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Mathematics Teacher Time Allocation

Ashley Martin Jones

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Arts

Blake E. Peterson, Chair
Keith R. Leatham
Douglas L. Corey

Department of Mathematics Education

Brigham Young University

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ABSTRACT

Mathematics Teacher Time Allocation

Ashley Martin Jones
Department of Mathematics Education, BYU
Master of Arts

This study was conducted in order to determine how mathematics teachers allocate their time in the classroom and the factors that influence teacher priorities in that time allocation. Research has indicated that math teachers may choose not to do certain activities in their classroom because of the amount of time that they take, but other underlying reasons may exist. In order to study this idea, six math teachers were interviewed on their current time allocation and rationale for that allocation, and the results from these interviews were used to create a survey that was sent to 581 math teachers in Utah. The results from the 224 completed surveys showed that many teachers allocate their classroom time in a fairly traditional manner, with an average of about 10% of class time being spent on student-centered activities. 40.63% of teachers spent 0% of their class time on student-centered activities. There is variation in time allocation and influencing factors based on a teacher's schedule, level of teaching, experience, and how student-centered their teaching methods are. Also, the results support the claim that there are factors, other than limited class time, that affect how teachers choose whether or not to do certain activities. Some of the most significant deciding factors found are whether the activities will help students with their end of level tests, if they will keep students working hard mathematically, whether others are using those activities or not, how the activities affect classroom rowdiness. It was also found that teachers who are more teacher-centered tended to choose activities based on how easy they were to implement, including their personal comfort level, ease of preparation, and ease of management with student behavior. More student-centered teachers tended to care more about keeping the students working hard mathematically.

Keywords: time allocation, instructional activities, student-centered, teacher-centered, reform mathematics, priorities

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Introduction

Curriculum developers, researchers, state education committees, and school administrators discuss the set of topics that they think should be taught to students and the order in which these topics should be introduced. To a large degree, these discussions eventually determine what concepts the students in secondary mathematics classrooms are being taught, but teacher influence also plays a very important role in what the students are taught. As Clark & Lampert (1986) pointed out, "teacher planning is a major determinant of what is taught in schools. The curriculum as published is transformed and adapted in the planning process by additions, deletions, interpretations, and by teacher decisions about pace, sequence, and emphasis" (p. 28). In planning lessons, teachers make decisions as to how the curriculum will be used or adapted for their classroom. McCutcheon (1980) talked about teachers making decisions on changes to the curriculum and activities to be done based off of multiple reasons. Some of the reasons that were mentioned for these changes were related to the amount of time available for particular activities, including whether there would be enough time for a certain planned portion of a lesson. This study found that changes were also made in the curriculum and activities when the amount of available time was cut short by assemblies or other interruptions to class time. Each of these teacher choices and changes to the curriculum and how teachers choose to allocate their time towards the different curricular activities can have a big impact on what students are learning in a mathematics classroom. Research suggests that teachers allocate classroom time differently (Betts & Shkolnik, 1999; Keiser & Lambdin, 1996; Leinhardt, 1983, 1989; Rice, 1999), but there is not a lot of research as to exactly how teachers allocate their available classroom time and *why* teachers allocate time the way that they do. More research on

teacher priorities in their decision making with classroom activities can provide insight into why certain activities are being used to teach the curriculum rather than other activities.

The classroom activities that are used to teach the curriculum material have big impact on what students are learning. In a mathematics classroom, some common classroom activities include reviewing previous material, grading and discussing previously assigned homework, concept development (including teacher doing examples, teacher explaining new concepts with methods other than examples, student exploration, and class discussion driven by students sharing and explaining solutions or ideas), and students doing homework or practice problems. Some teachers have indicated that it can be difficult to do some activities (particularly student exploration, student explanation, and other student-centered activities) because they do not have enough instructional time available (Cooney, 1985; Foss, 2010; Raymond, 1997).

One example of teachers being unsure about doing a particular type of classroom activity because of time allocation issues is seen in Silver, et al. (2005). In this study, teachers were encouraged to have their students consider multiple solutions for mathematics problems as a concept development activity; however, the majority of the teacher participants indicated that time constraints made it difficult to do this. One of these teachers "wondered how she could implement this idea, given the existing teaching realities, particularly the need to 'fit everything in, and rush kids' to cover the content in the prescribed time" (Silver et al., 2005, p. 295). While teachers pointed to limited time as one of the reasons why it was difficult for them to try to do this activity where students looked at multiple solutions in their classroom, the researchers thought that it was possibly something else. Of this insufficient time claim, the researchers said:

> [The issues] may have served as proxies for other, less visible, issues.… We suspect that these concerns are associated, at least in some part, with teachers' concerns about the adequacy of their own content knowledge and also about their unfamiliarity with

> instructional routines that might allow them to become proficient in this aspect of innovative teaching practice. (Silver et al., 2005, pp. 295-296)

These authors believed that insufficient time was not really the reason why these teachers were claiming that this kind of teaching activity had limitations, but rather that there were underlying reasons. Silver, et al. (2005) mentioned that the possibility of other reasons was something that they suspected, but that their data was not adequate enough to make definite claims on the topic.

Similar to the experiences of the teachers that Silver, et al. (2005) worked with, I have been in situations where I have felt that a particular teaching method was valuable, but I did not see how I would be able to allocate the time necessary for the types of activities involved. My particular experiences have been with my attempts to implement the NCTM pedagogical suggestions (1991, 2000). The suggestions differed from what I was used to in that there was much more focus on student reasoning and participation. The NCTM Professional Standards (1991) and the Process Standards (2000) encouraged the use of mathematical tasks that engage students' intellect and have them problem solve and reason about mathematics. This problem solving was not something to simply be done on occasion, but rather the goal was to regularly "build new mathematical knowledge through problem solving" (National Council of Teachers of Mathematics, 2000, p. 182). The NCTM *Standards* (1991, 2000) also encouraged a focus on students "taking intellectual risks" (1991, p. 57) by making conjectures of their own, then exploring examples and creating justifications and proofs for their conjectures. Another main idea was to focus more on students communicating mathematically, including justifying their ideas for the class, as well as analyzing the justifications and mathematical thinking of others in the class. The following quote from Mathematics Teaching Today summarizes the general vision of the NCTM *Standards* (1991, 2000):

> The tasks in which students engage must encourage them to reason about mathematical problems. By expecting students to participate, listen respectfully to one another, present their ideas, and pose questions to the teacher and to peers, the teacher establishes an environment that nurtures the learning of mathematical processes and concepts and the development of skills. (Martin, 2007, p. 54)

In general, the teacher is more of a facilitator for this problem solving learning atmosphere rather than purely a lecturer as I had been used to previously.

When I originally heard about NCTM and their pedagogical suggestions, I was excited to start learning how to teach students in a way that utilizes their ideas and really attempts to reach the goal of student understanding as opposed to students simply being able to apply memorized procedures. I had, however, always thought that one of the major drawbacks of this method was how much classroom time is needed for implementation of the activities. It seemed that if students were going to try to figure out mathematical concepts largely on their own along with guidance from the teacher, that it was going to take much longer than a traditional lecture would. It also seemed that the student communication and justification would take quite a bit of class time. When I was doing my practicum for my Mathematics Education undergraduate program, it seemed that because of attempts to follow NCTM recommendations, the lessons were going much slower than they should and that the concepts were probably taught much more quickly in a traditional class. I felt that when I became a full time teacher, it was going to be important to "keep up" with other teachers in the school in terms of what section of the textbook was currently being taught, and I also felt it would be important to help the students fully understand all of the state-required items before end of level tests. It seemed that if a teacher was going to meet these two goals, that lessons would have to go much more quickly than what I had experienced.

Teaching in a non-traditional manner may involve doing some activities that require a significant amount of time. Simon (1995) described a situation where he spent eight days on an area of rectangles lesson that was anticipated to take only one or one and a half days. Also, Ball (1993) indicated that in one of her classes, she allocated a significant amount of time to one student's reasoning that six was both an even and an odd number because it can be split up into three groups of two, and three is an odd number, but it can also be split up into two groups, and two is even. In situations such as this, where students are allowed and encouraged to conjecture and time is given for them to think mathematically, often unexpected situations occur. With this type of instruction, students become interested in ideas that may not have been considered in instruction previously, and having students reason through the mathematics and these unexpected ideas can take longer than activities in a traditional classroom where students are given a formula and told to apply it. This possibility of additional time is problematic because if teachers feel that they do not have enough class time available to implement certain types of instruction, they may not do so, even if they see the alternate instruction as being beneficial.

In my teaching experiences, I have wanted to follow the suggestions of NCTM (2000) reform instruction by having students problem solve, communicate their reasoning and justification, and evaluate the explanations of others. I see the value in these activities, but I have bumped up against issues of feeling like I need to cover certain topics within a certain period of time. I felt the need to cover as much material from a textbook as I could within a 50 minute period, because I thought that doing so would help adequately prepare the students for their exams. Often the instructional time that I had available was rather limited and this perceived time constraint made me want to abandon the new teaching strategies that I had learned. However, following the ideas of Silver, et al. (2005), there may be other reasons

underlying my reluctance to implement instruction based off of the ideas of the NCTM *Standards* (2000) In reflecting on this possibility and wondering if time was just an excuse for me, and if there were really other underlying reasons for my struggle to implement this type of instruction, I realized that for me a lot of it was cultural. Feeling like I had to keep up with the pace of other teachers, or the pace of a textbook curriculum made me feel like I did not have enough time to explore topics in more depth. Exploring these underlying excuses that I had has helped me to evaluate what is really most important to me about the activities I choose to allocate time to in the classroom. Finding underlying reasons and priorities of other teachers is helpful because those other teachers will also be able to evaluate whether they are really focusing on the most important aspects of teaching activities.

As research (Cooney, 1985; Foss, 2010; Raymond, 1997; Silver et al., 2005) and my own experiences have indicated, teachers may be reluctant to do certain types of instructional activities in their classroom because they do not feel that they have enough time available to allocate to those activities; however, there may actually be other underlying issues for teacher time allocation (Silver et al., 2005). The way that time is allocated for different types of activities in the classroom indicates how and what students are learning. It is the purpose of this study to identify how mathematics teachers are allocating their time in the classroom, and what their priorities and influencing factors are for allocating their time in that way. Looking at these issues of time allocation can help better illustrate current mathematics classroom structure. Also, it leads to further insight into the suggestion of Silver, et al. (2005) as to whether teachers choose not to do certain types of classroom activities that they see as being valuable because they feel that there is not enough time, or if there are actually other reasons behind these decisions.

Theoretical Framework

This section provides an overview of the stance that was taken during this research study that guided the methodology and analysis. This section will outline some typical activities in a math class, some categories of possible variation in teacher time allocation, and some thoughts on teacher priorities in deciding which math activities to use in the classroom. The research questions on teacher time allocation and priorities are also outlined.

The Mathematics Classroom

This section outlines some activities that mathematics teachers typically spend their time doing. There is also a discussion on how these activities and the classroom in general can vary based off of whether the activities are more student-centered or teacher-centered.

Typical classroom activities. In order to study how teachers typically allocate their classroom time, a list of activities that are used in typical mathematics classrooms was created based off of research and experience. Stigler and Hiebert (1999) outlined the following common classroom activities: warm-up activity, checking homework, doing an example/demonstrating a procedure, practicing learned procedures, reviewing procedures and definitions, students finishing a worksheet, students analyzing or presenting problems, students explaining solutions. In a study on junior high math classes, Sanford and Evertson's (1983) listed the following typical activities: administrative/procedural routine, transitions, grading, whole-class instruction, seatwork, tests, dead time, small-group instruction, and non-academic activities. Leinhardt (1989) also outlined "homework check, presentation, and monitored practice" (1989, p. 54) as typical lesson activities.

The list of typical mathematics classroom activities that was used for this study (see Table 1) represents a synthesis of the activities discussed in Stigler and Hiebert (1999), Leinhardt

(1989), and Sanford and Evertson (1983). In some cases, categories were combined into one broader category. For example, Sanford and Evertson's (1983) administrative tasks, transitions, and dead time were all grouped into one category of non-mathematical activities. In other cases, categories were broken down in order to be more specific. For example, whole-class instruction or presentation was renamed concept development and broken down into four categories that capture teacher-centered activities as well as activities that are more student-centered.

Table 1

Typical Mathematics Classroom Activities

Problem of the Day
Daily Quiz
Reviewing previous material
Grading and discussing previously assigned homework
Concept development
- Teacher doing examples
- Teacher explaining new concepts (not including examples)
- Student exploration of a task *prior* to explanation of the concept
- Class discussion driven by students sharing solutions or ideas
Students practicing learned procedures/problems
Students working on homework in class
Non-mathematical activities

SC and TC activities. These various activities may look different and could require different amounts of time to be allocated to them depending on whether the activity is teacher-centered (TC) or student-centered (SC), and the distinction between TC and SC activities is an important aspect of different types of activities that were considered in this study. There are

a wide range of definitions that are used for TC and SC. Some researchers have used these terms to describe whether a class is structured (teacher-centered) or unstructured (student-centered) (Dowaliby & Schumer, 1973). Gibbs (1992) mentioned that a student-centered classroom "gives students greater autonomy and control over choice of subject matter, learning methods and pace of study" (p. 23) . Pedersen & Liu (2003) talked about student-centered classrooms in a slightly different way, using them to describe situations where students work on a central question (rather than teacher objectives) and are more self-governed than in a teacher-centered classroom in terms of making goals, motivation, assessment, and student to student interactions. These studies show some of the various examples of ways to define TC and SC, but for this study, these terms are used in a slightly different way.

It is important to define TC or SC activities for this study because there may be significant differences in time allocated to a TC activity versus a similar SC activity. Stigler & Hiebert (1999) analyzed who did most of the work in mathematics classrooms by looking at who was controlling solution methods in the class. Their ideas of looking at who is doing the work in the classroom were used to create two questions that were used to distinguish between SC and TC activities in this study. For this study, SC and TC have been defined by looking at the answers to the following two questions: Who is doing the cognitively demanding mathematical work? Who controls the solution method of the problems? In a TC activity, the teacher is the one doing most of the cognitively demanding mathematical work, and the teacher is the one who chooses the solution methods. For example, Stigler & Hiebert (1999) described what I would classify as a concept development/practicing learned procedures activity where a teacher would show students a formula for the sum of the interior angles of a polygon and maybe the reasons why the formula works, and then students would be asked to compute an answer using the

formula. In this case, the teacher has done the cognitively demanding mathematical work, and has given a specific solution method. Alternatively, if this same lesson were taught in a more SC manner, students may be asked to measure the interior angles of various polygons, and then look for patterns. In exploring the patterns from the measurements and looking at solution methods given by the students, a general formula for the interior angle sum of polygons could then emerge. This example shows a more SC activity because the students are the ones doing most of the cognitively demanding mathematical work, and the students are the ones who control the solution method.

An important thing to point out here is that whether a class is TC or SC isn't just about who is talking or working, but who has done the cognitively demanding work and is controlling the methods. For example, an activity where most of the time is spent on students working at their desks on assigned problems could be either SC or TC depending on the type of questions given and on previous discussions. If the teacher has already outlined how to solve the problems (as seen in the TC example above), then it is not a SC activity because the teacher has already done most of the cognitively demanding work for the students, and has outlined a solution method. It is important to look at teacher ideas on SC and TC activities for this study because the time allocated to a TC activity may be drastically different from the time allocated to the same activity taught in a more SC way. Not only can time allocation to SC vs. TC activities vary, but the way that teachers choose which activities to do and the order of their classroom activities may vary as well. The factors influencing teacher priorities for SC and TC activities that they choose to do in their classrooms may also vary. For these reasons it is important to look at TC vs. SC in relation to the various classroom activities.

Since many classroom activities can be considered either strictly TC or strictly SC (as opposed to either), the following paragraph categorizes the activities mentioned in Table 1 as either TC or SC. This categorization was helpful during the analysis of this study to determine how much class time teachers spent on TC and SC activities. A typical problem of the day is usually TC because it is simply a review of previously learned material. There are a few rare cases where it could be SC if students are exploring something new, possibly to help introduce that day's topic, but for this study that was considered a TC activity. Similarly, a daily quiz would also be a more TC activity. Grading and discussing previous homework is usually TC where the teacher simply asked students for answers and students replied briefly with the answer. On the other hand, if the teacher were to have students explain their solution methods to some of the problems, and maybe compare different solution methods, it would be a more SC activity. However, if grading and discussing homework were conducted in this more SC manner, then it would be grouped under the category of class discussion driven by students sharing solutions or ideas. So for this study, grading homework was considered a TC activity. For the concept development activities, the teacher doing examples for the class and the teacher explaining new concepts were both considered TC activities. Even if the teacher asked the students basic questions to help in solving the example problems, it is still typically TC, because the teacher is generally the one controlling the solution method and doing most of the cognitively demanding work. However, the concept development activities of students sharing solutions or ideas and students exploration prior to explanation of the concept are SC activities. Finally, practice/homework activities are generally TC because students are just working on problems similar to ones they have already seen the teacher do, and the work is not very cognitively demanding. These activities could be SC if students are working on problems in which a

particular solution method is not already known, however this is rare for practice/homework activities, so these activities were considered TC activities for this particular study.

