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The Relationship Between Instructors' Teaching Contexts, Academic and Professional Backgrounds, and Their Uses of Class Time in Mathematics Content Courses for Elementary Teachers: Results of a National Survey

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*This article reports on a national survey of post-secondary mathematics instructors (*n *= 458) of mathematics courses designed for elementary teachers. The article links the use of various instructional practices to instructor characteristics. Specifically, there were statistically significant differences in reported use of class time depending on instructors' subject and level of their degree, their experience teaching in preK–12 classrooms, and whether they perceived the institutions at which they taught as selective. Use of regression models with interactions demonstrate that the relationship between academic and professional background, teaching context, and use of class time was complex.*

Keywords: *teacher education, mathematics content courses, instructional practices*

In the mathematics community, there is a consensus that strategies that actively engage prospective teachers in doing mathematics during class time should be used in the mathematical education of teachers (Association of Mathematics Teacher Educators [AMTE], 2017; Conference

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Board of the Mathematical Sciences, 2012). Actively engaging in mathematics during class time results in increased learning for all learners, including prospective teachers (Freeman et al., 2014; McCrory et al., 2009). Moreover, prospective teachers should "experience learning mathematics using methods that are consistent with the methods they should use as teachers" (AMTE, 2017, p. 48). In particular, these methods include eight effective practices identified by the National Council of Teachers of Mathematics (2000). These effective practices include students using mathematical relationships and solving problems that help them to develop conceptual understanding. Moreover, such instruction involves students engaging in discussions with one another. These practices are correlated with prospective teachers learning more mathematical knowledge for teaching. Courses where instructors reported a higher frequency of prospective elementary teachers explaining and solving problems themselves, as opposed to listening to the instructor explain ideas or procedures, demonstrated a higher level of growth in mathematical knowledge for teaching (McCrory, 2009; McCrory et al., 2009).

While there is agreement on the effective practices prospective teachers should experience, very little was known about whether these effective practices typically occur in mathematics content courses designed for elementary teachers (MCCETs) prior to this study. Research on college-level mathematics courses typically show that lecture is a predominant teaching method (Blair et al., 2013; Eagan et al., 2014; Walczyk & Ramsey, 2003). A nationwide survey found that a "combination of lecture-based and activity-based format" was common in MCCETs, but offered no further detail (Masingila et al., 2012, p. 352). There is a relationship between growth in prospective teachers' mathematical knowledge for teaching and the amount of class time they spend discussing and solving problems, as opposed to listening to the instructor. This study is one of the first to describe the variations in use of class time in MCCETs.

Some researchers have suggested that the instructor's background influences the instructional methods used. In particular, familiarity with the field of education as an academic discipline, experience working in preK–12 educational settings, and pedagogical training have been suggested as characteristics related to the pedagogical strategies instructors may use. Schoenfeld et al. (2016) found that, compared to mathematics teacher educators, university mathematicians' instructional actions were significantly influenced by their concern for mathematical correctness and precision, to the point of overshadowing other pedagogical concerns. Bleiler (2015) described differences in problem selection and the use of student thinking between a mathematician and a mathematics teacher educator collaborating together. Likewise, survey results suggest that science and mathematics instructors with pedagogical training in graduate school were more likely to seek out innovative sources and consult with others about teaching (Walczyk et al., 2007).Whether instructional practices vary due to instructor characteristics, such as academic discipline or training, is a particularly important question for mathematics courses for future elementary teachers, given that they are taught by instructors with varied backgrounds, according to Masingila et al.'s (2012) survey. Institutions that responded to the survey were approximately equally likely to indicate that instructors of these courses had doctorates in mathematics as in mathematics education. However, it was also very common for instructors to hold only a Masters as their highest degree. Masingila et al. lamented that few of the instructors had elementary teaching experience. They conjectured that instructors of mathematics content courses for elementary teachers therefore had "not had opportunities to think deeply about the important ideas in elementary mathematics" (Masingila et al., 2012, p. 357).

Another factor that impacts instructional practice is instructors' perception of their students. For example, instructors' use of textbooks is mediated by whether they perceive their students as potential STEM majors or as general education students (Mesa & Griffiths, 2012). Thus, the same instructor may use different practices based upon their teaching context.

An outstanding question is whether these instructors' characteristics (i.e., their academic backgrounds and experience teaching in preK–12 schools) matter in their work with current or future elementary teachers. In particular, this research study sought to determine if instructors with advanced degrees, with a background in mathematics education, or with elementary or secondary teaching experience were more or less likely to engage in the type of instruction advocated by AMTE and other stakeholders. Instructor characteristics include whether instructors have a terminal degree, whether their terminal degree is in mathematics or mathematics education or another discipline, and whether they have taught in preK–12 schools. Instructional practices include the reported percent of class time spent lecturing, having students work together in small groups, having students work individually, or having students present at the board or engage in a whole class discussion. The research question for this study is, Is there a relationship between instructor characteristics and their use of class time in mathematics content courses designed for elementary teachers?

