that order, should receive the greatest consideration when planning and carrying out mathematics instruction. Most of the participants did not see gender the same way, considering it an irrelevant factor. The analyses resulted in statistically significant differences by age in mean values for the survey item "Student socioeconomic status is a factor to consider in planning and carrying out mathematics instruction." The difference indicated that students over 25 years of age believe more strongly than students in the 18-25 category that student socioeconomic status should be considered when planning and carrying out mathematics instruction. Participants tended to be overly optimistic about their ability or the need to consider student demographics in the way they teach.

This agrees with Barajas and Pierce (2001) when they posit that a failure to recognize and consider the integration of race/ethnicity, gender socioeconomic status, and home language leads at times to an over simplification or inaccurate understanding of what occurs in schools, and therefore to inappropriate or simplistic prescriptions for educational equity. Participants did not perceive a need to factor in students' gender when planning and carrying out mathematics instruction. This finding may be based on research (e.g., Leder, 1992) that gender differences in mathematics performance between males and females are small compared to differences within gender groups. In addition, Ansell and Doerr (2000) note that gender differences relate to affective factors such as students' attitudes, self-concepts, and self-confidence, rather than performance and teaching style. However, most teachers do tend to see mathematics as a male domain – the subject being difficult for average-achieving girls than for equally average-achieving boys (Bennett & Bennett, 1994; Li, 1999; Tiedemann, 2000). Thus, it is important to consider the affective domain in relation to gender in mathematics instruction.

Participants consistently perceived factoring in students' race/ethnicity and home language when planning and carrying out mathematics instruction as a salient matter. One reason may be that the majority of the participants in the study face limited significant geographic as well as personal experience with individuals outside of their own cultures beyond selected k-12 classrooms. Another reason could be the fact that the majority of the children in the schools within this study site are non-native English speakers and come from low socioeconomic backgrounds. These are schools selected for pre-service teachers' field experiences.

Participants over age 25 perceive more than those ages 18-25 that student socioeconomic status should be considered when planning and carrying out mathematics instruction. One reason may be that students over age 25 have become aware of realities of socioeconomic and political disparities in the larger social order and how they are reflected in school routines, procedures, curriculum and textbook adoption, and classroom pedagogies (Bishop, 1998). Charalambos, Philippou, and Kyriakides (2002) and Ernest (2000) discuss the powerful impact of pre-service teachers' attitudes and beliefs on the practice of teaching. Such beliefs involve beliefs about students' demographics and learning styles, nature of mathematics, and the role of teachers (Tiedemann, 2000; Wallace & Kang, 2004). The findings in this study support these earlier findings. In addition, the results of this study could be used to strengthen the nature of diversity courses pre-service teachers are required to take because pre-service teachers need help understanding the strengths and needs of students who come from diverse linguistic and cultural backgrounds.

In their written commentary, participants called for better ways to experience diverse mathematics classrooms and to increase their awareness of cultural diversity and learning styles of demographically diverse students. These findings agree with Zimpher (1989), who asserts that the educational experiences, background and attitudes of pre-service teachers do not equip them to participate in the culture of schooling envisioned for an increasingly pluralistic society. Zimpher (1989) says that overwhelmingly white and middle class pre-service teachers typically are monolingual, and so they bring little intercultural experience from their largely suburban and small-town backgrounds. Stoddart (1990) echoes these sentiments and contends that substantial numbers of pre-service teachers do not believe that low-income and minority learners are capable of learning high-level concepts in the subjects they are preparing to teach. Unfortunately, current trends in learning style research have ignored issues of cultural diversity as complex facets of learning style (Gardner, 1983).

The pre-service teachers in this study believe that by providing students with hands-on projects and assignments, they will be able to support the learning needs of all students. This resonates with what other researchers have found. In particular, Mikusa and Lewellen (1999) found that constructivist teaching encourages students to actively construct their own knowledge of mathematics.

Therefore, connections between concrete work with materials and procedural knowledge must be made for students to understand procedural mathematics knowledge. Tzur and Timmerman (1997) suggest that teacher educators use knowledge of children's thinking to create activities that will help pre-service teachers develop their understanding of mathematics concepts. Based on their study of one pre-service teacher's effort to construct mathematical meaning, Lubinski, Fox, and Thomason (1998) suggest that construction of conceptual understanding is important for pre-service teachers to be able to teach these concepts to children in their future careers.

In discussing these findings, I return to the theoretical framework of critical pedagogy, and critical multicultural education. Leistyna and Woodrum (1996) explain that critical pedagogy supports pedagogical theories and practices that encourage both teachers and students to develop an understanding of the interconnecting relationship among ideology, power, and culture, rejecting any claim to universal foundations for truth, culture, and objectivity. Based on the findings from the study, it is important that pre-service teachers are prepared in ways that combine the conditions of mathematical cultural diversity with an emancipatory vision of educational practice. Critical pedagogy enacted in the mathematics classroom should adopt the pedagogical theories and practices of critical pedagogy, using mathematics as an analytical tool for examining social injustices. This will create conditions for students from diverse racial/ethnic and cultural backgrounds to question the social, economic, and political relations in which they have been historically situated. For example, how can a student's personal history and cultural context be used to explain the mathematical, economic, social, and cultural values in constructing both round and rectangular houses, given the same building materials. Many pre-service teachers do not have the opportunity, commitment and/or capacity to develop deep conceptual understanding of more recent or innovative concepts about emancipatory teaching. This study therefore, provides strong support for the argument that mathematics educators should make addressing pre-service teachers' attitudes and beliefs for teaching mathematics equitably a regular part of their pedagogy.

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