It can be seen from the previous outline that the SC activities mainly occur during concept development, particularly when students are exploring a task *prior* to an explanation of the concept and during class discussion driven by students sharing solutions or ideas. According to Stigler & Hiebert (1999), "Many educators agree that learning opportunities are enhanced when students do most of the mathematics work during the lesson" (p. 67). However, it is unclear from current research how much classroom time *should* be spent on SC activities. Stigler & Hiebert (1999) found that in America, tasks were mainly student-controlled in 9% of the lessons analyzed; however, in Japan, this number rose to 40% of the lessons. It was also found that on average only 0.7% of seatwork time in the United States was spent on invent/think tasks during seatwork (as opposed to practice and apply tasks). For Japanese classrooms, this average rose to 44.1% of seatwork time for invent/think tasks. Again, it is unclear exactly how much time researchers say *should* be spent on SC activities, but for this study, a classroom was considered SC if at least 20% of total classroom time was spent on SC activities. For this study, it was thought that on average teachers currently spend most of their time on TC activities; however, because of recent reform efforts encouraging more SC activities, 20% of class time spent on SC activities seemed like a reasonable expectation for classes that would be considered SC. In general, for this study, classes were referred to as more SC or more TC simply by how much of their classroom time was spent on SC activities.

Demographic Categories That May Cause Variation in Time Allocation

Not only is it important to know what kinds of activities are typical in a mathematics classroom, but also it is important to look at what causes variation in time allocation. One main

component that may affect teacher allocation of classroom time, and may also affect the factors that influence teacher priorities in that allocation, is what category of demographics they fall under. Research suggests that two categories that have shown variation in classroom time allocation are block schedule vs. daily schedule, and categories based off of years of experience (e.g. Buckman, King, and Ryan (1995), Evans, Tokarczyk, Rice, and McCray (2002), Rash and Miller (2000), Stronge (2007)). Even though it was not it the research, it was also thought that a category of what level teachers taught at, junior high or high school, may also be correlated with variation in time allocation. These particular categories were considered when analyzing the data for this study.

Block or daily schedule. Teachers may allocate their time in the classroom differently based off of the type of schedule that they have (block or daily). The National Education Commission on Time and Learning (1994) suggested that education could be improved by using time in new and better ways so that there was more flexibility and students and teachers did not become prisoners to time. Their suggestions sparked a movement to restructure scheduling in schools, and schools began to move to a block schedule instead of the traditional daily class schedule in hopes of improving education and providing more flexibility, including more flexibility in the use of new instructional strategies (Canady & Rettig, 1995) Since then, many schools have moved to block scheduling, and a large amount of research has been done on the effects of these changes. A block schedule is typically 80-100 minutes every other day, and a traditional daily class schedule is typically 45-55 minutes every day (Reller, 2010). For this study, a block schedule was defined to be 70 to 90 minute class periods that meet every other day, and a daily schedule was 45 to 50 minute class periods that meet every day. An "other" group was also made to include those who are on a modified block schedule or have other types

of schedules. These class lengths were chosen because of the way that classes are typically structured in the particular school districts of the study.

Years of experience. In some studies (Covino & Iwanicki, 1996; Druva & Anderson, 1983; Rash & Miller, 2000; Stronge, 2007), differences in the number of years that a math teacher has been teaching have also shown differences in what the teachers choose to do with their time. Many studies did not provide specific levels of experience based on the number of years teaching; however, one study (Stronge, 2007) mentioned that teachers who had been teaching for more than three years were more effective than those with less experience, and that the "differences seem to level off after five to eight years" (p. 12). For this study, four different groups for years of experience teaching mathematics were created. These groups are 0-3 years, 4-10 years, 11-20 years, and 21 or more years. The divisions between 3 and 4 years and 10 and 11 years of experience are similar to divisions mentioned by Stronge (2007), and were thought to be places that could show differences in teacher time allocation. Another division between 20 and 21 years was also created to see if any differences would exist there. Looking at whether a teacher was a novice or expert was initially considered instead of years of experience, but the distinction between novice and expert is something that would be too difficult to determine from the survey methodology that was used for this study.

Class level (junior high or high school). Another factor that may cause variation in time allocation is whether a teacher teaches at a high school or a junior high. This possible variation is not something that was found in previous research, but seems to be related to the block or daily schedules discussed above. The reason for this possible relation is because the participants in this study come from areas where most of the high school teachers teach on a block schedule, and the junior high teachers are fairly split between using a block schedule and a daily schedule.

Throughout this study, the term junior high will be used to refer to the collection of *both* junior highs and middle schools.

Teacher Priorities

Another main idea that was considered in this study is that of teacher priorities. One definition given by the Oxford Dictionary for priority is "a thing that is regarded as more important than another" (n.d.). In particular, this study will be looking at what teachers think is important in their decisions to do SC or TC activities. Priorities are closely linked to teacher beliefs, but for this study, data was mainly gathered through a survey, so it was unreasonable to infer the beliefs of the teachers based on the available data. It is very difficult to effectively determine teacher beliefs from a survey; however, priorities are something that can be examined more easily through a survey and were focused on in this study. For example, there is a question asked about what activities a teacher would choose to do if they had twice the amount of time to teach each class. This question gives an example of something that can be examined through the lens of teacher priorities, but it is harder to determine teacher beliefs that support those priorities using only a survey.

While some teachers say that they do not have enough time to do certain activities in their math classes, and SC activities in particular, there are other teachers who *are* able to find the time to do these activities. The difference in views here may be a matter of priories. These priorities can be seen in two different ways. First, it can be seen in teacher priorities to individual activities in the classroom, for example whether teacher lecture takes priority or students working on homework takes priority. If a teacher were to report that there is not enough class time to do a SC activity, it may be that they are really saying there is not enough time to do the SC activity *in addition to* the traditional activities they would normally do. In order to spend

more time on SC activities in a classroom, some other activities need to be replaced. Every teacher has the same amount of classroom time available. When teachers say that they do not have enough time to do a certain activity, it is really an issue of priorities, not time. For example, if someone were to say, "I didn't have time to go buy groceries today," it is not that there was not enough time in the day to go to the store and buy groceries, but rather there were other activities that took priority, whether they included work, school, going to a child's soccer game, or other activities. A similar thing can be said about not having enough class time to do SC activities. If a teacher said they didn't have enough time for a SC activity, what they really are saying is that there were other activities that they chose to do that took priority that they were not willing to replace.

Second, teacher priorities can be seen in which factors have the most influence on teacher decisions about the activities they choose to do. There are many factors that influence teacher decisions on which activities to do, including preparation for end of level tests, personal comfort and preparation time, classroom rowdiness, and the mathematical experience of the students. For each activity teachers decide to do, they weigh these and similar factors against each other. They also weigh these factors against how much time the activity will take in the classroom. Which factors teachers give the highest priority to will have an influence on how much time they spend on that activity in class. For example, if a teacher views a learning through exploration activity as providing a great mathematical experience for the students, but thinks that it provides extensive preparation time, then how teachers prioritize those two factors will affect if they do them or not. If the teacher gives more priority to the mathematical experience than required preparation time, they will likely be willing to spend extra time on that activity. If, however, the teacher gives more priority to required preparation time than to the students' mathematical experience, then

they likely will not be willing to spend a lot of time on activities like that. If a teacher says that they do not have enough time to do a particular activity, it is that the particular activity did not provide enough benefit for them in terms of the factors that they give priority to, and they would rather spend their classroom time in other ways.

Research Questions

Since the types of activities that students are doing in the classroom have a big effect on what and how they are learning, it is important to look at time allocation. Also, it would be insightful to know whether there are teachers who would like to allocate their time to more SC activities, but feel that there is not enough classroom time available to them. It would also be helpful to determine what other factors affect teacher decisions to not do SC activities and which of these factors teachers give priority to. Information on why teachers are choosing to allocate classroom time the way that they do can be gained by looking at teachers priorities in their decisions to allocate their class time the way that they do, and their priorities in regards to the factors that influence those decisions.

In order to provide some insight into the ideas mentioned in the previous paragraph, this study focused on the following research questions: 1) How do secondary mathematics teachers allocate their time in the classroom? 2) How much time do teachers generally spend on TC activities and SC activities? 3) What priorities do teachers give to the different factors that influence their choices about the types of activities that they do?

Literature Review

In this section, the existing research on teacher time allocation is discussed as well as the lack of research on teacher priorities behind those choices. First, basic research on how time is allocated in some typical mathematics classrooms in the U.S. will be discussed. In the second section, there is a discussion on how much time teachers currently spend on SC and TC activities during the concept development portions of their lessons. Next, it is important to look at not only how time is typically allocated, but also time allocation that does not follow the norm. For this reason, the third section describes some variation in teacher time allocation based off of the categories of teacher demographics outlined in the theoretical framework (block/daily, junior high/high school, years of experience, and SC/TC). Finally, the fourth section examines current research on *why* teachers allocate classroom time the way that they do and the priories that may influence teacher choices on whether to do SC or TC activities.

Typical Time Allocation

In looking at basic research on how teachers allocate their time in the classroom, Sanford and Evertson (1983) provided the following table (Table 2) in their results on teacher time use in junior high classes. From the table it can be seen that teachers allocated the majority of class time to student seatwork and to whole-class instruction. Student seatwork included any time that students were working on individual tasks. Whole-class instruction included teacher-led activities such as lecture, explanation, or review. This study gave an overview of time allocation in junior high classes, but there is no explanation of why the teachers decided to allocate their time in this way or their priorities in choosing activities.

Table 2

Time Use in Mathematics Classes (reproduced from Sanford & Evertson, 1983, p. 142)

Activity or Time-Use Category	Mean Raw Minutes per Class Meeting	*SD*	Range in Teacher Means
Administrative/procedural routine	3.76	2.24	.38– 9.16
Transitions	4.83	2.44	1.06–10.54
Grading	4.12	2.50	.25–10.06
Whole-class instruction	15.33	6.94	6.34–33.37
Seatwork	19.81	7.37	8.13–35.25
Tests	2.90	3.39	0.00–10.53
Dead time	1.71	1.65	0.00– 6.31
Small-group instruction	1.18	5.46	0.00–28.47
All nonacademic activities	14.42	3.88	6.50–21.85
Total minutes	54.29	2.00	50.59–59.06
Total academic time	39.23	4.00	31.66–46.73

More recently, in an in-depth analysis of the TIMMS study, Stigler and Hiebert (1999) gave an outline of what an average U.S. 8th grade mathematics class looked like according to their data. Table 3 summarizes the time allocation to various activities in a 48 minute lesson, and this time allocation was representative of the majority of the other classes.

Table 3

Time Use in Mathematics Classes (Stigler and Hiebert, 1999)

Activity	Time Spent (in minutes)
Warm-up review activity as a class	5
Checking homework	6
Doing an example/demonstrating a procedure	≈11
Students practicing learned procedures (for review), including the teacher doing two examples for them	11
Reviewing procedures and definitions	5
Finishing the rest of the worksheets they were working on	5

It is hard to compare the time allocation results of Sanford and Evertson (1983) and Stigler and Hiebert (1999) directly because they split up their lists of activities in different ways; however, it seems that most of the activities of Stigler and Hiebert (1999) would probably fit into Sanford and Evertson's (1983) whole-class instruction and seatwork. Sanford and Evertson (1983) reported about 36% of class time on seatwork and 28% on whole-class instruction, whereas Stigler and Hiebert's (1999) description seemed to explain 54% of class time on seatwork and 45% on whole-class instruction. Some of these differences could be because of the different years or populations of the studies, because of the different definitions of the activities, or because Stigler and Hiebert's (1999) outline was not an average of time allocation in a variety of classrooms, but rather an explanation of a representative classroom.

Stigler and Hiebert (1999) indicated that the lesson structure outlined in the previous paragraph was typical for many of the lessons the authors looked at; however, they did point out that there were some variations where the teacher had more review time, or more student participation time (including students analyzing or presenting problems, and explaining solutions). Stigler and Hiebert (1999) pointed out that the variations that included more student participation time "might show the effects of current reform efforts" (p. 53) , referring to the NCTM *Standards* (1991, 2000).

Time Spent on SC and TC Activities

In order to look at how much time is spent on SC and TC activities during typical lessons, the two research studies from the previous section were analyzed further to look at which activities were SC and TC. Sanford and Evertson's (1983) research showed the following TC activities that accounted for a total of 41.17% of the total class: grading, whole-class instruction, tests. A total of 38.66% of class time was spent on seatwork and small-group instruction. It was

unclear from the study whether seatwork and small-group instruction would be TC, SC, or a mixture of both here. It is likely that much of it is TC and would contribute to the percentage of class time spent on TC activities. These seatwork and small-group instruction were the only two activities that could possibly be considered SC in that lesson.

Examining the research of Stigler and Hiebert (1999), all of the activities that they listed would be considered TC activities. So in this typical class outline, 0% of the class time was spent on SC activities, and 100% of the class time was TC. It is possible that the warm-up activity that they had in their typical class outline could be considered a SC activity in some cases, but for this study, warm-up activities were considered to be TC activities. As mentioned in the previous section, Stigler and Hiebert (1999) said that there were some variations that included a few classes that allotted time for students to analyze or present problems and to explain solutions, which would add in some SC activities. However, specific numbers were not included in that mention of variation, so it is unclear exactly how much time was usually given to the SC activities in those alternate class structures. Stigler and Hiebert (1999) did provide some other data on student-led activities however. As mentioned previously, they found that "tasks were predominantly student-controlled in 9% of the American lessons" (p.67). They also found that during student seatwork time, 0.7% of it was spent on invent/think tasks. A invent/think task would be considered a SC task, but does not account for very much of the total class time.

In another analysis of the TIMSS study data (Schwerdt & Wuppermann, 2011, p. 65), a chart (See Figure 1) was given showing the percentage of time spent on various activities. It provided only one activity that could be considered SC, and this activity was working on problems without guidance. From the explanation in the study, it is clear that students working on problems without guidance could include TC activities where students are solving problems

that they have already been taught solution methods for, but that the teacher is not currently guiding them through the solution. Students working on problems without guidance may also include the SC activity of student exploration of a task *prior* to an explanation. The activity of students working on problems without guidance accounted for 18% of total class time. There was also 3% spent on other activities (that may or may not be SC). From this study, it can be seen that on average at least 79% of the total class time was spent on TC activities, and likely more.

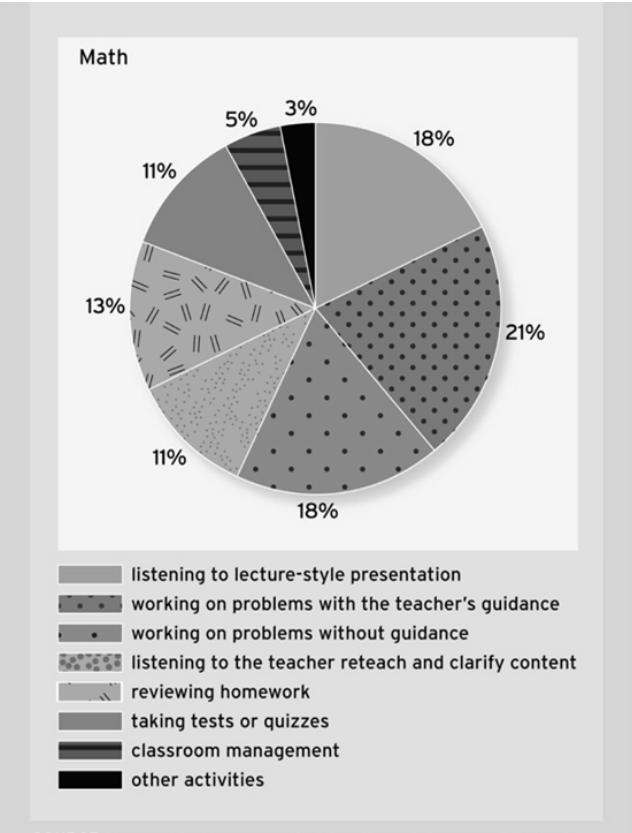

Figure 1. A pie graph showing how math teachers used class time in a TIMSS study analysis.

These studies (Sanford & Evertson, 1983; Schwerdt & Wuppermann, 2011; Stigler & Hiebert, 1999) provide insight into how much time may be spent on SC activities in the classroom, but for it is generally unclear which activities would be considered SC and which

would be considered TC. This ambiguity makes it hard to determine how much time teachers typically allocate to these activities.

Variations in Time Allocation Based on Teacher Demographic Categories

As mentioned previously, Stigler and Hiebert (1999) pointed out that there are variations in time allocation that may be due to reform efforts. In looking at how teachers typically allocate their classroom time, finding different variations in this time allocation is also important. Research has shown variations in terms of whether the class is on a daily or a block schedule, the years of experience of the teacher, and whether the class is generally more SC or TC.