Method

Survey Instrument

We conducted a nationwide online survey (n = 458) of instructors of mathematics content courses designed for elementary teachers (MCCETs). These courses may have included prospective or current teachers, no distinction was made. Survey participants answered questions about their use of class time and various instructional practices from a previously validated survey, the Postsecondary Instructional Practices Survey (Walter et al., 2016). Walter et al. (2016) reported a high level of correlation between observed practice and responses on this survey. While there are several items on the survey, only use of class time is reported here. Survey participants reported the percent of weekly class time spent in various formats (small group, individual work, listening to the instructor, or other). Just under half of the respondents (216, or 47%) chose the “other” category. Of these, 34% described activities such as whole class discussion or student presentations, or a combination of both. These were grouped together into a category referred to as “whole class student engaged activities,” abbreviated “student engaged." While students can be engaged during small group or individual work, we chose this term to highlight the fact that these are whole class activities in which students are doing mathematics, as opposed to only listening to the instructor.

Participants answered questions about their academic and professional background, including whether they had experience teaching in elementary, middle, or high school, and the subject and level of their highest degree. Participants also provided information about their teaching context. In particular, they reported the number of sections they taught each semester and the average number of students in their sections. They indicated whether they believed that their program was highly selective, moderately selective, or not selective, based upon the caliber of the students in their MCCETs. Thus, perceived selectivity is a subjective construct combining the instructors' perception of their elementary education students and their perception of the institution or program. Questions about the caliber of students, independent of the institution, would likely be difficult for instructors to respond to, given the variation of skill in one class. In addition, focusing on instructors' perception of the program, rather than only students, may have mitigated the impact of social desirability bias. Many educators are aware that believing in students' abilities is related to student achievement. Survey items discussed in this study can be found in the Appendix. Descriptive statistics are provided for all participants who provided data. Regression analysis was conducted only on those participants who provided data about their academic or professional background.

Survey Participant Recruitment and Data Collection

A link to the anonymous online survey was sent to instructors of MCCET in the Fall of 2016. There were 458 participants who had sufficient usable data about the percent of class time spent in different formats, and 402 instructors completed 95% of the survey or more. The survey link was emailed to the email lists of organizations concerned with the mathematical education of teachers. In addition, the researchers sent a link to the survey to the heads of mathematics departments at over 1,800 institutions in the United States. Follow-up emails requested the department chairs send the survey link on to faculty members who taught mathematics courses for elementary teachers. Participants were asked to send the link to other instructors they knew. The snowball sampling method was used in order to increase the potential participation of instructors whose primary role is not necessarily elementary teacher preparation, such as part-time instructors and those who teach other mathematics courses, or instructors who may be transient or unaffiliated with particular professional organizations. Because of the snowballing nature of the sample, there is no way to determine response rate. The sample included instructors who reported teaching both mathematics content courses designed for elementary teachers and courses that combined mathematics and pedagogy, but not purely methods courses.

Data Analysis

Regression analysis offers insight into how related predictor variables work together by allowing researchers to statistically control for one variable in order to determine the impact of another. For instance, regression analysis can describe the relationship between the field of a participant's degree and the use of class time, while controlling for perceived selectivity of an institution. Interactions were used because it was hypothesized that the relationship between instructor characteristics could be compounded or mediated by other independent variables. For instance, the relationship between the level of instructors' degree and the use of lecture was different for programs perceived to be selective versus those perceived to not be selective.

The dependent variable was the use of class time. This included the reported percent of class time prospective teachers spent working in small groups, listening to the instructor, working independently, or participating in whole-class "student-engaged activities," that is, whole class discussion and student presentations. The independent variables were: (a) the instructor's possession of a doctoral degree; (b) having one's terminal degree in mathematics education, as opposed to mathematics or another discipline; (c) having experience in preK–12 education; and (d) perceiving one's institution or program as selective, based upon the caliber of students in the instructor's MCCETs.

Results

Description of Participants

The majority (82%) of the instructors participating in the survey were full-time faculty. There were more respondents with their highest degree in mathematics education than pure mathematics (57% compared to 32%). Seventy percent (70%) had either earned their doctorate or volunteered that they were working on their doctorate at the time of the survey. One-fifth (20%) of the sample had experience teaching preK–5. Only 28% had no experience teaching preK–12 students. Over half (56%) had experience teaching Grades 9–12 and 41% had experience teaching Grades 6–8. Over half (52%) responded "highly selective" or "moderately selective" to the question "*Thinking about the caliber of your students in these classes*, how would you describe this institution or program?" Collectively, the instructors who participated in this survey taught over 27,200 future elementary teachers each year, with a mean of 2.8 sections (*SD* = 1.6) per semester and a mean of 23.6 students (*SD* = 8.7) per section.