Block or daily schedule and class level. Many researchers have found that there are differences in the types of activities that teachers allocate their time towards for teachers that have a block schedule as opposed to a traditional daily class schedule. When using a block schedule, teachers generally had more variation in the techniques and types of activities that they used in their classrooms (Buckman et al., 1995; Deuel, 1999; Evans et al., 2002; Gullatt, 2006; Veal & Flinders, 2001; Wilson & Stokes, 2000). It has been suggested that this variation could be due to simply the additional length of classroom time, and also the need to change activities to keep student interest and focus at high levels during the longer class periods (Reller, 2010).

In looking at some of the actual differences in the types of activities that teachers allocated their time to, Evans, et al. (2002) found that teachers on a block schedule spend more time on group assignments, independent projects and presentations, and working with individual students. Also, teachers did not spend the majority of their class time on teacher-centered lecture activities. Other researchers have also reported on the increased use of projects and hands-on activities for block schedule teachers (Hurley, 1997; Rofes, 2001). In looking at some differences the schedule made in a group of Virginia high schools, Rettig and Canady (2003) found that

teachers with a block schedule engaged students more in active learning strategies. Similar to these results that indicate more time spent on SC activities, Buckman, et al. (1995) said that a block schedule might encourage more problem-based learning activities and projects, as well as more student collaboration. They also argued that it would increase the likelihood of reform teaching practices. Similarly, Canady and Rettig (1995) talked about how daily schedules could hinder the use of reform instructional strategies:

> Single short periods offered by most scheduling models limit flexibility in terms of the kinds of instructional strategies that can be accomplished. When teachers are faced with only 45 minutes, they often feel pressed to at least expose children to curriculum. The most efficient way to provide "exposure" to content is the lecture. Unfortunately, the lecture is probably not the most effective means for students to learn material. (Canady & Rettig, 1995, p. 8)

This study found that in their experience, teachers said that cooperative learning was good, but that they did not have time for it. The authors also reported that "When teachers instruct in longer blocks, most are unable to lecture effectively for long periods of time and they may see the benefit of other instructional strategies" (Canady & Rettig, 1995, p. 9). Most of these studies indicate that teachers on a block schedule could show more variation in the types of teaching strategies they use, and in particular they may spend more time on SC activities.

The problem with many of these studies is that the majority of the results come from teacher or student reported perceived benefits, which may be biased or incomplete. In fact, there are other researchers who have found that there were few or no significant differences between teachers on a daily schedule and teacher on a block schedule in how they allocated time to different kinds of activities (Flynn, Lawrenz, & Schultz, 2005; Reller, 2010). Also, these results don't give a very complete picture on exactly how much more time is spent on the SC learning activities and other activities mentioned, nor do they fully explain where *less* time is spent in order to make up for the added time on other activities.

It is clear from the results of these studies that one thing that may affect teacher time allocation is whether they are teaching on a daily class schedule or a block schedule. This possibility is something that was considered during the data collection and analysis for this study. Also, as explained in the theoretical framework, a factor that may be related to a block or daily schedule is whether the teacher is at a junior high or a high school. Differences in time allocation for junior high and high school teachers were not found directly in the literature, but junior high or high school was thought to be a place that differences in time allocation could be seen and thus results from this study could contribute to the current literature on teacher time allocation.

Years of experience. One other area of research that may show differences in teacher time allocation is the years of experience of the teachers. In a study of achievement in California schools, a positive correlation was found between the average number of years of teaching experience of the teachers at schools and the test scores of the students in standardized testing (Fetler, 1999). This study, along with others found that more years of teaching experience was correlated with higher achievement in math (Darling-Hammond, Berry, & Thoreson, 2001; Stronge, 2007). One possible reason for this correlation could be because of different teaching practices for teachers of different experience levels.

In a study of science teacher characteristics, Druva and Anderson (1983) found that science teachers with more experience asked higher-level questions that were more cognitively demanding in their classes. This study is referring to science teachers, but a similar result may also be true in mathematics where teachers use activities that are more cognitively demanding for students, and hence more SC.

The research of Covino & Iwanicki (1996) found that more experienced teachers "are better able to apply a range of teaching strategies, and they demonstrate more depth in differentiation in learning activities" (Stronge, 2007, p. 12). Similarly, Rash & Miller (2000) found that within a group of teachers of gifted students, those with more teaching experience used a greater variety of teaching methods. These research studies (Covino & Iwanicki, 1996; Rash & Miller, 2000; Stronge, 2007) did not talk specifically about differences in time allocated to various teaching methods or activities between teachers with different amounts of experience, but rather just mentioned that differences in instructional strategies exist. It was expected that the results of this research study could contribute to this body of research in providing more detail on the areas of difference.

Whether a teacher is considered to be a novice or an expert teacher has been correlated with differences in time allocation. The differences between time allocation of expert and novice teachers was not a focus of this study because it would be too difficult to determine which teachers were experts and novices with the survey methodology planned for this study. While the number of years of experience of a teacher is not directly related to whether they are a novice or expert, the research on novice and expert may still provide some background and insight into this study. Leinhardt (1983) studied a group of student teachers, which she classified as being novice teachers, and a group of teachers whose students had high growth scores, which she classified as being expert teachers. She found that expert mathematics teachers tended to use teacher presentations (lecture), sometimes student discussions, doing examples, students doing example problems at their board or in their seats with teacher guidance, and sometimes independent seatwork. Novice teachers, however, seemed to allocate their classroom time a little bit differently. The novice teachers tended to either spend more time on teacher presentation

activities or decide to do presentation that included ideas from both the teacher and the students. Also, the novice teachers rarely had students do example/practice problems at the board or in their seats before students began on their homework/seatwork.

In a later article, Leinhardt (1989) also mentioned that the novice mathematics teachers spent more time transitioning between different lesson activities than expert mathematics teachers (six minutes as opposed to two minutes), and that their lesson structures and time allocation were not as consistent from lesson to lesson as were those of the expert teachers.

These results show some basic differences in classroom time allocation that research has identified based on the teachers' years of experience, as well as expert or novice teachers. For this study, other possible differences in time allocation based off of years of experience were sought as the results were analyzed.

SC or TC Class. Whether a teacher has a more SC class or a more TC class can also cause variations in teacher time allocation in the classroom. In response to NCTM (1989, 1991) documents that "recommend a shift from a teacher-centered approach with emphasis on skill development to a student-centered constructivist approach with emphasis on problem solving" (Keiser & Lambdin, 1996, p. 23), the Connected Mathematics Project (CMP) worked to construct a curriculum that aimed to follow these recommendations. In an evaluation of the CMP curriculum, Kieser & Lambdin (1996) found significant differences between how teachers allocated their classroom time using this reform curriculum as opposed to the traditional mathematics class time allocation. They mentioned that, "for some, this [transition to CMP curriculum] caused a total upheaval in the way they allocated time in their classroom" (Keiser & Lambdin, 1996, p. 26).

As Kieser & Lambdin (1996) reported, the CMP curriculum focuses more on activities where students are actively involved in the mathematical ideas, applications, and reflections than does a traditional classroom curriculum. This change in focus shows a difference in time allocation between reform and traditional classrooms, and shows differences between classes that are more SC or TC. In talking about the actual time spent on individual classroom activities, these teachers spent less time "lecturing, reviewing previously taught ideas, and doing computational practice" (Keiser & Lambdin, 1996, p. 26). In connecting these activities to the list of classroom activities that were outlined earlier, they fit most closely in the categories of concept development (particularly teacher explaining new concepts, which may or may not include doing examples), reviewing previous material, and students practicing learned procedures. While less time was spent on these activities, the teachers reported that more time was spent on classroom activities such as reviewing assignment/homework, students discussing applications of concepts, working in small groups, reading student materials, using manipulatives, using calculators, and students talking about mathematical ideas (Keiser & Lambdin, 1996, p. 27). The reviewing assignment/homework activity falls into my category of "grading and discussing previously assigned homework". It is difficult to tell based on the descriptions given, but it seems that students discussing applications of concepts and students talking about mathematical ideas would be "class discussion driven by students sharing solutions or ideas" activities as a subset of concept development. It could also be part of "student exploration." Using manipulatives and calculators, working in small groups, and reading student materials, could also be seen as part of concept development, with group work possibly being a "student exploration" activity.

These results of Keiser and Lambdin (1996) provide one example that shows how reform teachers who are trying to have a more SC classroom may allocate their classroom time differently than teachers with a more TC classroom. Leinhardt (1989) also mentioned that in traditional lessons, teachers may move from TC presentations of material, to student practice activities; however in inquiry-based/reform lessons, this order may be switched. The switch in activities indicates again that teacher time allocation may be affected by whether the teacher is a more traditional teacher with a more TC class or a reform teacher with a more SC class. Other places of differences in teacher time allocation based off of whether teachers had a more SC or TC class were also examined in this study in order to provide a better description of what exactly changes and how much more time is spent on some activities rather than others.

Teacher Priorities in Choosing SC and TC Activities

The research studies mentioned in the previous sections gave some indication as to how different types of teachers allocate their classroom time; however, most of these studies did not indicate teachers' priorities to the different factors that affect how they chose to allocate their time. While it is important to get a general sense of how teacher allocate their classroom time, a more important topic is *why* teachers allocate classroom time the way that they do. In other words, what priorities do teachers have in deciding how to allocate classroom time, and particularly on whether they choose to allocate it to more SC activities or more TC activities.

There is not a lot of research on teacher priorities to different factors that influence how they choose to allocate classroom time to various activities, but some teachers have claimed that they choose *not* to do certain types of SC activities because of a lack of classroom time. In a study of middle level mathematics teachers and their reflections on implementation of the CMP curriculum and reform teaching, the teachers were concerned about "the time constraints in their

daily schedules that might preclude their implementation of new instructional strategies" (Foss, 2010, p. 10). It is unclear here exactly why teachers thought that time constraints would prevent them from using new strategies, or what exact strategies or possibly activities these teachers were referring to. However, it seems that this study indicates that how much classroom time an activity takes affects whether teachers decide to use that classroom activity.

Other researchers have also noted this problem of the extra time required to teach from a problem solving perspective that includes more SC activities. Cooney (1985) reported the following on one teacher named Fred who attempted to encourage his students to really think about the mathematics in his classroom:

> When he reacted to the report on his beliefs, he expressed frustration over the extensive time demands a problem-solving orientation required of him. He complained about having "little time to consider genuine problems that will in some ways excite students and get them involved." He confessed that "it is much easier to teach by the book, so to speak, and leave heuristics out completely." (Cooney, 1985, p. 330).

Fred was very determined to give students activities that motivated them and allowed them to problem-solve in mathematics; however, when he actually tried to implement these SC activities in the classroom, the issue of time caused him a lot of frustration and made him consider allocating his classroom time in different ways. He also seemed to express that he gave priority to activities that were "easier" rather than having problems that have more student involvement.

Raymond (1997) reported that one teacher suggested that teachers may revert back to a traditional (more TC) mode of teaching is because of perceived constraints that have been put on them, and time constraints in particular. Five out of the six teachers that Raymond (1997), who all had primarily non-traditional beliefs about teaching and learning mathematics, identified time constraints as one of the main reasons for what they considered to be inconsistencies between teacher beliefs and practices. It can be seen that even though teachers may believe that more SC

instruction is helpful, their perceptions and beliefs about how much time it may take can contribute to their decisions to revert back to traditional TC mathematics teaching styles. To help better understand this issue, a business analogy may be helpful. A business owner will choose to spend money on what they believe will be most beneficial for their company. If something is expensive, and will not benefit the company at all, then of course money will not be spent there. However, if something is expensive and also very beneficial to the company, then in this situation, the costs may be worth it because the potential gains take priority. Time in the classroom can be related to money in the business context. Teachers have a certain amount of time available to them, and the activities that they view as being most beneficial in some way will be what they will spend their time on. It seems that teachers may want to do SC activities, but do not give high enough priority to them to enable them to abandon some of the more traditional TC activities that they give higher priority to. How much class time an activity takes weighs against the priorities that teachers have and can cause them to choose to allocate their classroom time to different kinds of activities.

The conclusion can be made that some teachers choose not to do certain types of activities in their classroom because they feel that there is not enough time, particularly in their attempts to implement more SC reform instruction (Cooney, 1985; Foss, 2010; Raymond, 1997). In a study on the use of instruction time in middle school mathematics, Elizalde (2011) concluded that increasing total instructional time (from 60 minutes daily to 90 minutes daily) could be beneficial to students and provide them with "additional exposure of mathematical concepts and contextual experiences with greater depth" (Elizalde, 2011, p. 103). This result, along with teacher comments as mentioned previously, seem to indicate that if teachers had more time, then they would allocate their time differently and possibly use different types of classroom

activities. However, some studies (Betts & Shkolnik, 1999; Silver et al., 2005) have indicated that lack of instructional time is not the real reason why teachers choose not to do SC activities or other types of instruction. Betts & Shkolnik (1999) found that "when total class time per week was increased: Teachers reacted not by adding on more material, but by expanding review time instead" (p. 209). These teachers did not allocate time to new types of activities in their class (including more SC activities), but rather just allocated more time to review activities. Also, as mentioned previously, Silver, et al. (2005) believed that when teachers mentioned concerns and limitations due to time constraints, in reality there were other issues preventing them from fully implementing a specific classroom activity. Particularly, "concerns about the adequacy of their own content knowledge and about their unfamiliarity with instructional routines that might allow them to become proficient in this aspect of innovative teaching practice" (Silver et al., 2005, p. 296) were mentioned as possible underlying issues. These possibilities mentioned by Silver, et al. (2005) give rise to some factors that may influence teacher time allocation choices if they give priority to them. In particular, these factors are comfort level with the mathematical content that may arise during the activities, and comfort level with the teaching strategy in general.

As seen in the previous paragraphs, personal comfort levels with content and pedagogy are some possible factors that influence how teachers choose to allocate classroom time, and whether they choose to do SC activities or TC activities. The level of priority that teachers give to these and other factors affects how much classroom time the teacher is willing to devote to particular activities. Other influencing factors can be found in Leinhardt's (1983) study on expert and novice teachers where it was found that some teachers (experts) may choose to allocate their time to a variety of activities in their classroom each day in order to hopefully keep students

more interested and engaged in the activities. This result shows that some teachers give priority to the influencing factor of wanting activities that keep students motivated.

Other factors that may influence how much time teachers allocate to various activities are related to the cultural aspect of teaching. Hiebert (2008) found that one of the main reasons it is hard to implement reform techniques is because teaching is cultural in that it is based off of how they have seen others teach, and there are various constraints that are put on teaching by the culture. Hiebert mentioned that a few of the constraints that are a part of cultural teaching are that students are expected to know how to do certain tasks or problems and to perform well on standardized tests, and that affects teaching strategies. Another example of the cultural aspect of teaching is seen in the experiences of Henry (2007), a high school geometry teacher who struggled as he attempted to implement reform instruction in his classroom. He said, "It was obvious… that I was not comfortable in my new roles and that I struggled to feel like I was teaching effectively… it was still harder than I anticipated. These new roles take lots of practice. They are very different from the traditional roles and require time to develop" (Henry, 2007, pp. 58-59). Henry expressed his frustration in trying to teach from a new role and trying to help the students understand their new roles in the classroom. He also mentioned that it was particularly difficult for him to implement reform instruction because he felt like students were taking over the stage in a sense. More student involvement changed the environment and attitudes of everyone in the class, and he was not used to students having this much of an effect on the energy levels in the classroom. The culture of a traditional classroom was familiar to this teacher and to all of his students, so it was difficult for them to transition from this familiarity to the unfamiliar reform classroom.

The results from these two research studies bring up some factors that teachers may give priority to in their decisions on what classroom activities to devote time to. These influencing factors are how similar their teaching is to that of other teachers, preparation for standardized tests, and feelings of comfort or discomfort with changing norms in the classroom. The way that teachers prioritize these factors and the previously mentioned influencing factors affects how much time teachers are willing to allocate to particular activities. Other than the research studies mentioned in this section, there is not a lot of research on factors that influence teacher time allocation and the priorities that teachers give to those influencing factors.

In order to expand research on teacher time allocation and priorities, this study focused on the following research questions: 1) How do secondary mathematics teachers allocate their time in the classroom? 2) How much time do teachers generally spend on TC activities and SC activities? 3) What priorities do teachers give to the different factors that influence their choices about the types of activities that they do?

Methodology

This section describes the participants in this study as well as data collection and analysis methods. This information is given in order to help the reader better understand the selection methods and how they help to answer the research questions about teacher time allocation and the priorities related to that time allocation. First, a description of how participants were selected for this study will be provided. Second, the types of data that were collected and how they were collected will be described. Third, how the resulting data was managed and analyzed will be explained. A survey methodology was used for this study, and some preliminary interviews were conducted in order to improve that survey before it was piloted and then distributed to the participants. The fourth section provides a brief description of some of the results from this preliminary study.

Participants

For this study, 6 local mathematics teachers were chosen based off of certain demographic characteristics. These participants were initially identified through the recommendations of some of the BYU Mathematics Education Department faculty on secondary mathematics teachers that would be willing to be observed and interviewed, and that could provide some good insight into their time allocation. The faculty members were asked to provide information on what they knew about each teacher's class level (jr high or high school) and schedule (block or daily), experience, and whether the teacher was more reform or traditional in their approach to teaching. From this list of approximately 20 teachers, six teachers were selected for a class observation and interview. These six teachers were selected in a way that provided variation in four categories listed above. To really account for every possible variation in teachers based off of these four categories, 16 teachers would had to have been observed and

interviewed. 16 teachers was determined to be an unnecessarily large number for this preliminary study, and 6 teachers provided enough variation in the four categories for this initial data to be able to get some ideas about each group. Demographics of the 6 teachers are listed in Table 4.

Table 4

Demographics of Observed and Interviewed Teachers

Teacher	Class Level	Schedule	Experience	Reform/Traditional
Teacher 1	High School	Block	Novice	Mostly Reform
Teacher 2	Junior High	Block	Experienced	Reform
Teacher 3	Junior High	Block	Experienced	Traditional
Teacher 4	Junior High	Daily	Novice	Reform
Teacher 5	High School	Block	Experienced	Traditional
Teacher 6	Junior High	Daily	Experienced	Traditional

The second set of participants were 11 local mathematics education graduate students who were sent a pilot survey in order receive feedback and to improve the survey. The third and final set of participants was 581 secondary mathematics teachers from 5 different school districts in Utah that were asked to complete a survey. These teachers were sent an e-mail about the study and were requested to participate. One week later, another e-mail was sent that included a website link to the updated survey, and a statement informing the teachers that their response to the survey indicated their consent and willingness to participate in the study. A total of 224 surveys were fully completed, and those 224 responding teachers were the main participants of the study.

Data Collection Methods

The six mathematics teachers that were chosen for the preliminary study were observed and then interviewed, and this data was used to improve the survey used later. The teachers were observed for one class period each, and field notes were taken during each observation, particularly on what types of activities the teacher did and for how long. This data was used to gain insight into different ways that teachers may choose to allocate their time. Notes were also taken on whether activities were more TC or SC as defined previously. These notes were taken in order to get a clearer picture of exactly what the activities looked like. As explained in the theoretical framework, while some may see a TC and a SC group discussion (or other type of activity) as being fundamentally the same thing, these activities can actually be quite different and require different amounts of time allocated to them.

After these initial observations, each teacher was interviewed in order to gain insight into their time allocation during the observation and different factors that affect their priorities in time allocation in the classroom in general (see Appendix A for a list of interview questions). The list of interview questions was slightly adapted and added to throughout each of the interviews in order to clarify and build off of teacher responses. Each of these interviews was about 30 to 60 minutes long and short notes were taken during some of the interviews. The interviews were voice recorded and transcribed in order to be analyzed and coded. The interviews were done so that some ideas could be gathered about what some teachers were saying about their priorities and factors influencing why they allocate time the way that they do. These results were then used to help adapt and improve the survey that was then sent to the other participants in the study. When the survey was created, some of the questions and the multiple choice answers reflected the ideas of the mathematics teachers interviewed in the preliminary study. Clearly the six

teachers that were observed and interviewed could not entirely encompass all of the views of every secondary mathematics teacher, but they gave insight into teacher perceptions on teacher time allocation and this insight was used to improve the final survey.

Based off of the literature, observations, and interviews, survey questions were created and adapted. An in-depth explanation of the analysis of the preliminary study and the resulting adaptation of the survey is described later in the methodology. The survey was then e-mailed to 11 graduate students as a pilot study. This pilot study was done so that the survey could be refined further and then be e-mailed to the 581 teachers described previously. The survey (see Appendix B) was created and distributed using Qualtrics Online Survey Software. It is 17 questions long, with many of the questions including multiple parts. It includes both multiple choice and short answer questions. The survey was designed to be taken online, which allowed the survey questions to vary slightly based on the participant's previous responses.

The survey questions were designed to evaluate both how teachers allocate their classroom time and why they choose to allocate it the way that they do. First, to determine how teachers allocate their classroom time, teachers were asked to indicate how long their typical math class period is, and then how many minutes they typically spend on the typical activities listed in Table 1. That list of activities was chosen to specifically to provide some activities that were more SC and some that were more TC. The outline of which activities were TC and which were SC was given in the theoretical framework in the SC and TC activities section. The concept development portion of the lesson is one of the main places where differences in SC and TC can be seen, so many different methods of concept development were used for that survey question. Categorizing the activities as SC and TC helps to answer the second research question on how much class time teachers typically spend on SC activities as opposed to TC activities. Another

goal of the survey was to find some way to find a group of SC teachers and a group of TC teachers and compare their results on the other survey questions. This question made it possible to see which teachers spent the most and least amount of time on SC activities so that the responses of those groups could be compared to the other survey results.

A different question was also in the survey to fulfill this purpose of finding out which teachers were more SC and which were more TC. This question asked teachers to indicate if they did a lot of PSEAs and if they found them challenging to do or not. As described in the results section, this question ended up being problematic in its wording, so it was not able to be interpreted in a way that could find SC and TC teachers as intended.

In order to look at factors affecting teacher priorities in their time allocation, teachers were asked to rank statements on a 5-point scale from strongly disagree to strongly agree. There was one question that got directly at the idea of teacher priorities by giving the following prompt: "I choose to spend my class time on the activities that I do because _____." Teachers then rated different statements that were chosen to fill in the blank. The statements for the blank in this question were mostly identified from the interview results, which will be discussed later. In relation to the teacher priorities, there were many questions that were included in the survey in order to determine if teachers really said that the reason they don't do SC activities is because they don't have enough class time. There were two questions in the survey that asked teachers what they would do if they had twice the amount of class time available to teach. One of these questions had the teachers rank statements again, and one was a fill in the blank for any other additional activities they would like to do that weren't listed.

There were also questions on some basic beliefs about PSEAs and their usefulness as instructional strategies, fun activities, and other similar things. These were used to understand

what the teachers' opinions were on some of the external codes on factors affecting time allocation, such as *better way to learn* and *keeps students motivated*, as well as some of the internal codes, such as *availability (or lack) or resources*. Also, in order to see if the external *cultural* code was an influencing factor, questions were asked on the similarity of the teacher's instructional strategies to those of other teachers.

The 17 questions also included 7 basic demographic questions about the teacher, for example, how many years they have taught, what classes they had taught, and whether they were on a block or daily schedule. These demographic questions were asked in order to see if different types of teachers choose to allocate their time in different ways and if they had different factors influencing their time allocation.

Data Management and Analysis

While interviewing and observing, and also during the analysis of the survey responses, short memos and notes were used to record notable ideas or responses that teachers had and where they occurred in the data. The interviews were transcribed and the observation notes, the interview transcripts, and answers to the free response survey questions were coded. The survey results were then analyzed using statistical software.

Interview and observation analysis. In coding the observation notes and interview transcripts, similar themes were identified for both how teachers choose to allocate their classroom time, and why they choose to allocate it that way. An analytical-inductive method (Knuth, 2002) was used, beginning with a set of external codes, or pre-determined codes based off of prior research and experience. During the data analysis process, internal codes were developed based on common themes seen in the data. This method was a suitable way of coding

for this study because some possible answers to the research question had already been identified, but more themes and answers were likely to emerge from the data as well.

The external codes (pre-determined codes) were grouped into the two main categories of how teachers allocate their time and factors affecting teacher priorities in time allocation. The codes for how teachers allocate their time include different types of activities, keeping in mind whether they were SC or TC. The different types of activities that were coded are the typical activities that were outlined previously in Table 1. These activities were reviewing previous material, grading and discussing previously assigned homework, concept development (including teacher doing examples, teacher explaining new concepts with methods other than examples, student exploration, and class discussion driven by students sharing and explaining solutions or ideas), and students practicing learned procedures/problems, students doing homework in class, as well as internal codes (data based codes) that may have emerged.

The other set of external codes were on factors affecting teacher priorities in time allocation (see Table 5). These codes were based off of typical responses that a teacher may give as to *why* they allocate classroom time the way that they do. In analyzing the transcripts from the interviews, common themes were identified in order to create more internal codes and gain more insight into how teachers allocate their classroom time and the factors affecting teacher priorities in that time allocation. The results of the observations and interviews, along with the internal codes that emerged, will be discussed in the next section as preliminary results. These preliminary results were used to create and adapt items to be used in the survey.

Table 5

External Codes on Factors Affecting Teacher Priorities in Time Allocation

Not enough time
Better way to learn
Keeps students motivated
Cultural (how other teachers have done it)
Desire to allocate time differently
It is familiar or comfortable

Survey analysis. For the surveys, statistical analysis was done on the quantitative questions using IBM SPSS Statistics Software, Microsoft Excel, and Fathom Dynamic Data Software. Mean values were used to determine how much time teachers spend on various activities in general, and to identify the top reasons that teachers give for allocating time the way that they do. Correlation and regression data was used to determine if how SC a teacher was had any correlation to the responses on the other survey questions. The surveys were also analyzed using t-tests and one-way ANOVAs to see if any differences could be seen in teacher time allocation between different types of teachers that would be consistent with or vary from previous research results. T-tests were also used to determine if average responses were statistically different from 0 or not. Factor analyses were also done with the survey data to see if there were other possible groups of teachers that could be created based off of similar time allocation. The factor analyses basically combined the results on teacher time allocation and created groups from responses that were similar. These groups were then examined further for possible explanation on the variation.

Preliminary Study Results from Observations and Interviews

The results from the observations and interviews will now be discussed outside of the actual results section so that they can be used to discuss the adaptations that were made to the survey before it was administered. After analyzing the data from the observations and interviews, the codes on how teachers allocated their classroom time did not change at all. All of the activities that the teachers did could fit into the previously identified external codes on how teachers allocate their time. The other set of codes, on factors affecting teacher priorities in time allocation, were developed considerably from the observations and interviews. There was a lot of support seen in the interviews for the previously defined external codes, but many internal codes were also created. This data on the external codes will briefly be discussed, followed by supporting data for the developed internal codes.

For the external code of *not enough class time*, a couple of the teachers said that this factor was not an issue for them, but for the other teachers interviewed this issue seemed to be a *major* influencing factor for why they do not do certain activities. Teachers were reported saying the following,

- "We have so very little time that I am almost forced to try and teach it" (as opposed to more student-centered teaching)
- "As far as learning all of your concepts by discovery, it's not very practical. It's too time consuming."
- "I think that they're valuable, because they don't take as long.... Those kinds of things take maybe 30 seconds." (referring to activities where students explain/justify)

There was also a lot of support from the interviews for all of the other external codes. Many of the quotes from teachers in each of these coded categories just basically explained what

the code name already describes, so those are not discussed here; however, there were quotes in some codes that provided further insight beyond what is described in the code name. One of them was under the *cultural* code where one teacher said the following: "I don't know I just do the same… because our departments all on the… me and the other Pre-Calculus teachers we all do the same homework, same schedule..." Under the *familiar or comfortable* code, one teacher said the following about new teaching methods: "[Teachers are] not comfortable with them… I've talked to teachers who have never done it, and so they want to stick with what they are comfortable. What they've done before works for them and they don't want to change." Also, in the *desire to allocate time differently* code, one teacher said the following:

> With math you don't really have much of a say. Like you teach these concepts and…. You know there's lots of activities that I would love to do with them, but you have to wait until after you are done with the testing and then you can do it then.

These quotes are just some examples of what teachers said. In reality there were many comments from teachers in support for each of the codes, this list is just a sample of some of the most interesting because they provide insight beyond what the code name describes.

There were also many teacher responses that supported the development of some internal codes. The first internal code was *fear*, which included the codes of *lack of mathematical knowledge*, and *lack of training*. For *lack of mathematical knowledge*, in reference to why teachers might not do SC activities, one teacher said, "They don't know what to do, or how it might lead… For some, I think there's a lack of content knowledge. I mean, what if a kid says something I don't…" Another teacher pointed out that when kids are asked to explain and justify ideas, "[Teachers are] afraid of what the kids might say. If they give a totally ridiculous answer and they're not sure how to… address it or if they give an answer where they're not exactly sure if that's right or not."

There was also support for an *easier/harder* code, meaning that a particular instructional method is used because it is easier. Referring to why he doesn't do exploration activities much anymore, one teacher said:

> I think when you explore… all the gaps in their understanding from previous classes show up. And it's like how do you deal with all of that? Right in the middle of this lesson you're supposed to deal with this gap, and this gap. So that was difficult to deal with.

An *end of level tests or other evaluations* code was developed, and as an example one teacher said the following in regards to why they don't do group exploration activities:

> I have to teach this many concepts in so much time before the end of level tests, and if I take two days to do this project or three days to do this project, I am not going to get through the core. I'm just not, in the time that I have.

There was also support for the other internal codes of lack of training (referring to teachers not knowing how to use a particular instructional method), availability (or lack) of resources, lack of out-of-class time (planning & after school), benefit vs. difficulty not worth it (tried & failed), parents get upset, too difficult for students (untrained or unable), and block vs. daily schedule. Again, the quotes supporting these codes did not provide extra insight beyond what the code name describes, so they were not provided here.

Based on frequency of the responses, some of the most significant reasons that were found from the internal codes as to why teachers don't do certain types of instruction are that the teachers are often fearful about their own content knowledge and their knowledge about the types of activities that they would like to do, there are not enough curriculum resources available, and that the planning time is too extensive. The results of teachers being fearful about their own content knowledge and their knowledge about the types of activities are exactly in line with what Silver, et al. (2005) hypothesized on why teachers were not doing certain activities.

Some other interesting results from the interviews were the teacher views on review, problem-solving activities to teach content, and preparing students adequately for homework. Multiple teachers mentioned that the time that they spend on review from previous years causes a time crunch in their class, preventing them from teaching how they would want. Also, it became evident in the interviews that some teachers didn't see the use of problem-solving exploration activities as a method of teaching, but rather as a supplemental activity, which could be one of the reasons why these teachers feel pressed for time when trying to implement these activities. In their minds, traditional lecture methods should be used to teach the main mathematical content, and problem-solving exploration activities should be used for review or simply as a fun activity. There were also some interesting beliefs that teachers talked about that may be causing this time crunch. One of these beliefs was that some teachers indicated that it was a problem if students left class not knowing how to solve all of their homework problems.

The external and internal codes, as well as the other interesting results, were used to help adapt and create survey questions in order to examine teacher priorities and factors influencing those priorities for their class time allocation. The original survey questions are provided in Appendix C, with the revised survey in Appendix B. For the revisions, all of the external codes on factors influencing time allocation were added to the list of agree/disagree statements for the stem "I choose to spend my class time on the activities that I do because _____. They were also added to the question about what makes problem solving exploration activities difficult. For example, one of the external codes created was *availability (or lack) of resources*. This led to "there aren't enough curriculum resources available for teachers" and "there is too much planning time involved" being added to the list of things that teachers rated on what made problem solving exploration activities difficult.

The other interesting results also led to changes in the survey. For example, it seemed that some teachers didn't think that problem solving exploration activities could be used as a means of teaching content, but rather that they were just fun activities that were interesting to students. Because of this, two questions were added to ask if teachers though these activities could be used to teach state core concepts, or if they should mainly be used for supplemental activities. Questions were also added to the survey to see if teachers thought that it was a problem if students left class not knowing how to solve all of their homework problems, and to see if teachers felt that they had to spend so much time reviewing concepts from previous years that they couldn't teach in the way that they would want. These were all ideas that showed up in the interesting results from the interviews.

After these changes were made to the survey, it was piloted to the 11 graduate students. From their feedback, some of the wording was adapted to make the questions more clear and easier to answer. For example, a question on whether the teacher had taught any subjects other than math was clarified by adding the phrase "in public schools." Also, one of the graduate students said that when they were asked to indicate how much time they spent on individual activities, that they would put answers in one box and then realize that a later box was more similar or appropriate. Because of this, I added in a suggestion that indicated it may be helpful to briefly look over all of the categories and then answer the question. Another change was that a question was added after the agree/disagree scales on which activities they would do if they had double the amount of class time. This new question asked if there were any other activities that they would do if they had double the amount of class time (other than those activities given in the previous question), and if the teacher responded yes, there was an entry box where they could indicate what those other activities were.

One of the other graduate students also indicated that some clarification may be needed with some of the other questions. These questions were referring to problem solving exploration activities. The graduate student highlighted the fact that this may not be a common definition among teachers. From this feedback, it was clear that a definition for problem solving exploration activities may be helpful. In trying to create a good definition, it was difficult create something that was concise but still explained enough so that every teacher would understand what was meant. In the end, no clarifying definition was given, which did create some problems and had to be considered when interpreting the results of these few questions.

Results

Out of the 581 surveys that were distributed, 235 were started, and 224 were fully completed. These 224 surveys that were fully completed represent 38.55% of the total number of surveys that were distributed, and these survey results were the only ones that were used in the analysis. As described in the methodology, the data was analyzed using IBM SPSS Statistics Software, Microsoft Excel, and Fathom Dynamic Data Software. The software programs were mainly used for finding averages, correlations, regressions, and factor analyses. In reporting the survey results, first some of the basic results on how teachers generally allocate their time are discussed, and then the results on which factors influence teacher priorities in that time allocation. Following that section, there is an explanation of some main groups that were found using factor analyses, as well as variation in survey responses based off of other groupings.