Summary statistics for the reported use of class time and instructor characteristics are presented in Tables 1 and 2. The box and whisker plot in Figure 1 demonstrates how the use of class time compares across these classroom activities.

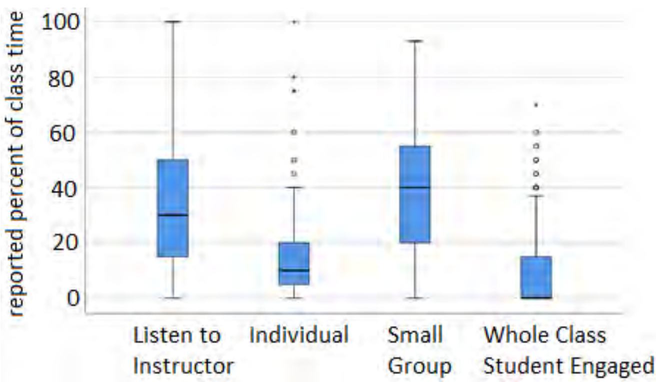
Table 1
Summary Statistics for Dependent Variable (Use of Class Time, in %)

	n	*M*	*SD*	*Mdn*	Minimum	Maximum
Listen to instructor/lecture	458	36.9	24.5	30	0	100
Individual	458	12.7	12.5	10	0	100
Small group	458	38.8	22.9	40	0	93
Student engaged in whole class	458	8.0	13.4	0	0	70

Table 2
Summary Statistics for Independent Variable (Instructor Characteristics)

	n	Total	%
Have or working toward a doctorate (doctorate)	402	281	69.9%
Highest degree is in math education (mathED)	402	230	57.2%
Has preK–12 teaching experience (K12exp)	402	288	62.9%
Perceives institution as moderately or very selective (selective)	400	237	51.7%

Figure 1
Reported Percent of Class Time Spent in Various Activities



As can be seen in Tables 1 and 2, the survey included instructors from a variety of backgrounds in regard to the level of their highest degree and their experience teaching preK–12 students. Moreover, there is variation in the reported percent of class time spent having students listen to the instructor and having students working in small groups, as shown in Figure 1. Summary statistics of the dependent variables grouped by the independent variables are presented in Table 3. In this table, it is clear that at least some of the variation in the use of class time may be related to instructor characteristics. For example, on average, the reported percent of class time spent having students listen to the instructor was more than 10% lower among instructors with a doctorate or working toward a doctorate. Table 3 also demonstrates that various instructor characteristics are correlated with reported use of class time.

Table 3

Mean and Standard Deviation of Percent of Class Time Spent in Various Formats, Grouped by Instructors' Backgrounds and Perceived Selectivity of Program

	Lecture		Individual		Small groups		Student engaged in whole class	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Doctorate								
None ($n = 121$)	45.1	25.6	15.6	16.8	31.5	22.0	4.3	9.7
Have ($n = 281$)	33.8	23.4	10.7	8.9	42.4	22.5	9.9	14.6
Missing ($n = 56$)	34.4	24.0	16.4	15.3	36.5	22.6	6.3	12.2
Math education degree								
None ($n = 172$)	43.6	26.9	12.6	13.7	33.9	24.2	5.7	11.5
Have ($n = 230$)	32.4	21.5	11.8	10.6	43.0	21.1	10.1	14.6
Missing ($n = 56$)	34.4	24.0	16.4	15.3	36.5	22.6	6.3	12.2
PreK–12 teaching experience								
None ($n = 114$)	39.2	27.2	10.6	11.6	40.0	25.8	8.3	14.8
Some ($n = 288$)	36.4	23.5	12.8	12.1	38.8	21.6	8.2	13.1
Missing ($n = 56$)	34.4	24.0	16.4	15.3	36.5	22.6	6.3	12.2
Perceived selectivity								
Low ($n = 163$)	40.6	26.3	13.3	15.5	36.9	23.7	6.5	12.6
High ($n = 237$)	34.9	23.1	11.4	8.9	40.8	22.2	9.3	14.1
Missing ($n = 58$)	34.6	24.3	16.6	15.1	36.1	22.5	6.6	12.4

As the dependent variables must sum to at most 100% for each respondent, there is an inherent lack of independency within these variables, as can be seen in the correlations between the dependent variables presented in Table 4. To examine the dimensional structure, a principle components analysis without rotation was run. Though the variables are not orthogonal (Bartlett's test: $\chi^2[6] = 786.0$, $p < .001$), the KMO sampling adequacy measure was .204. This indicates that a common latent factor structure does not adequately explain a substantive amount of shared variation among the variables. Thus, examining each of the dependent variables separately is justified.