Typical Time Allocation and Priorities

In order to get an initial idea of how secondary mathematics teachers typically allocated their time in the classroom, the following question was asked: "During a typical math class period, approximately how much time do you devote to each of the following activities?" (See Appendix B). Teacher responses on this question were then converted to the percentage of total class time that they spent on these various activities. Percentages were used to be able to compare the results easier, because the length of the class periods varied from 20 minutes to 115 minutes. There is a summary of these results in Table 6. In general, teachers spent the majority of their class time on teacher explanations (through examples or other means), students solving problems after concept explanation or working on homework, and going over the previous night's homework.

Table 6

Percentage of Class Time Math Teachers Typically Allocate to Activities

Percent	SD*	Activity
19.1%	10.68	Teacher doing examples to explain a new concept (can include some help from students)
14.9%	11.36	Students working on homework in class
13.2%	9.16	Teacher explains new concepts (definitions, formulas, etc.) at the board while students listen and ask questions if needed – Does not include doing examples
11.4%	8.39	Students solve problems posed by the teacher **after** an explanation of the concept
11.3%	7.80	Going over previous night's homework
8.2%	7.39	Reviewing previous material
5.4%	8.96	Student exploration of a task posed by the teacher **prior** to an explanation of a the concept
5.3%	6.68	Daily quiz
5.0%	7.08	Class discussion driven by students sharing solutions or ideas
4.1%	5.60	Problem of the Day
2.1%	7.50	Other activities as entered by survey takers (including clean-up, administrative tasks, and student self-started activities)

* SD stands for Standard Deviation

There was also a question in the survey that attempted to understand what factors influence teacher priorities in their time allocation. It began with the following prompt: "I choose to spend my class time on the activities that I do because _____." Teachers were then asked to rate the completing statements on a 5-point scale from strongly disagree (-2) to strongly agree (2). The average teacher responses are provided in Table 7, ordered by level of agreement. One-sample t-tests were also used to determine if the average responses were statistically different from zero.

Table 7

Factors Influencing Teacher Time Allocation Priorities

I choose to spend my class time on the activities that I do because…	Average Response	SD*
Those activities will help the students with their end of level tests	0.89**	0.77
The activities keep students working hard mathematically	0.89**	0.71
I have seen others teach using those activities (including co-workers and your past teachers)	0.45**	0.80
Those activities make it easier to manage the class in terms of rowdiness or discipline	0.38**	1.06
I have always taught using those activities and I feel comfortable with them	0.19**	0.90
The activities keep students motivated because they are fun	0.17**	0.90
There are a lot of curriculum resources available for those activities	0.17	1.03
It is easier to do preparation and planning for those activities	0.03	1.10

* SD stands for Standard Deviation
** These mean values were shown to be statistically different from zero ($p < .01$)

This table shows that according to the teacher responses, the main factors influencing teacher priorities in time allocation are end of level tests, how hard their students are working mathematically, cultural factors (seeing others use the activities), and ease of management with rowdiness/discipline.

Variables Created From Time Allocation Factor Analysis

Table 6 showed the averages on how teachers allocated their classroom time, but through doing a factor analysis on the results for this" amount of class time" question, some interesting differences in teacher time allocation emerged. Through this factor analysis, five main variables in how teachers allocated time were identified. In order for these new variables to emerge,

teacher had to have similar time allocation for some activities. This similar time allocation would include some activity categories where teachers had high percentages of time allocation, and other activity categories where they had low percentages. There were also other teachers who had the opposite time allocation, as explained further in the variable explanations. The main components of these five new variables will now be explained. A table summarizing these variables is provided after all of them have been discussed (Table 8).

One of the variables that emerged, which will be called the **Correcting Homework**, was focused on how previous material is discussed. Those who rate high on the Correcting Homework variable spend more time going over the previous night's homework, and less time reviewing previous material, while those who have a low rating on the Correcting Homework variable, allocate their time in an opposite way (less time going over homework, and more time reviewing previous material). There is a negative correlation between these two activities. This variable seems to indicate that many teachers don't often spend much time on both of these activities, but rather choose to do one or the other. This explanation is reasonable because teachers often want to remind students of what was discussed previously in some way, but the way that they do it can vary. Doing a brief review of the previous material and going over homework problems are two ways to remind student of what they had discussed previously. Another explanation for this variable could be that some teachers may have confused the two activities, but the two activities seemed to be quite distinct in the survey, so this alternative explanation may not be very likely.

A second variable, the **Problem of the Day** variable, captures whether teachers choose to do a problem of the day in their classroom or a daily quiz. Those who rate high on this variable tend to spend more time doing a problem of the day and less time doing a daily quiz. Similar to

the previous variable, a low rating on this Problem of the Day variable would show the opposite. This data indicates that many teachers often spend time on either a problem of the day, or a daily quiz, but not both. While a problem of the day is sometimes used as an introduction to new concepts rather than to assess understanding, in general, this Problem of the Day variable may indicate the different forms of an initial assessment that are typically done in a class. Since a daily quiz is more of an assessment activity, teacher may choose to do a Problem of the Day as an assessment activity as well. As an alternative explanation, teachers may choose not to do an assessment activity, and their Problem of the Day activity is used as an introduction to the new lesson. Either way, it seems that teachers tend to do one of these two activities, but rarely both.

A third variable, **Working on Homework**, seems to indicate some differences in how teachers have their students work on problems in class. A high rating on the Working on Homework variable indicates that the teacher spends more class time on students working on homework in class, and less class time on students solving problems posed by the teacher *after* an explanation of the concept. Again, a low rating on this variable would indicate the opposite. This variable seems to indicate that teachers often choose between these two activities rather than spending a lot of time on each of them. These two activities are very similar, with a slight difference being that the homework problems done in class would most likely be a take-home assignment if they do not finish, whereas problems posed by the teacher in class may not turn into a take-home assignment. It is not surprising that teachers often just do one or the other, rather than both of these activities. They are different ways to enable students or the teacher to check student understanding after a concept has been explained, but it seems that they both can fulfill this purpose and only one of these activities is needed.

A fourth variable, **Examples to Explain**, seems to capture differences in how teachers explain new concepts. A high rating on the Examples to Explain variable indicates that the teacher spends a lot of time doing examples to explain a new concept, but not as much time explaining concepts using definitions, formulas, and other means. A low rating on this variable would indicate the opposite. This variable shows that there aren't very many teachers who spend a significant amount of class time on *both* of these activities, but rather that they tend to choose one or the other. There are alternative ways to introduce new material, but this variable seems to highlight these two activities as common ways that concepts are often taught in math classes.

A final variable, the **Student-Centered** (SC) variable, seems to indicate the degree to which a class is SC or TC. Teachers who rate high on this variable typically spend a relatively large amount of class time on student exploration of a task *prior* to explanation of the concept, and also on class discussions driven by the students sharing solutions or ideas; however, they spent very little time on the teacher explaining concepts at the board while students listen, students working on homework in class, and the teacher doing examples to explain a new concept. Those who rated low on the SC variable would typically have time allocation that was opposite to that of the high rating (very little time on student explorations and students sharing solutions and ideas, and more time spent on teacher explanations and students working on homework in class). This variable seems to indicate how SC a class is because the opposing factors involved match the descriptions of SC classrooms and activities vs. TC classrooms and activities explained in the theoretical framework. Teachers who have a high rating on this variable will be considered more SC teachers, and those who have a low rating on this variable will be considered to be more TC.

It is important to point out that this variable that emerged from the data fits quite nicely with Keiser and Lambdin's (1996) description of the variation in time allocation in traditional and reform based classes. The reform class spent less time on lecture, review, and students practicing learned procedures. They spent *more* class time on students sharing ideas and talking about mathematics, working in small groups, using calculators and manipulatives, and other activities. Students "working in small groups" probably can't be directly related to student exploration of a task *prior* to explanation of the concept, but it may overlap. However, many of the other activities that Keiser and Lambdin found that show differences between the two groups directly relate to the key components that were identified in this SC variable. Table 8 summarizes the five variables that were identified.

Table 8

Five Variables Identified Through Factor Analysis

Variable	Meaning of High Rating
Correcting Homework	More going over previous homework (vs. reviewing previous material)
Problem of the Day	More problem of the day (vs. daily quiz)
Working on Homework	More working on homework problems (vs. other problems)
Examples to Explain	More examples to explain concepts (vs. other types of explanations)
Student-Centered (SC)	More student-centered (vs. teacher-centered)

As described previously, within each of these variables there is a negative correlation between the two components involved. These variables show some of the main differences in how teachers allocate their classroom time. The SC variable is the main one that will be focused on for multiple reasons. First, it is directly related to some of the initial interests and rationale for

this study, and provides additional insight into the research question on teacher priorities in their time allocation. Second, this variable is more complex than the other variables in that it includes many different types of activities. Also, it is an interesting variable to look at because there are some links to this variable and differences in factors that influence teacher priorities in time allocation. Similarly, it is important to look at this variable because there are many significant differences in teacher responses to other survey questions based off of their rating on the SC variable. The analysis of the SC variable and the differences in survey responses for more SC as opposed to more TC classroom time allocation will be discussed in the next section.

Variations in Survey Responses

This section describes variations in the survey responses based off of different groupings of teachers. The first variations that will be discussed are based off of the SC variable that was just described. The second section is on differences in survey responses based off of the schedule that the teacher has and the level that they teach. Finally, variations based off of years of experience of the teacher are discussed.

Differences based on SC variable. In analyzing the SC variable, it is first important to look at how this variable was calculated, and how teachers rated on that variable in general. The SC variable was identified based off of the factor analysis that was done, but finally calculated by adding together the percentage of minutes spent on the more SC activities. As explained above, the SC activities were defined as student exploration of a task *prior* to explanation of the concept and class discussions driven by the students sharing solutions or ideas. The TC activities were defined as teacher explaining concepts at the board while students listen, students working on homework in class, and the teacher doing examples to explain a new concept. During initial data analysis, the percentage of time spent on these TC activities was subtracted from the

percentage of time spent on the SC activities, but this method showed to be a fairly poor way of determining which teachers were more TC and which were more SC. That initial analysis made it so that teachers who were spending no time on the SC activities and a minimal amount of time on the TC activities would get a higher SC rating than teachers who spent up to 35% of their class time on the SC activities, but 50% of their class time on the TC activities. This result was seen as a problem because for the purposes of this paper, a teacher who spends 35% of their class time on SC activities should be considered more SC than a teacher who spends 0% of their class time on SC activities. For this reason, only the percentage of time on SC activities was used in the actual SC variable calculation.

The average teacher rating for this computed SC variable was 10.43, with a standard deviation of 14.21 and a median of 6.37. This means that on average, teachers spent 10.43% of their classroom time on the two SC activities of student exploration *prior* to explanation and discussion driven by students sharing solutions or ideas. Also, 91 of the teachers (40.63%) had a rating of 0 for the SC variable, and the highest rating of the teachers was 75 (2 teachers). Figure 2 shows the distribution of the SC variable ratings.

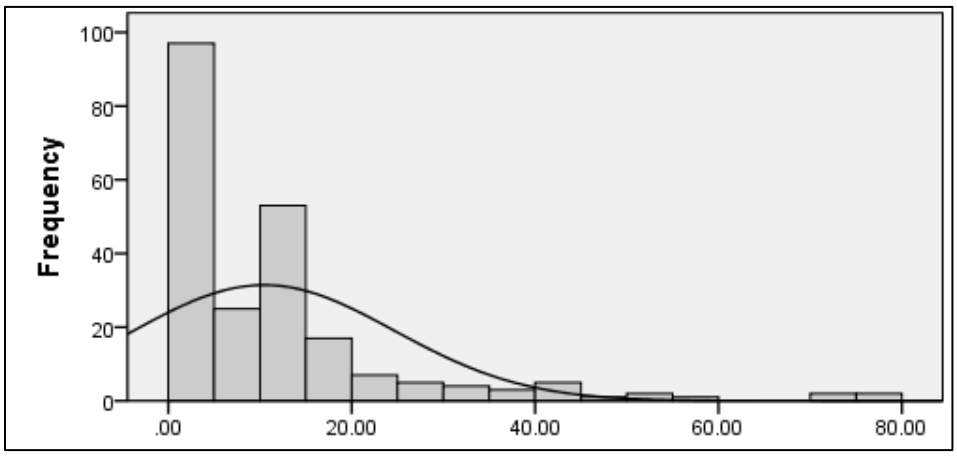

Figure 2. A frequency table showing how teachers rated on the SC variable.

In the survey there was a question (See Appendix B, Question 7) where teachers reported on whether they have students do a lot of problem-solving exploration activities (PSEAs) in class or not. The question was worded with the phrase "a lot of problem solving exploration activities," and it was up to the teacher to decide what a lot meant to them. Teachers likely interpreted this phrase differently, and thus the results to this question are not necessarily consistent with the SC variable. 26.8% of teachers (60 out of the 224) indicated that they did a lot of PSEAs in their class, which for this study are considered SC activities. For the 60 teachers who said they did a lot of PSEAs, the average percentage of time spent on the SC activity of students exploring tasks *prior* to an explanation of the concept was 10.3% of the total class time. The average SC rating for those 60 teachers was 18.40, while it was 7.51 for those who said they do not do a lot of PSEAs in their classroom. It seems that in general, teacher responses on this question were consistent with their teacher time allocation to SC activities (based on the SC variable). However, there were some teachers whose responses do not seem as consistent. There were 13 teachers who had a rating of 0 on the SC variable, but said that they do a lot of PSEAs. There were also 9 teachers who had a SC rating higher than 24.64 (1 standard deviation above the mean) who said that they do not do a lot of PSEAs. Figure 3 shows the relationship between teacher responses on whether they do PSEAs or not, and how they rated on the SC variable.

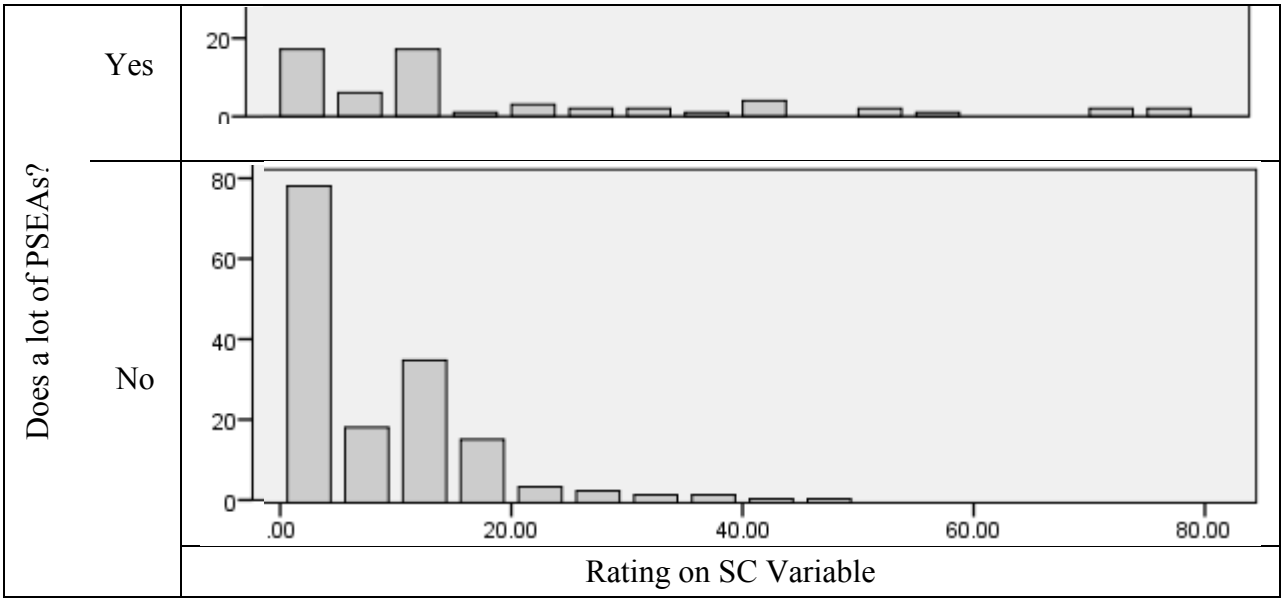

Figure 3. A frequency table showing how teachers rated on the SC variable, categorized by whether the teacher said they do a lot of PSEAs or not.

The top row in this chart indicates those who say they are currently doing a lot of PSEAs, and the bottom row indicates those who say they are not currently doing them. It can be seen from this chart that there a few teachers who have a relatively low SC rating but say that they do a lot of PSEAs, and there also some teachers who have a relatively high SC rating but say that they do not do a lot of PSEAs. One thing that could explain this result is that these teachers may have misinterpreted what was meant by PSEAs. Alternatively, some teachers could think that they need to be doing *more* PSEAs in order for it to be considered "*a lot* of PSEAs," possibly because they are aware that lessons can be taught where these types of activities are the main focus for a majority of the class time. On the other hand, some teachers could be thinking that they do use PSEAs quite a bit in their classroom, but when compared with the time allocation of other teachers, the percentage of time that they spend on PSEAs is actually quite low. This question was written so that teachers would use what *they* considered to be "a lot of PSEAs," so it is expected that there would be variation in how teachers responded on that question.