Prior to running a MANOVA, exploratory data analyses for each dependent variable were conducted including various regression models using different model selection strategies. This process indicated that the main effects should be included along with 2 two-way interactions (doctorate by selectivity and K–12 experience by selectivity) and 1 three-way interaction (doctorate by math ed by selectivity). Including all of these effects and interactions (along with all sub-two-way interactions), the MANOVA indicated a significant multivariate effects for a number of these independent variables. The MANOVA test statistics and significance levels are summarized in Table 5.

Following on from the MANOVA omnibus test, separate ANOVA models were examined for each of the dependent variables. The models reported below were chosen in such a manner that inclusion of any additional main or interaction effects did not result in a significant change in R^2. All final models are presented in Table 6.

Table 4

Correlation Between Variables

	Lecture	Individual	SmallGrps	StudntEngag	doctorate	mathED	K12exp	Selectivity
Lecture	—	–.111*	–.721**	–.411**	–.212**	–.226**	–.051	–.114*
Individual	–.117*	—	–.251**	–.206**	–.191**	–.036	.080	–.077
SmallGrps	–.697**	–.250**	—	–.014	.221**	.201**	–.024	.085
StudntEngag	–.392**	–.206**	–.011	—	.191**	.157**	–.004	.102*
Doctorate	–.211**	–.188**	.218**	.192**	—	.253**	–.102*	.074
mathED	–.225**	–.033	.198**	.159**	.255**	—	.279**	.102*
K12exp	–.051	.082	–.026	–.003	–.100*	.281**	—	.029
selectivity	–.114*	–.077	.085	.102*	.074	.102*	.029	—

Note. Correlation above diagonal obtained via listwise deletion ($n = 400$); correlations below diagonal obtained via pairwise deletion (n ranges from 400 to 458). Gray cells indicate point-biserial correlations; upper-left cells are Pearson correlations; lower-right cells are φ coefficients. For these correlations, values $r \leq .09$, $p > .05$.

* $p < .05$. ** $p < .01$, $r \geq .15$.

Table 5

MANOVA Test Statistics and Significance Levels

	Effect	Wilks' Λ	F	p
Main	Doctorate	.930	7.254	.000
	Math Education degree (mathED)	.968	3.239	.012
	preK-12 teaching experience (K12exp)	.982	1.802	.128
	Perceived selectivity (selectivity)	.963	3.747	.005
2-way	doctorate × mathED	.980	1.970	.098
	K12exp × selectivity	.986	1.407	.231
	mathED × selectivity	.983	1.625	.167
	doctorate × selectivity	.953	4.727	.001
3-way	doctorate × mathED × selectivity	.972	2.823	.025

Table 6

Final ANOVA Models Predicting Percent of Class Time From Instructors' Academic and Professional Background and Perception of the Selectivity of the Program.

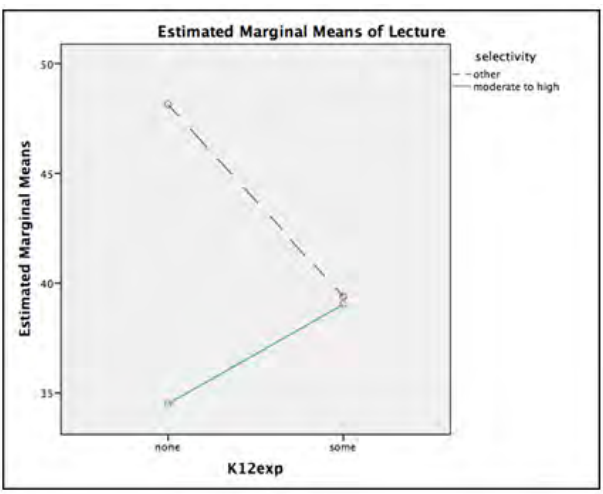
	Lecture		Individual	
	Main	2-way	Main	2-way
R^2	.084	.099	.04	.056
F (for ΔR^2)	9.07***	6.34*	8.32***	6.81**
Df	4,395	1,394	2,397	1,396
MathED (m)	−8.48 (2.61)**	−8.22 (2.59)**		
Doctorate (d)	−8.78 (2.71)**	−88.8 (2.69)**	−4.86 (1.29)***	−8.65 (1.94)***
Selectivity (s)	−4.19 (2.42)	−13.63 (4.45)**	−1.54 (1.21)	−6.17 (2.14)**
K12exp (k)	−0.96 (2.77)	−8.74 (4.14)*		
Ks		13.27 (5.27)*		
Ds				6.74 (2.58)**

	Student engage whole class		Small Groups	
	Main	Main	2-way	3-way
R^2	.049	.074	.082	0.093
F (for ΔR^2)	10.3***	10.6***	1.06	4.78*
Df	2,397	3,396	3,393	1,392
MathED (m)	3.18 (1.38)*	6.94 (2.32)**	8.64 (4.91)	17.02 (6.21)**
Doctorate (d)	4.77 (1.49)**	8.889 (2.49)***	12.69 (4.32)**	17.98 (4.93)***
Selectivity (s)		2.64 (2.26)	9.35 (4.41)*	14.97 (5.08)**
K12exp (k)				
Ks				
Ds			−7.09 (5.03)	−17.1 (6.79)*
Dm			0.39 (5.01)	−12.09 (7.57)
Ms			−3.35 (4.69)	−18.41 (8.32)*
Dms				21.99 (10.06)*

Note: Unstandardized coefficients reported (with standard errors in parentheses). Significance indicated as *$p < .05$; **$p < .01$; ***$p < .001$.

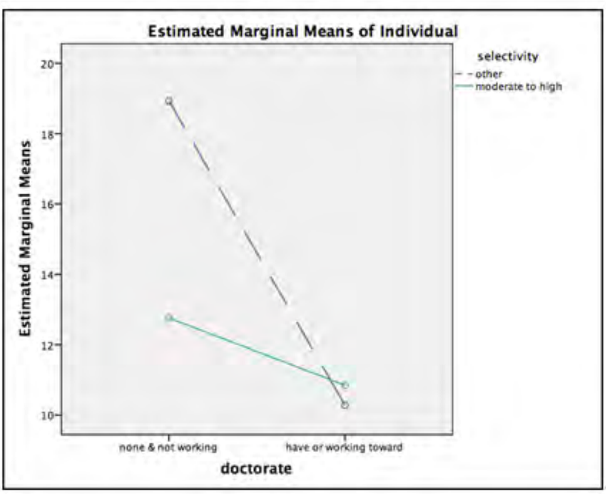
For lecturing, the final model explained R^2_{adj} = 8.7% of the variance ($F_{(5,394)} = 8.62$, $p < .001$). The statistically significant main effects were doctorate ($F_{(1,394)} = 10.92$, $p = .001$), math education ($F_{(1,394)} = 10.07$, $p = .002$), and perceived selectivity ($F_{(1,394)} = 6.98$, $p = .009$). On average, participants with a doctorate lectured 8.9% less. Participants with their highest degree in mathematics education lectured 8.2% less than participants with their highest degree in mathematics or another discipline. Participants who perceived their institution to be more selective lectured 3.6% less. There was a statistically significant interaction for preK–12 teaching experience by perceived selectivity ($F_{(1,394)} = 6.34$, $p = .012$), presented in Figure 2. While instructors with preK–12 teaching experience, on average, tended to use the same percent of time lecturing regardless of how they viewed the selectivity of their program, those without preK–12 experience at institutions perceived to be less selective lectured more than their peers at institutions perceived to be more selective.

Figure 2
Interaction Between Instructors' Perceived Program Selectivity, PreK–12 Teaching Experience, and Reported Use of Lecture



For individual work, the final model explained $R^2_{adj} = 4.9\%$ of the variance ($F_{(3,396)} = 7.90$, $p < .001$). The statistically significant main effects were doctorate (those holding a doctorate had 1.9% less individual class work, $F_{(1,396)} = 16.7$, $p < .001$), and perceived selectivity (institutions perceived to be more selective had 0.6% more individual class work, $F_{(1,396)} = 4.70$, $p = .031$). There was a statistically significant interaction for doctorate by perceived selectivity ($F_{(1,396)} = 6.81$, $p = .009$), presented in Figure 3. While those who held a doctorate or were working toward a doctorate on average spent the same amount of time having students work individually in class, those without a doctorate tended to have students spend less time working individually if they perceived their institution to be more selective.

Figure 3
Interaction Between the Level of Instructors' Highest Degree, Instructors' Perceived Selectivity of the Program, and Use of Individual Work During Class Time