In deciding on a good way to split up the data for further analysis on the survey responses, it seemed that it was best to analyze the other responses in terms of how teachers rated on the SC variable, as opposed to looking at their response on whether they did PSEAs or not. The data was analyzed both ways (using the variable and the teacher response), but there didn't seem to be many statistically significant differences in responses when just looking at their response to doing PSEAs or not. It was decided that because of the ambiguity in the PSEAs question, it would be more accurate and useful to look at teacher time allocation, not their answer to whether they do a lot of PSEAs or not. Not every teacher necessarily defines problem solving exploration activities the same way. The teachers also had to personally choose what "a lot of PSEAs" meant to them personally, so there is variation there as well. It is better to look at teacher time allocation, which is easier for teachers to report and is more consistent between teachers than whether they do a lot of PSEAs or not. Also, as explained in the theoretical framework, whether a teacher is more SC or TC would most likely show differences in time allocation. It is important to look at this idea of SC vs. TC, because there is a lot more that goes into a SC classroom than just PSEAs.

In the analysis that follows, the teachers will be considered along an SC continuum to see if there are any correlations between their position on that continuum and their responses to other survey questions. For the discussion of these correlations between the SC variable and other survey responses, teachers were considered more SC on the continuum as the ratings on the SC variable increased, and more TC on the continuum as the ratings on the SC variable decreased (did not spend a lot of time on SC activities).

Statistical analysis was done to see if there were correlations between the SC variable and the responses to the survey questions. The statements that did not show a statistically significant

correlation indicate that there is not a statistically significant difference between those who do a lot of SC activities and those who do not (more TC). Table 9 shows summarized survey statements where teachers had similar responses (no correlation found) regardless of whether these teachers were more SC or more TC (lower SC variable rating). The average teacher response is also provided, which indicates the teacher level of agreement or disagreement with those statements on a scale from -2 (strongly disagree) to 2 (strongly agree) with 0 being neutral. One-sample t-tests were used to determine if the average responses were statistically different from zero.

Table 9

Statements Where SC and TC Responses Were Similar

Summarized Statement	Average Response
1) Given double the class time, I would do more exploration or problem solving activities.	1.40*
2) I choose the activities that I do because they help students with end of level tests.	0.89*
3) Given double the class time, I would increase practice or homework time.	0.56*
4) I choose the activities that I do because I have seen others use those activities (including co-workers and past teachers).	0.45*
5) I choose the activities that I do because they are easier to manage with rowdiness and discipline.	0.38*
6) Given double the class time, I would cover topics that are not included in the state requirements.	0.31*
7) I typically leave out material from the Core in order to spend more time talking about certain topics more in depth.	0.13
8) Given double the class time, I would start the next section.	-0.20*
9) Mathematics PSEAs are easy to find curriculum resources for.	-0.45*

* These mean values were shown to be statistically different from zero ($p < .01$)

This data shows that regardless of whether teachers were more SC or more TC, they generally agreed with statements 1 through 6 above, were neutral on statement 7, and disagreed with statements 8 and 9. These results show that regardless of whether teachers were more SC or more TC, they still generally agreed that if they had more class time, they would do more PSEAs, increase practice/homework time, and cover topics that are not in the state core requirements; but they would *not* choose to start the next section. They also seem to feel some sort of push from end of level tests. Also, in choosing which activities they would like to do, they generally agree that part of it is cultural (what they have seen other teachers do) and that they pick activities that are easier to manage. It is interesting to note that these last two reasons are about ease for the teacher, not whether the activity is *mathematically* motivating or stimulating cognitively.

The remaining statements were those that did show correlations with the SC variable. These are places where SC and TC teachers differed in their responses. Table 10 summarizes the correlation statistics, ordered from those that have the strongest relationship to the weakest. As with the statements from Table 9, the responses for these statements indicate the level of teacher agreement with each, on a scale from -2 (strongly disagree) to 2 (strongly agree).

Table 10

Correlation Data between SC Variable and Survey Responses

Summarized Statement	Pearson Correlation Coefficient
1) I devote <u>most</u> class time to going over examples and students working on homework because it is a problem if students leave class not knowing how to solve all of their homework problems.	-0.499**
2) My use of class time is similar to that of most math teachers that I had in school.	-0.377**

3) I choose the activities that I do because they are easier to prep/plan for.	-0.359**
4) Math PSEAs are accessible for most students (difficulty).	0.334**
5) Given double the class time, would review more.	-0.311**
6) Math PSEAs can be used as a primary method of teaching Utah Core math concepts.	0.289**
7) Math PSEAs are fun for most of my students.	0.277**
8) Math PSEAs are easy to manage in terms of student behavior.	0.277**
9) I choose the activities that I do because I have always taught using those and feel comfortable with them.	-0.270**
10) There are activities or teaching styles that I would like to do in my class, but don't because they take too much class time.	-0.257**
11) Not enough time to teach all of the state-required material in the way that I would want because I spend so much of my class time reviewing concepts from previous years.	-0.243**
12) I choose the activities that I do because there are a lot of curriculum resources available for those activities.	-0.228**
13) My use of class time is similar to that of most math teachers in my school.	-0.219**
14) Math PSEAs are mainly for supplementary concepts	-0.198**
15) It is valuable for students to solve problems before being shown similar ones.	0.197**
16) I choose the activities that I do because the activities keep students motivated because they are fun.	0.190**
17) Time required for an activity greatly impacts whether or not I use it in class.	-0.185**
18) Given double the class time, would do more daily quizzes.	-0.172**
19) I choose the activities that I do because they keep students working hard mathematically.	0.155*

* $p < .01$, ** $p < .05$

Table 11 gives some additional information on the responses to the statements that showed differences based off of whether teachers were more TC or more SC. The least-squares regression lines for each statement were used to approximate typical answers for teachers based on SC ratings that are two standard deviations below the mean (more TC) and two standard deviations above the mean (more SC). A value of 0 on the SC variable was used for the more TC approximations, and a value of 38.85 was used for the more SC approximations. These values were used as the input in the equations for the least-squares regression lines for each statement in Table 10. The resulting outputs are given in Table 11, along with the difference between the two values. This information shows the estimated responses on the survey based on the extremes of the SC variable.

Table 11

Survey Responses for Extremes in SC Variable (Based on Correlations)

Summarized Statement	Value for More TC	Value for More SC	Diff Between Values
1) I devote <u>most</u> class time to going over examples and students working on homework because it is a problem if students leave class not knowing how to solve all of their homework problems	0.74	-0.78	-1.52
2) My use of class time is similar to that of most math teachers that I had in school	0.09	-1.04	-1.13
3) I choose the activities that I do because they are easier to prep/plan for	0.32	-0.77	-1.09
4) Math PSEAs are accessible for most students (difficulty)	-0.07	0.78	0.85
5) Given double the class time, would review more	1.10	0.47	-0.62
6) Math PSEAs can be used as a primary method of teaching Utah Core math concepts	-0.16	0.65	0.82
7) Math PSEAs are fun for most of my students	0.20	0.93	0.74

8) Math PSEAs are easy to manage in terms of student behavior	-0.29	0.45	0.74
9) I choose the activities that I do because I have always taught using those and feel comfortable with them	0.37	-0.29	-0.66
10) There are activities or teaching styles that I would like to do in my class, but don't because they take too much class time	0.68	-0.06	-0.74
11) Not enough time to teach all of the state-required material in the way that I would want because I spend so much of my class time reviewing concepts from previous years	1.06	0.32	-0.74
12) I choose the activities that I do because there are a lot of curriculum resources available for those activities	0.34	-0.29	-0.62
13) My use of class time is similar to that of most math teachers in my school	0.64	0.06	-0.58
14) Math PSEAs are mainly for supplementary concepts	-0.40	-0.87	-0.47
15) It is valuable for students to solve problems before being shown similar ones	0.09	0.60	0.51
16) I choose the activities that I do because the activities keep students motivated because they are fun	0.04	0.51	0.47
17) Time required for an activity greatly impacts whether or not I use it in class	0.65	0.15	-0.51
18) Given double the class time, would do more daily quizzes	-0.05	-0.51	-0.47
19) I choose the activities that I do because they keep students working hard mathematically	0.81	1.12	0.31

In looking at the differences in survey responses based off of ratings on the SC variable, the more TC teachers tended to agree that most of their class time involves going over examples and students working on homework, because it is a problem if students leave class not knowing how to solve all of their homework problems. The more TC teachers tended to agree with this

statement, but as teachers rated higher on the SC variable, they tended to disagree with this statement. Also, as teachers' SC rating increased, they moved from agree to disagree for the statements that they choose to do activities that they have done in the past and feel comfortable with, that there are a lot of curriculum resources for, and that it is easier to do preparation and planning for. However, it was the opposite for the statement on choosing activities that keep students motivated because they are fun. A low SC rating was correlated with being neutral for this statement, but a high SC rating was correlated with agreement with this statement.

Another statement that showed a correlation with the SC variable was on choosing which activities to do because of more cultural factors. The more SC teachers generally disagreed on a statement that their style of teaching was similar to teachers that they had growing up, but as the rating on the SC variable decreased, the responses tended to be more neutral. Also, on a similar statement referring to being similar to other math teachers in the school, the responses moved from agree to more neutral as the SC rating went up.

The more TC teachers also generally agreed that how much class time an activity takes would affect whether they chose to do it or not, and there are activities or styles of teaching that they don't do because they take too much class time. The more SC teachers tended to be more neutral on these statements. Similarly, the more TC teachers generally agreed more with the statement that they don't have enough time to teach how they would want because they have to spend so much time reviewing. However, even the teachers who were more SC tended to agree with this statement slightly.

The more TC a teacher was, the more they tended to feel a need to do review, and didn't see as much value in having students try to solve math problems before being shown similar problems and solutions as the more SC teachers. On statements involving math PSEAs, the more

SC a teacher was, the more they tended to agree that PSEAs are accessible for most students, are fun for most students, can be used as a primary teaching method, and are easy to manage in terms of student behavior. The more TC teachers agreed that PSEAs are fun for students, but generally disagreed with the other 3 statements. For a related statement that PSEAs are mainly for supplementary concepts, as teachers moved from more TC to more SC, their responses moved from disagree to stronger disagreement. Finally, all teachers tended to generally agree that they pick activities that keep their students motivated mathematically, but the more SC teachers generally agreed with this statement *more* than the TC teachers.

Differences based on schedule and level. As explained in the literature review, research has indicated that there may be differences in time allocation based on the type of schedule (block or daily) that the class has. In looking at this possibility, some interesting results emerged when looking at the differences in answers between teachers on block and daily schedules in both junior highs and high schools. It was found that most teachers surveyed taught at high schools with a block schedule, or at a junior high with block or daily schedule. Only 12 teachers out of the 224 surveyed that did not fit into one of these three groups (see Table 12).

Table 12

Number of Survey Takers in Level and Schedule Categories

Level and Schedule	Frequency (out of 224)	Percent of Teachers
High School – Block (HS-B)	93	41.5%
Junior High – Block (JH-B)	61	27.2%
Junior High – Daily (JH-D)	58	25.9%
High School – Daily (HS-D)	5	2.2%
Other (modified schedule)	7	3.1%

The purpose of looking at the level and schedule of the teachers was to look for the major differences in responses to the other survey questions. For that reason, the average responses that showed statistically significant differences between groups are the ones that are reported here. These were found using a one-way ANOVA. The main differences in the time allocation of these different groups are in the time spent on students working on homework in class, daily quizzes, and student exploration of tasks *prior* to an explanation of the concept.

First with students working on homework, the teachers who spent the greatest percentage of their time on this activity were those who had a HS-D schedule (30.45% of class time). The next two groups were the JH-D schedule (17.79% of class time), and HS-B schedule (14.77% of class time). Finally, those with a JH-B schedule spent the least amount of time on students working on homework in class (11.35% of class time). In general those with a daily schedule spent a greater percentage of time on homework than those with a block schedule. Then within those groups, those in high schools spent more time on homework than those in junior highs.

With daily quizzes, there is a significant difference in time allocation between the HS-B teachers and the JH-D teachers. On average, the HS-B teachers spent 8.12% of class time on daily quizzes, whereas the JH-D teachers spent 2.06% of their class time on average. These results agree with what was said in the interviews, where teachers generally seemed to indicate that they used daily quizzes in order to help the class remember what was discussed in the previous lesson or lessons because it had been a couple of days at least since their last class period. This objective of helping students remember the previous lesson material may be why teachers on a block schedule tend to give more quizzes than teachers on a daily schedule.

There were also statistically significant differences between groups with student exploration of a task *prior* to an explanation of the concept as well as class discussions driven by students sharing solutions or ideas. The major differences in time spent on these activities were between JH-B when compared to HS-B teachers and JH-D teachers. On average, JH-B teachers spent 10.01% of class time on the student exploration activities, whereas HS-B teachers spent 3.38% of class time on these activities and JH-D teachers spent 4.02%. Also, the JH-B teachers spent 8.44% of class time on students sharing solutions or ideas, whereas HS-B teachers spent 3.55% of class time and JH-D teachers spent 3.72%. The two activities being looked at here were the two activities used to compute the SC variable. Using an independent samples t-test, the average values on the SC variable were shown to be statistically different between junior high teachers and high school teachers ($p<.01$). The average amount of time on the SC variable for junior high teachers was 13.27%, whereas it was 6.84% for high school teachers. These were the major differences in time allocation. The other significant differences between level and schedule categories along with their means are given in Table 13. These were found using a one-way ANOVA.

Table 13

Differences in Time Allocation for Level and Schedule

Activity	Average % of Time Spent for Lvl/Sched.		Diff. in Means	Sig. Level ($p<.05$)
Problem of the day	HS-B, 2.43	JH-D, 5.61	-3.18	.004
Teacher explaining with definitions/formulas	JH-B, 9.80	HS-B, 14.46	-4.66	.010
	JH-B, 9.80	JH-D, 15.19	-5.38	.007
Student exploration	JH-B, 10.01	HS-B, 3.38	6.64	.000
	JH-B, 10.01	JH-D, 4.02	5.99	.001

Discussion with students sharing solutions/ideas	JH-B, 8.44	HS-B, 3.55	4.89	.000
	JH-B, 8.44	JH-D, 3.72	4.72	.001
Working on homework	HS-B, 14.77	HS-D, 30.45	-15.68	.011
	JH-B, 11.35	JH-D, 17.79	-6.44	.008
	JH-B, 11.35	HS-D, 30.45	-19.10	.001
Daily quiz	HS-B, 8.12	JH-D, 2.06	6.05	.000
	HS-B, 8.12	JH-B, 4.34	3.78	.002

There were also statistically significant differences between the different groups in their answers to some of the other survey questions. Again, for this study, only major differences in responses based on the categories were sought, so those are what is reported here. Two of the questions that had the greatest difference between different groups were regarding teaching material required by the state vs. review material, and using problem solving exploration activities (PSEAs) to teach material required by the state. First, on the statement that the teacher doesn't have enough time to teach all of the state core requirements in the way that they would want because they spend so much time reviewing concepts from previous years, JH-B teachers averaged an answer of 0.49 (on a scale from -2 to 2, with -2 being strongly disagree and 2 being strongly agree), whereas HS-D teachers had an average answer of 1.80. This result shows that on average, JH-B teachers only slightly agreed with this statement, but HS-D teachers agreed to strongly agreed with this statement. One reason for this result may be that there is more pre-requisite knowledge required in high schools (hence more need for review). Along with this possible explanation, it may be that the high school teachers are more dissatisfied with how prepared the students are that are coming in than the junior high teachers are. This difference in

answers may also have something to do with the idea that daily teachers may feel more pressed for time in general.

Secondly, on a statement that mathematics PSEAs can be used as a primary method of teaching state core concepts, HS-B and JH-B teachers differed significantly. On average, the HS-B teachers had an average answer of -0.28 (again on a strongly agree/disagree scale from -2 to 2), and the JH-B teachers had an average answer of 0.48. This result shows that for those on a block schedule, the high school teachers tended to disagree slightly with this statement, whereas the junior high teachers tended to agree slightly with this statement.

Differences based on years of experience. The literature also indicated that how many years of experience a teacher has may have an effect on time allocation (Covino & Iwanicki, 1996; Rash & Miller, 2000; Stronge, 2007). As explained in the theoretical framework, for this study, the teachers were split into four groups based off of years of experience teaching mathematics: 0-3 years, 4-10 years, 11-20 years, and 21+ years. Table 14 shows how many teachers were in each of those four groups, as well as the percent that is of the total 224 teachers.