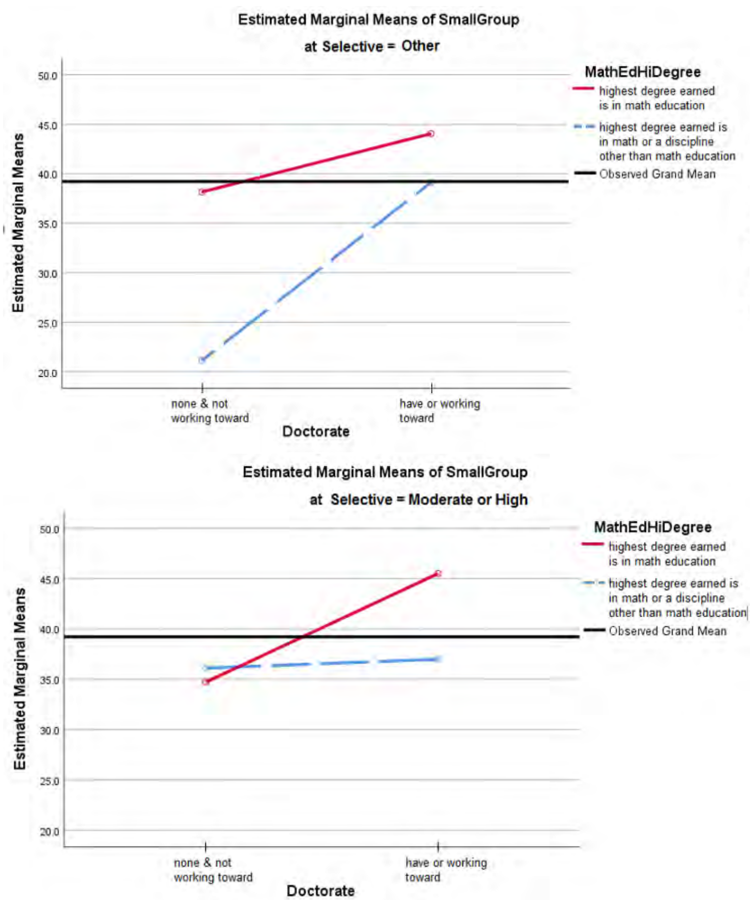


For small group work, the final model explained $R^2_{adj} = 7.7\%$ of the variance ($F_{(7,392)} = 5.74$, $p < .001$). The statistically significant main effects were doctorate (those holding a doctorate had 10.8% more small group work,

$F_{(1,392)} = 12.5$, $p < .001$), and math education (those with their highest degree in mathematics education had 8.5% more small group work, $F_{(1,392)} = 8.37$, $p = .004$). There was a statistically significant three-way interaction among doctorate, math education, and perceived selectivity ($F_{(1,392)} = 4.78$, $p = .029$), presented in Figure 4.

Figure 4

Interaction Between Subject of Highest Degree, Possession of a Doctorate, Perceived Selectivity of Program, and Use of Small Groups During Class Time



At institutions perceived to be less selective, among instructors whose highest degree was in a discipline other than mathematics education, there was a significant difference in the average use of small group work among instructors without a doctorate and those who held or indicated they were currently working toward a doctorate. While there were differences in other groups, the distinction was not as great.

For student engaged in whole class activities, the final model explained $R^2_{adj} = 4.5\%$ of the variance ($F_{(2,399)} = 10.5$, $p < .001$). There were only two main effects, and both were statistically significant: doctorate (those holding a doctorate had 4.8% more time spent in whole class student engaged activities, $F_{(1,399)} = 10.4$, $p = .001$), and mathematics education (those with their highest degree in mathematics education had 3.2% more time spent in whole class student engaged activities, $F_{(1,399)} = 5.40$, $p = .021$).

Findings

Overview

This study found that the use of class time in mathematics courses designed for elementary teachers differed by participating instructors' academic and professional backgrounds and their perception of the selectivity of the program. Instructors in the sample with a doctorate or working on a doctorate and instructors with their highest degree in mathematics education, as opposed to pure mathematics or another discipline, tended to spend less class time having students listen to the instructor and more class time having students work in small groups. Additionally, having preK–12 teaching experience was related to the reported use of class time, but those relationships were dependent upon the participating instructors' perception of the selectivity of the program, a trend that would have been missed if only the main effects were used. Moreover, there was a complex relationship between the instructors' academic and professional backgrounds and their perception of the selectivity of the program that impacts their use of class time and various instructional strategies.

The Impact of Academic Background

Among participants in the sample, having a doctorate and having one's highest degree in mathematics education was related to less time reported spent lecturing, more time having prospective teachers work in small groups, and more time having prospective teachers present their work or participate in whole class discussions, even when controlling for perceived selectivity of the institution. As can be seen in Table 6, survey respondents with their highest degree in mathematics education reported spending on average 8.48% less time lecturing than their counterparts. Respondents with doctorates reported spending on average 8.78% less time lecturing than their counterparts.

The Impact of PreK–12 Teaching Experience and Instructors' Perception of their Students

With the main effects model, it did not seem that having preK–12 teaching experience or the instructors' perceived selectivity of their institution, based upon the perceived caliber of their students, were related to the reported use of class time. However, after introducing interaction variables, some relationships became clear. When considering survey participants with preK–12 teaching experience, there was not a significant difference between the average reported percent of class time spent lecturing among those participants who perceived their institution or program to be highly or moderately selective and those who perceived their institution or program to be nonselective, based on the caliber of the students in their course, as can be seen in Figure 2. However, among participants without preK–12 teaching experience, there was a significant difference in the average reported percent of class time spent lecturing, depending upon whether they perceived their institution or program to be selective. Similarly, the perceived selectivity did not seem to be related to the average percent of class time spent having students work individually among instructors who held or were working toward a doctorate. However, among instructors who did not have a doctorate, there was a significant difference between the average reported percent of class time students spent working individually. Participants without a doctorate who perceived their institution to be more selective spent on average 6% more time having students work individually than those at less selective institutions.

Regarding small group work, the relationship follows a similar, if more complex, trend. Participants who did not hold and were not working toward a doctorate, whose terminal degree was in a discipline other than mathematics education, and who perceived their institution to be nonselective reported spending less time having students work in small groups. On average, these participants spent 21% (*SD* = 19.5) of class time having students work in small groups. In contrast, participants who perceived their institution to be less selective but who had a doctorate or a degree in mathematics education were more likely to report spending more time with small groups, 42% (*SD* = 23.4) and 43% (*SD* = 22.3) of class time respectively. This difference can be seen in the graph on the left in Figure 4, comparing the lowest point to the other three points. In fact, participants with a doctorate in mathematics education typically spent much more time having students work in small groups, regardless of whether they perceived their institution to be selective or not, about 45% (*SD* = 21.2) of class time.

In other research, reported use of class time has correlated with observed use of class time when survey items are specific and low-inference, such as the use of lecturing or small group work (National Center for Educational Statistics, 1999). Assuming instructors' reported typical use of class time is a reasonable proxy for their actual use of class time, teacher candidates in programs perceived to be less selective may have fewer opportunities to engage in mathematics themselves and with their peers during class time, compared to their peers in more selective institutions. However, if their instructor has particular credentials, such as a doctorate, a degree in mathematics education, or preK–12 teaching experience, they may be more likely to have similar opportunities as their peers at more selective institutions. Further qualitative research will be necessary to determine why this is the case. Perhaps, for instance, instructors with preK–12 teaching experience or advanced degrees in mathematics education have a greater repertoire of non-lectured based activities for students with weaker backgrounds in mathematics.

Student Engagement Activities

Lastly, this analysis found that instructors who held or were working toward their doctorate and instructors whose highest degree was in mathematics education, as opposed to pure mathematics or another discipline, were more likely to volunteer that they spend more time engaging in whole class discussion or having students present their work. This is an area for future research, as these activities were not explicitly listed on the survey, though 34% of participants volunteered this information.

Discussion

Higher education institutions at all levels are responsible for the mathematical education of teachers, from Ivy League graduate schools to open enrollment community colleges. This study suggests, however, that teacher candidates enrolled at institutions perceived as less selective by their instructors might experience different instructional practices in their mathematics-for-teachers courses. These differences may be an appropriate response to working with students with diverse mathematical backgrounds. However, this analysis would suggest that this is not necessarily the case. Instructors in the study with particular credentials—for example, preK–12 teaching experience, a doctoral degree, or an advanced degree in mathematics education—tended to report using class time differently from their peers at similar institutions. These differences tended to put those instructors with particular credentials in closer alignment with the vision put forth in AMTE's (2017) *Standards for Preparing Teachers of Mathematics*, especially in regard to more small group work and less lecturing, and thus more time for prospective teachers to be doing mathematics themselves. Thus, there appear to be particular skills or expectations that instructors with preK–12 experience, with doctoral degrees, or with an advanced degree in mathematics education develop for working with students with diverse mathematics or educational backgrounds. Additional qualitative research may further illuminate such skills or expectations.

There are limitations to this study. First, this study used a snowball sampling method, which may have resulted in an over-representation of different kinds of instructors. For example, part-time instructors were under-represented in the sample. Similarly, as with all survey studies, this study was subject to voluntary response bias. It is likely that those who are interested in the education of elementary teachers spent the 20 to 40 minutes required to answer the survey. Instructors for whom teaching this course was not a priority might not have answered. While there is evidence that self-reported use of class time correlates with observers' reports of use of class time (National Center for Educational Statistics, 1999), there was no way to verify the actual amount of time spent in these instructors' class in various class formats.

In addition, conclusions from the survey must be made carefully due to the design of the items. In regard to the selectivity item, this item was not designed to capture the actual selectivity of the institution or program. Rather, it captures the respondents' perception of the institution or program based on the perceived caliber of the students in the MCCETs. This choice was made because the instructors' perceptions of their students has been linked to their instructional choices in qualitative research (Hart et al., 2013; Lo et al., 2008; Mesa & Griffiths, 2012). If the item had asked specifically about the students and not about the program, it may have introduced social desirability bias, since many educators are aware that an instructor's negative opinion of students' abilities has been related to students' opportunities to learn (Papageorge et al., 2020). The item emphasized that the response should be based upon the caliber of the students in the mathematics for teachers courses by using italics and followed several questions emphasizing instructional practices used in MCCETs. Many MCCETs are taught in the mathematics department, but the item was designed to measure the respondent's perception of the program in which the elementary teachers were enrolled, though participants may have answered the question in regard to their institution as a whole. Previous research has found that instructors make a distinction between students taking mathematics to meet institutional requirements and students taking mathematics for their future careers in STEM fields (Mesa & Griffiths, 2012), and this item was intended to collect data on their perception of education students and the program or institution in which they were enrolled. The term "caliber" may also lack a standardized meaning among participants.