Table 14

Number of Survey Takers in Experience Categories

Years of Experience	Number of Teachers	Percent of Teachers
0-3	43	19.2%
4-10	83	37.1%
11-20	48	21.4%
21+	48	21.4%
No response	2	0.9%

In looking at the data across these four experience categories, there weren't any statistically significant differences in the way that the teachers allocated their time, but there were some differences for the other survey questions on factors affecting teacher priorities in time allocation. The area where there was the greatest difference between categories was on a question about doing PSEAs. Only looking at the group of teachers that said that t*hey do a lot of PSEAs, but find it challenging to do them*, there were some statistically significant differences in responses to other survey questions based on the experience levels. In particular, the teachers with 4-10 years of experience differed in some answers from those with 11-20 years of experience. On a statement about PSEAs being challenging to do because it is difficult to handle the concepts or student questions that may arise, the 4-10 years group rated this statement a -1.20 on average meaning that they disagree quite strongly, whereas the 11-20 years group rated this statement a -0.10 on average, meaning that they only slightly disagreed with that statement.

Also, only looking at the teachers that *do a lot of PSEAs, and find them challenging*, on a statement of there being too much planning time involved, those with 4-10 years of experience rated this statement a -0.4 on average, meaning they slightly disagree. However, those with 11-20 years of experience rated this statement a 0.7, meaning that they tend to agree with this statement.

For those teachers that do a lot of PSEAs and find them challenging, on a statement about it being harder to manage the class in terms of rowdiness or discipline, the teachers with 4-10 years of experience rated this statement a -0.93, meaning that they disagreed with this statement. However, those with 11-20 years of experience rated this statement a 0.6, meaning that they slightly agreed with the statement.

Finally, there were some differences between teachers with 4-10 years of experience and those with 20+ years of experience on the challenges of PSEAs for those who already do a lot of them. On a statement about it being difficult for students to discover complex math ideas on their own, those with 4-10 years of experience rated this statement a -0.27 on average, meaning that they slightly disagreed. Whereas, those with 20+ years of experience rated this statement a 0.87 on average, meaning that they agree with this statement.

Discussion

The results of the survey provided answers for the three main research questions of this study. The following sections discuss those answers on how teachers allocate their classroom time, how much time teachers spend on TC and SC activities, and what priorities teachers give to the various factors that influence teacher time allocation.

How Secondary Mathematics Teachers Allocate Time in the Classroom

The survey data showed that, in general, teachers spent most of their class time explaining concepts through examples or a discussion (32.3% of class time), having students work on homework in class or other problems that involve previously discussed concepts (26.3% of class time), and going over the previous night's homework (11.3% of class time) (see Table 6 for full results). In general, these are the main activities that take priority in the secondary math classes. On average, very little class time (less than 10% each) was spent on review, student exploration, daily quizzes, discussions driven by students sharing solutions or ideas, and problem of the day. This time allocation is not surprising because it is similar to a traditional math class that was outlined in the literature review. However, there are still some significant differences in the percentages. Sanford and Evertson (1983) reported the amount of time that teachers spent on whole-class instruction and on seatwork. The activities in their article don't match up directly with the ones that were used in the survey for this study, but for the types of activities listed in the survey that would be considered "whole-class instruction" by their definition, 45.5% (more than the 28.24% that Sanford and Evertson (1983) reported) of class time was spent on those (this group includes any class discussions, teacher explanations, or review). The survey results also showed that about 41% (more than the 28.24% that Sanford and Evertson (1983) reported) of class time was spent on seatwork by their definition (anything where students are working at

their desks). Sanford and Evertson (1983) also found that teachers spent about 18.97% of their total class time on transitions, administrative tasks, and dead time, whereas the survey data showed that these activities only accounted for 2.1% of class time. It is likely that this number would have been higher in this study, but these activities were not provided in the time options on the survey, so teachers would have had to enter them in. Also, these activities probably tend to be the ones that teachers under-estimate when they are thinking of their time allocation in class. Another possible reason for some of the differences could be because the data from Sanford and Evertson (1999) was not self-reported like the survey data was.

Another comparison can be made between the survey results on time allocation and Stigler and Hiebert (1999) found. This comparison is done separately from the results Sanford and Evertson (1983) reported previously because it is unclear how these two articles could be compared to one another. In comparing the survey results to Stigler and Hiebert's (1999) results, time spent on warm-ups and checking homework was comparable; however, there were other major differences. They reported 70.9% of time spent on going over examples, procedures, and definitions (mostly examples), while the survey showed that only 37.3% of class time was spent on these activities. Also, they found 10.4% of class time spent on homework compared to the 14.9% found from the survey results. Numbers on students doing other types of problems in class, or on some of the more SC activities such as student exploration were not found in Stigler and Hiebert (1999), which could be part of the reason why there was so much discrepancy between the results.

A complete cross-analysis of the results of the survey, Sanford and Evertson (1983), and Stigler and Hiebert (1999) cannot really be done because of the slight differences in activity definitions between the three; however, time spent on the class discussion activities with

examples or definitions can kind of be compared. In general, the survey found that slightly more time was spent on this activity than what Sanford and Evertson (1983) reported, and significantly less time than what Stigler and Hiebert (1999) reported.

Time allocation based on level and schedule. The survey data on how teachers allocated their class time was analyzed even further to look at differences in time allocation based off of categories of teacher demographics. First, there were differences that were found in teacher time allocation based off of what level they taught at (jr high or high school) and schedule (block or daily) they had. Differences in time allocation between junior high and high school teachers was not something that was found specifically in the literature, but the analysis of the survey results showed that significant differences did exist between these two groups.

In looking at the differences in responses based off of what level and schedule teachers had, there were some general differences in terms of time spent on homework and quizzes as explained in the results section. However, some of the major differences between groups with different class levels and schedules were between the junior high block when compared to the high school block and junior high daily teachers. Junior high block teachers outweighed both of the other two groups in terms of the percentage of class time spent on student explorations and students sharing solutions or ideas. This result is significant because it shows statistically significant differences in time allocated to these activities both in terms of the level and schedule of the teachers. When holding one of the two variables constant, and just looking at the teachers who teach at the junior high level, those on a block schedule did more SC activities. Also, when just looking at the teachers on a block schedule, those in junior high did more SC activities. This result shows that in general, block teachers and junior high teachers do more SC activities. These differences support the results of the multiple research documents explained in the literature

review (e.g. Buckman, et al. (1995), Evans, et al. (2002)) that there are indeed differences in time allocation between teachers on a block schedule and teachers on a daily schedule. In particular, it supports the idea that teachers with a block schedule spend more time on the SC activities of student exploration and students sharing solutions or ideas. This finding is consistent with the multiple research studies described in the literature review that indicated that teachers on a block schedule may use more projects, hands-on activities, and active learning activities which are more SC activities (e.g. Hurley (1997), Rettig and Canady (2003)). These activities listed from the literature are not exactly the same as student exploration and students sharing solutions or ideas that were found from the results of this study, but they are related.

There may be some possible reasons for the increase in time spent on the two SC activities for teachers on a junior high block schedule. First of all, it may be that junior high teachers spend more time on SC activities than high school teachers because high schools may traditionally be more lecture-based than junior highs, which might have more group activities and other styles of teaching. Assuming junior highs did have more group activities, it could make a transition to PSEAs and other similar activities easier for junior highs than high schools. It is possible that the complexity of the subject matter at the higher levels makes it more difficult to do PSEAs. Alternatively, current high school students may be used to a more traditional teaching style, which may make it harder for high school teachers to transition from a traditional lecture-based mode of teaching to something that is more SC. This difficulty could cause them to abandon attempts at using SC activities and give priority to more TC activities.

Finally, junior high teachers may be more open to changing their styles of teaching and looking for different pedagogical ideas, which may lead to them spending more time on the SC activity of students exploring a task prior to an explanation of the concept. An answer to a later

survey question seems to align with this theory about junior high teachers being more willing to look for different pedagogical ideas. The junior high block teachers generally agreed that PSEAs can be used as a primary means of teaching concepts required by the state, but high school teachers generally disagreed with this statement. This idea of using PSEAs to teach main concepts is a relatively new one, and high school teachers may be more set on using a traditional lecture-based style of teaching, resulting in them giving more priority to TC activities than to SC activities. Again, this possibility could be because PSEAs may be harder to do with more complex material.

Time allocation based on years of experience. Next, the survey results on time allocation based off of years of experience of the teacher will be discussed. The data analysis showed that there were actually no statistically significant differences in time allocation based on the four categories for years of experience. The literature suggested that teachers with more experience ask more cognitively demanding questions (Druva & Anderson, 1983), and for the purposes of this study, more cognitive demand for the students would suggest a more SC activity. The literature also suggested that more experienced teachers showed more variation in the types of teaching strategies and activities they choose to do (Covino & Iwanicki, 1996; Rash & Miller, 2000; Stronge, 2007). However, these possibilities of more SC activities and variation in types of activities used for more experienced teachers could not be seen the survey data on teacher time allocation.

How Much Time Teachers Generally Spend on TC and SC Activities

The survey data on teacher time allocation was analyzed even further to focus specifically on SC vs. TC activities. The SC variable was used to calculate what percentage of time teachers spent on the two SC activities of student exploration of a task *prior* to explanation

of the concept and class discussions driven by the students sharing solutions or ideas. Using this variable, it was found that on average, teachers spent 10.43% of class time on these two SC activities (median of 14.21%). As explained in the theoretical framework, the remaining activities from the survey were considered TC activities for this study; however, some could be considered SC in some instances. This would mean that 89.57% of class time was spent on non-SC activities. We know that some of that time could have been spent on transitions and other activities as mentioned in some of the literature (Sanford & Evertson, 1983). Since this survey did not include questions about transition time or other administrative activities we don't know how much of that 89.57% of class time is spent on those types of activities. We can infer, however, that a large portion of the class time was spent on TC activities. However, this number may be slightly lower if some teachers conduct their problem of the day, review activities, or other activities in a more SC manner. On average, the problem of the day and review activities didn't account for much of the total class time, so these activities wouldn't affect those percentages very much even if the teacher conduct them in a more SC manner. Also, 40.63% of teachers spent 0% of their class time on the SC activities, and the maximum time spent on SC activities was 75%.

It seems that in general, it is not rare for a teacher to spend all of their class time on TC activities, and that around 10% of class time on SC activities is normal. The value of 38.85% is two standard deviations above the mean and was used as the cut off for teachers who have a high SC rating when doing some of the comparisons in the results section. Comparing these results to the literature on math class time allocation, the results of Sanford and Evertson (1983) showed an average of at least 61.34% of class time on TC activities, and Schwerdt and Wuppermann (2011) results showed at least 79% on TC activities. It is likely that the percentage of class time on TC

activities was actually higher for both of these studies, but it was hard to tell from their definitions if the remaining activities were TC or SC. Stigler and Hiebert (1999) actually described a typical math class where 100% of the class time would be considered TC from the definitions used in this study. They did mention that variations that included student explanations (a SC activity) existed, but no data on specific percentages of time were given for these variations. It seems that the results of the survey in this study seem generally in line with these other studies in finding that about 89.57% of class time was spent on TC activities.

The survey data also seemed to give some insight into how much class time on SC activities teachers considered to be "a lot". There was a question asking teachers if they did "a lot" of PSEAs, where teachers had to decide for themselves what "a lot" meant. For the teachers who said they did a lot of PSEAs, the average amount of class time spent on SC activities was 18.40%, while it was 7.51% for those who said they do not do a lot of PSEAs in their classroom. For time spent on student exploration, the average was 10.29% for those who said they do a lot of PSEAS, and 3.67% for those who said they do not. These numbers may provide some ideas of what teachers may consider to be a lot of exploration activities and a lot of SC activities. Also, the average amount of class time on student explorations *prior* to explanations was 10.3% for those who said they did a lot of PSEAs. This result seems to indicate that these teachers consider about 10% of class time on student exploration activities to be a lot.

The results on this PSEAs question showed that there were some teachers whose response on if they did a lot of PSEAs did not seem consistent with their responses on their time allocation. A few teachers spent no class time on SC activities, but said that they do a lot of PSEAs, while a few other teachers had a SC rating higher than 24.64 (1 standard deviation above the mean) and said that they do not do a lot of PSEAs. There are a few possible reasons for these

results. First, as mentioned in the results section, that question on PSEAs was kind of ambiguous and hard to analyze because of the use of the phrases "a lot" and "problem solving exploration activities." The teachers were the ones determining what "a lot" meant. There may be teachers who believe that doing "a lot of PSEAs" implies doing them more often than in math classes that they had as a youth, or than in math classes of other teachers in their school. To them it could mean doing them once or twice a week for a few minutes, or it could mean that 60% of the class time is spent on PSEAs nearly every day. The possible differences in opinion on what it means to do "a lot" of PSEAs could play a big role in the seemingly conflicting statistics for doing PSEAs and the SC variable ratings. Also, not every teacher will think of PSEAs in exactly the same way. For example, some teachers may counting a whole class discussion with the teacher leading the discussion and doing most of the talking as PSEAs, whereas this activity would be considered a TC activity for this study and was not what was intended for PSEAs (a SC activity).

The ambiguity in this survey question could explain why the response of some teachers seemed to conflict with their rating on the SC variable. However, it does not seem to fully explain the 13 teachers who had a rating of 0 on the SC variable, but said that they do a lot of PSEAs. One alternate possibility is that some teachers may think that they are doing a lot of SC PSEAs in their classroom, but in reality, they aren't doing them as much as they think. This could be because teachers just aren't aware of how little time they are really spending on these activities because they get caught up in other activities that take priority, such as grading homework or doing examples. Alternatively, it could be because teachers haven't really captured the full vision of what it means to have more SC activities. This finding that perhaps a few teachers think they are teaching in a certain way, but in reality it is quite different than they think has also appeared in the literature. Stigler and Hiebert (1999) talked about the complex system of

teaching. They pointed out that even though some surface features may change, that doesn't necessarily mean that the underlying, basic nature of the instruction changes. A teacher can change surface features of instruction, such as having students work in groups more often, without necessarily changing the fundamental instruction. This may be the case with some teachers who are thinking they are doing a lot of PSEAs, but in reality, they aren't doing them as much as they think. For example, on the surface the activity may seem like great PSEAs, but lack the SC autonomy that is required for the students to really go through the problem solving process or other features of a good PSEA. This would be the case if the teacher is the one doing most of the explaining and problem solving in the PSEA. One of the most significant results that Stigler and Hiebert (1999) reported that supports this idea is teacher responses on whether they are currently implementing reforms in their classroom (based off of NCTM documents and others). They found that:

> When asked whether or not they implemented reforms in their classrooms, and whether or not we would find evidence of such in the videotape we collected from their rooms, 70 percent of U.S. teachers we asked responded in the affirmative. Teachers even pointed us to specific places in the videos where we could see examples of their implementation of reform… When we looked at the videos, we found little evidence of reform, at least as intended by those who had proposed the reforms. (Stigler & Hiebert, 1999, pp. 105-106)

This example is a very specific case of teachers thinking and reporting that they are teaching one way, when in reality their teaching is quite different than they perceived. The data from the SC variable and the question on if the teacher does a lot of PSEAs were both self-reported, but it could still be the case that teachers think they are doing a lot of PSEAs, when in reality the PSEAs that they are thinking of are more TC because the teacher is the one leading the problem solving and explanations. This possibility could be an alternate reason why some of the teachers said they do a lot of PSEAs, but at the same time they spent 0% of their class time on the SC activities.

Teacher Priorities and Factors Influencing Time Allocation Choices

After looking at how teachers allocate their classroom time, and how much time they allocate to SC activities in particular, this section will discuss what factors influence teacher priorities in that time allocation. As explained previously, some teachers have indicated that it can be difficult to do some activities because they feel that they do not have enough instructional time available, and some may choose to abandon these activities because of it (Cooney, 1985; Foss, 2010; Raymond, 1997; Silver et al., 2005). However, teacher priorities are really what determine which activities a teacher will decide to do with the time that they have available to them. This section will first discuss the evidence of teachers in this study saying that they do not have enough instructional time available to teach in the way that they would want. Next, a discussion on factors influencing teacher priorities in time allocation will be provided, including looking at differences in priorities based on years of experience and SC vs. TC time allocation.

Teachers say they do not have enough class time. There were many examples in the survey data where teachers seemed to indicate that time played a role in teacher decisions about whether or not they would choose to use an activity. For example, there were 131 out of the 224 teachers surveyed (58.48%) that said they would like to do some other activities or styles of teaching in their class, but don't because they require too much class time. When asked what these activities or styles of teaching that they would like to do are, 92 of these 131 teachers (70.2%) mentioned something about doing more activities that involve problem solving, exploration, discovery, or other activities that are similar to PSEAs. Also, regardless of whether teachers were more TC or SC, they still generally agreed that if they had more class time, they would do more PSEAs. Another similar result is that teachers said that they agree to strongly agree (rating of 1.4) with the statement that given double the class time, they would do more

exploration or problem solving activities (this response had the highest rating for the question on what they would do with double the class time). The data also showed that teachers generally agree that they do not have enough time to teach all of the state-required material in the way that they would want because they spend so much time reviewing concepts from previous years. The data showed that in general, teachers feel some sort of push from end of level tests and would like to take more time to cover some topics that are not part of the state requirements as well.