A second limitation concerns the design of the items measuring the use of class time. There were three specified options: (a) students listening to the instructor, (b) students working individually, and (c) students working in small groups. Respondents had to select "other" to volunteer that they also had students engaged in whole class discussion and student presentations. This may have resulted in an underestimate of the use of these strategies and an overestimate of the use of other class formats. On the other hand, providing whole-class discussion as an option may have resulted in an overestimate of the use of this class format. Other researchers have written about how what an instructor perceives to be whole-class discussion, may really be the instructor effectively lecturing, with funneling questions sprinkled throughout or instructors fishing for particular answers (Herbel-Eisenmann & Breyfogle, 2005).

Conclusions

These survey results provide more detail on the relationship between certain instructor characteristics and their reported use of instructional practices. Previous quantitative research on college mathematics courses generally (Blair et al., 2013; Eagan et al., 2014; Walczyk & Ramsey, 2003) and qualitative research on MCCETs (Hart et al., 2013) implied that using practices aligned with the *Standards for Preparing Teachers of Mathematics* (AMTE, 2017) may not be widely occurring in MCCETs. However, respondents to this survey reported structuring their class time in ways that would support the use of these practices, such as time for small group work, whole-class discussion, and student presentations of problem solutions.

However, there were differences based on instructors' academic and professional background. This analysis showed that the instructors' perception of the institution, based upon the caliber of students in their mathematics courses designed for elementary teachers, is related to the instructors' use of class time. Moreover, instructors with additional credentials, such as a doctoral degree, an advanced degree in mathematics education, or preK–12 teaching experience, were more likely to teach students at institutions or programs perceived as less selective in ways more similar to the reported methods used at more selective institutions.

Research indicates that teaching strategies that actively engage learners in doing mathematics, including a focus on collaborative problem solving as opposed to lecture, leads to more mathematical learning for all students, including prospective teachers (Freeman et al., 2014; McCrory et al., 2009). Moreover, AMTE has indicated that prospective teachers should experience mathematical instruction similar to the instruction that they are expected to use with their future elementary students (AMTE, 2017). The survey results discussed in this article suggest that such instruction may be occurring, but to a lesser degree, in institutions perceived to be less selective. Moreover, instructors with particular credentials report using class time in ways similar to instructors at more selective institutions, and in closer alignment with the instructional practices suggested by research. One implication of this study, therefore, could be considerations for recruiting and hiring instructors for MCCET among less-selective institutions. Alternatively, an additional area of research is to identify the particular skills or expectations that these instructors have that lead them to use class time in ways more similar to instructors at more selective institutions, and more in alignment with the AMTE recommendations. Attention to this topic could allow us to support instructors who do not have preK–12 teaching experience, or doctoral degrees, or advanced degrees in mathematics education, as many of them do not (Masingila et al., 2012). These survey results, in combination with other research on mathematics courses for elementary teachers (e.g., Hart et al., 2013; Lo et al., 2008; Welder et al., 2013) may help to identify the areas of growth or need for instructors of various backgrounds.

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Appendix

The following are selected questions from the survey. Radial buttons indicate "select one" option, and are shown with circles. Check boxes indicate "select all that apply" and are shown with squares. Straight lines indicate that participants wrote their own response.

Q3 Please indicate what proportion of class time during a typical week is spent in the following activities. The sum of these answers should equal 100%.

The instructor talking to the whole class. ___ %
Students working individually. ___ %
Students working in small groups. ___ %
Students doing something else. (Please specify:) ________ ___ %
Students doing something else. (Please specify:) ________ ___ %
Students doing something else. (Please specify:) ________ ___ %

Q18 How many sections of mathematics content courses for elementary teachers do you teach each academic year, on average? (Enter a number.)

Q19 About how many students are in one section? (Enter a number.)

Q20 Thinking about the caliber of your students in these classes, how would you describe
this institution or program?
o highly selective
o moderately selective
o not selective or open enrollment

Q21a Please tell us more about your background. What is your highest degree?
o Doctorate
o Masters

o Other (please explain:) _______________

Q21b What subject is your highest degree in?
o Mathematics
o Mathematics Education
o Other (please explain:) _______________

Q21d Please indicate if you are a full-time faculty member or full-time post-doc, a part-time or adjunct instructor, or a graduate student.
o full time
o adjunct/part-time
o graduate student
o Other (please explain:) _____________

Q21e Have you ever taught in a PreK–12 school? Please select all that apply.
No
Yes, Elementary (grades PreK–5)
Yes, Middle (grades 6–8)
Yes, Secondary (grades 9–12)