It is clear from this data that generally teachers do say that there are some activities or teaching styles that they would like to use in their classroom, but don't because of some perceived time constraints in the class. In particular, most teachers said that it is PSEAs or something similar that they would like to do more often. However, as the data has shown, there *are* teachers who are able to do PSEAs in their classroom, and some of them spend as much as 50% percent of their class time on them. So while class time is a major reason that teachers cite for why they do not do PSEAs and other activities that they would like to do, in reality, if teachers gave higher priority to the PSEAs or other activities that they would like to do, then that is where they would choose to spend their class time.

Differing priorities based on experience. There were some differences in teacher priorities based off of how many years they have been teaching. In splitting up the data based off of the years of experience, it was surprising to see that there were no statistically significant differences in how teachers allocated their time in the classroom. However, there were differences in some of the answers to other survey questions, leading to some indications about why they allocate their classroom time the way that they do and factors influencing their priorities in their time allocation. It was also very surprising to see that most of these differences

that did arise were between the two middle groups with 4-10 years and 11-20 years of experience, rather than between the group that had 0-3 years of experience and the other groups.

Looking at some of these actual differences, with teachers who said they do a lot of PSEAs but find them challenging for certain reasons, there were quite a few differences between the group that had been teaching for 4-10 years and the 11-20 years group. The 4-10 years group *strongly* disagreed that it was challenging because of the difficulty of concepts or student questions that may arise, but the 11-20 group only slightly disagreed with this statement. This result may indicate that the 11-20 group is a little more unsure of their ability to handle these difficult concepts or student questions that may arise. Other differences between these groups is that the 11-20 group tended to agree that it is hard to do PSEAs because of planning time and also because of rowdiness and discipline, but the 4-10 group didn't seem to have problems with planning time and rowdiness in PSEAs. There are a couple of possibilities that could account for these three differences in responses. First of all, it could be that those who have been teaching longer are used to a more traditional style of teaching, and these are a few of the main places where they have noticed a difference between the two styles of teaching. The social norms in a class with more PSEAs are usually much different from those in a traditional classroom, and these new norms could cause some discomfort with noise level in the classroom and other similar discomforts. Second, it could be that the teachers who have been teaching for 11-20 years haven't seen as many examples of what PSEAs should look like and how they should be done. This second possibility, however, did not seem so show up in the survey question regarding this idea. There was no statistically significant difference on a question regarding PSEAs being difficult because they haven't seen very many examples of what it should look like and how it should be done. However, this may still be an issue that the older group of teachers may not

realize. It may be that the group that has only been teaching for 4-10 years may have gotten their degree more recently, and been taught more about how to have a SC classroom and implement PSEAs in the classroom. This recent preparation for SC instruction could enable them to be more prepared to answer difficult student questions, not have as many issues with rowdiness and discipline, and know where to find curricular resources and cut down on planning time.

There was another significant difference between beliefs of the 4-10 years group and the 21+ years group on whether PSEAs are difficult because it is hard for students to discover complex math ideas on their own was significant. The 4-10 group slightly disagreed, whereas the more experienced 21+ group agreed with this statement. This result tells a lot about the beliefs of the teachers. Similar to what was described in the previous paragraph, this result may have to do with the fact that the group that has been teaching for 4-10 years most likely went to school more recently than the 20+ group, and has therefore probably had more exposure to these new ideas and a more SC style of teaching. Those who have been teaching for 20+ years are probably more set in their traditional ways of teaching and have set beliefs that have not been altered as much by recent reform movements in mathematics education.

Leading factors influencing teacher priorities. As explained in the theoretical framework, every teacher has the same amount of time available. If a teacher thinks that SC activities are better than TC activities, then the teacher will choose to spend their class time on SC activities. However, if TC activities have more priority, then a teacher may not want to give up time spent on those activities in order to spend time on SC activities. Using the analogy from the theoretical framework, when someone says they didn't have enough time to go to the store and buy groceries, it is not that there was literally not enough time in the day for them to buy groceries, but rather that other activities took priority. We can also look at an example of the

teacher priorities from the survey data. According to the data, the activity that teachers spent the most time doing in the classroom is going over examples to explain a concept. Teachers generally did *not* spend much time on students sharing solutions and explaining. In general the teacher activity of going over examples to explain a concept took priority over students sharing solutions and explaining. This explanation shows that while teachers may say that they don't have enough time to do SC activities or other activities, in reality it is their priorities that are preventing them from doing those activities.

Similar to the ideas explained in the previous paragraph, Silver, et al. (2005) hypothesized that there were actually underlying reasons, other than time, that teachers choose not to allocate time to certain activities in their classroom. The following section outlines the factors influencing teacher priorities in their time allocation that may deter teachers from doing more SC activities in their classroom. These factors can almost be thought of as things that a teacher considers when deciding if an activity is worth doing or not, and these factors all weigh against one another in order to decide how a teacher will prioritize activities.

The top four factors that teachers identified as to why they choose to allocate time to the activities that they do were that those activities would help students with their end of level tests, the activities keep students working hard mathematically, they have seen others teach using those activities (including coworkers or their past teachers), and the activities make it easier to manage the class in terms of rowdiness or discipline. These reasons are much different than the reasons that Silver, et al. (2005) hypothesized as to why teachers weren't doing a particular style of teaching. That study mentioned "concerns about the adequacy of their own content knowledge and about their unfamiliarity with instructional routines that might allow them to become proficient in this aspect of innovative teaching practice" (Silver et al., 2005, pp. 295-296). If

these factors were the major factors affecting teacher priorities, it should have been indicated in some of the other responses on why they allocate class time the way that they do, such as "I have always taught using those activities and feel comfortable with them." While teachers did indicate that these were some of the factors that influence which activities they give priority to, they did not rank as high as the four factors listed previously. It is important to note that there is a slight difference here in the topic being discussed, because the top four factors outlined above are on why teachers choose to spend time on the instructional strategies that they do, not why they *don't* spend time on certain activities as Silver, et al. (2005) is hypothesizing about. However, there may still be some overlap. Particularly, teachers cited seeing others teach using those activities as one of the main deciding factors, and also ease of managing class rowdiness. Both of these are influencing factors that could be related to the suggestions of Silver, et al. (2005) that teachers are concerned about their unfamiliarity with the instructional routines. If teachers haven't seen others using a particular type of instruction, they would be unfamiliar with it. Also, if a teacher is more unfamiliar with a particular style of teaching, it is likely that the class will be harder to manage.

Factors influencing priorities for TC vs. SC teachers. The main interest in this study was not just to know what factors influence teacher priorities in their time allocation in general, but rather to know what factors influence whether teachers choose to do SC activities. Looking at some of the correlations between the SC variable and the other survey responses can help identify some of these factors. The results from the correlation data with the SC variable and the survey responses is very significant because it shows that when the data is divided based off of teacher time allocation (SC variable), different sets of factors that influence their priorities in time allocation emerged.

One factor that can be seen in the differences between more SC and more TC teachers is that of requiring students struggle with the mathematics. I consider this a factor that influences time allocation because a teacher may say "I choose to do the activities I do because it does/doesn't require students to struggle with the mathematics." The responses on the survey questions seem to indicate that teachers who are more TC do not really want to choose activities that require their students to struggle with the mathematics; however, the more SC teachers do find value in those types of activities. For example, the more SC teachers saw more value in having students try to solve math problems before being shown similar problems and solutions than the more TC teachers. Also, the more TC teachers said that they spend a lot of class time going over examples and having students work on homework, because it is a problem if students leave class not knowing how to solve all of their homework problems, whereas more SC teachers disagreed with this statement. This factor is related to the basic definitions of what it means to be SC and TC, so this factor may not seem very surprising. This factor of having students struggle with the mathematics can also be seen in the survey question about math PSEAs being accessible for most students in terms of difficulty, and in general, the more TC teachers disagreed with this statement, while the more SC teachers agreed that they are accessible. TC teachers may not want to do those activities in their class if they feel they are too difficult for the students and would require them to struggle mathematically.

There were many other factors that came from the data that may affect teacher priorities where more TC teachers and more SC teachers had differing views. In general, the more SC a teacher was, the more they tended to care about the factor of keeping their students *mathematically* motivated. The more SC teachers didn't care about the factors of doing activities that they have done in the past and feel comfortable with, that there are a lot of curriculum

resources for, and that are easier to do preparation and planning for, whereas the more TC teachers did care about these factors. The more SC teachers also cared less about doing review and how much class time an activity takes. Finally, the more SC teachers agreed that PSEAs are easy to manage in terms of student behavior, whereas more TC teachers disagreed with this statement. The TC teachers may not want to do PSEAs partially because they think that they are difficult to manage. In looking at these differences, the more SC a teacher was, the more they cared about the mathematics of the activities that they choose to do; however, the more TC a teacher was, the more they seemed to be concerned with the factors of ease, comfort, and convenience of an activity.

This factor of personal comfort level of the teacher can be applied in the opposite way to the SC teachers. In general, the more SC a teacher was, the less they cared about their own personal comfort level. This can be seen in the preparation and planning time aspect of activities. The more SC teachers did not care as much about preparation and planning time, even though their mode of teaching may require more planning time in general. In the interviews and survey responses on what makes PSEAs difficult, teachers indicated that planning time seemed to be a major reason that they may be difficult. Those who have a more SC style of teaching indicated that they don't really care about the factor of planning time when they are thinking about what activities to give priority to. It seems that these teachers still choose to give priority to the SC activities even though they may take more planning time because there are other factors that they care about more than the factor of planning time.

Something that goes along with the teacher's personal comfort level is how similar their style of teaching was to other teachers (both in their school and that they had growing up). The more TC teachers seemed to rate much higher on these cultural factors. In order to adopt a style

of teaching different from your mentors or peers, it would most likely require discomfort in trying to adapt to a new teaching style, and also a lot of preparation time to study about the new teaching style and find or develop curriculum resources for it. Both the personal comfort level and required preparation time were factors that the more TC teachers were more concerned about, which may cause their teaching to be more similar to that of their peers or mentors. Whereas the more SC teachers were not as concerned about their personal comfort level and required preparation time, so they may be more willing to deal with these consequences of trying to work with a new teaching style.

Another factor that the more TC teachers were more concerned about than the more SC teachers was how much time an activity takes to do in class. This result could indicate a few different things. First of all, it could indicate that the more SC activities actually *do* require more class time in general, but that the more SC teachers value the SC activities enough that they are willing to invest the time and give priority to those activities anyway. At the same time, it could indicate that the more TC teachers cares significantly about the amount of class time an activity takes, so they may choose to not do a time-consuming activity even though it may be a good mathematically stimulating activity. This would indicate that the teacher may care more about the factor of amount of class time an activity takes than they do about the factor of how mathematically stimulating an activity is or some other factor that they may see as being beneficial about the time-consuming activity.

One other difference between the more SC and more TC teachers has to do with the idea of review and its relation to the more TC teachers being more concerned about the factor of how much time activities take. The more SC teachers didn't feel as much of a need to do review as the more TC teachers. This result could be because of an underlying belief about review or the

method of teaching, or it could be because the more SC teachers feel that their style of teaching does not require as much review time. This result is something that might cause the more TC teachers to feel like they do not have as much time to do PSEAs and other SC activities, because they might feel like they have to spend a certain amount of time reviewing. If teachers are trying to follow the pattern of a traditional TC math class, and then *on top* of that add in more PSEAs and other SC activities, then of course they will feel pressed for time and be more concerned about how much time activities take. However, if the SC activities are seen as a *replacement* of previous TC activities, teachers may not feel as worried about the amount of time that the activities are taking.

There were many differences in the factors that the more SC teachers cared about when compared to the more TC teachers. In general, the more TC a teacher was, the more they cared about the factors of not having their students struggle with the mathematics, the level of comfort they personally feel with the activities, how easy the activities are to prepare for (including the availability of curriculum resources, as well as having seen other teachers use those activities), time required, and ease of management with student behavior/discipline. The more SC a teacher was, the more the teacher cared about the factor of having activities that are mathematically motivating for the students.

All of these differences in survey responses between the more SC and more TC teachers seem to indicate that the more SC teachers believe so strongly in the benefits of doing PSEAs and other SC activities, that they do not worry so much about personal comfort, required preparation time, required class time, and other similar factors. They care about the factor of activities being mathematically motivating, and choose to give priority to the SC activities regardless of some other factors that may cause teachers to give priority to more TC activities.

Conclusion

The way the majority of teachers currently allocate their class time is fairly consistent with a traditional style of teaching. In general, teachers allocated most of their class time to teacher explanations (through examples or other means), students solving problems after concept explanation or working on homework, and going over the previous night's homework. Variation was found in time allocation by looking at different groups of teachers. Differences in time allocation and rationales emerged from looking at what type of class schedule they had and what level teachers taught at. Also, the literature indicated that there may be differences in time allocation based off of the years of experience of the teacher; however, there were not any statistically significant differences found in the survey results on time allocation based on experience levels. In looking at how much class time was typically spent on SC and TC activities, on average teachers spent about 10% of their class time on SC activities, and 40.63% of teachers spent 0% of their class time on SC activities.

Teacher priorities are what determine how teachers will choose to allocate their classroom time. If a teacher cares more about a classroom activity being cognitively demanding mathematically for their students than they do about the possibility of extended preparation time that activity may take, then the teacher will decide to do it. Also, if a teacher places priority on daily quizzes, doing examples for concept development, having students work on homework in class for extended periods of time, and other activities, it is likely that SC activities will get placed to the side. Teacher priorities in time allocation and the factors that influence those priorities are what really determine teacher time allocation in the classroom.

The top four factors that influence teacher priorities in time allocation that were found in this study are: those activities would help students with their end of level tests, the activities keep

students working hard mathematically, they have seen others teach using those activities (including coworkers or their past teachers), and the activities make it easier to manage the class in terms of rowdiness or discipline.

There were also differences in influencing factors based off of whether a teacher was more SC or more TC. In particular, the TC teachers cared more about not having their students struggle with the mathematics, the level of comfort they personally feel with the activities, how easy the activities are to prepare for (including the availability of curriculum resources, as well as having seen other teachers use those activities), and ease of management with student behavior/discipline. All of these factors have one common theme in them, and that is ease for the teacher. If students are struggling with the mathematics, it will be more difficult for the teacher (even if it is a productive, connection building kind of struggle). Also if teachers have to deal with behavioral issues it the activity will not be as easy for them to carry out in class. Finally, if teachers are not familiar or comfortable with the teaching activity, or if they have to spend extra time preparing for the activity, then it will not be as easy for them. In generally it was found that the more TC a teacher was, the more tended to choose activities based on how easy they were for them to prepare and implement. However, the more SC a teacher was, the more they tended to choose activities based on whether they kept students working hard mathematically.

Implications

One of the major results of this study is that there are many underlying factors that affect teacher priorities in time allocation. Some of these factors could cause teachers to not use certain types of activities in the classroom, even though they may see them as effecting teaching tools. If teachers don't see the benefits of the teaching activity as much as they see certain complicating factors (such as added difficulty in management or preparation), then they are likely to not use

those activities. One implication of this result is that in order to really transform teaching in order to follow NCTM recommendations, or to create more SC classes, these underlying issues that are holding teachers back need to be addressed.

Teachers should be encouraged to examine their own personal classroom time allocation and factors influencing their priorities in time allocation. Are they choosing activities because they require more cognitively demanding mathematical work from their students? Or are teachers more concerned about the other issues of personal comfort, preparation time, required class time for activities, end of level tests, and other similar issues as found in this study? As teachers examine their own rationale for how they allocate time in their classroom, hopefully they can move towards more meaningful and important reasons for their choices that focus more on students learning mathematics. This self-examination can improve teaching by helping teachers evaluate their priorities and find ways to do the activities that they believe are most beneficial for students.

Not only should teachers examine their own reasons for how they allocate their time, but researchers, curriculum developers, and others who have an effect on the mathematics education community should also be aware of these reasons for how teachers choose to allocate their time and why they choose not to allocate time to certain activities. It may be true that teachers would probably allocate more time to SC activities if they understood more of the benefits of the SC activities, and if the importance of these benefits outweighed the effects of the hindering factors in the minds of those teachers. However, there are still steps that could be taken to address some of these factors hindering implementation. In particular, this study found that personal comfort of teachers and required preparation time were two factors that were related to whether teachers did a lot of SC activities in their classroom or not. If teachers are provided with better examples of

what teaching using SC activities or NCTM recommendations actually looks like, it could alleviate some of that personal discomfort. Also, teachers need a greater amount of good curriculum materials for this type of instruction. That was clear from the interviews as well as from the surveys. This increased quantity of good resources could greatly diminish the required preparation time for this type of instruction, and encourage more teachers to implement it in their own classrooms.

Similar to what was done in this study, researchers should continue to look for reasons why teachers are not allocating classroom time in the way that they would in an ideal situation. Then solutions can begin to be addressed, and lasting change and improvement can be made in mathematics education.

Limitations of the Study

One of the main limitations of this study is that it was done in only 5 school districts in Utah. It provides good insight and results, but it is important to keep in mind that the results may not be comparable across the U.S. Also, a major limitation of this study is that most of the data collected was teacher-reported from a survey. The survey itself creates some potential problems because the survey may include some bias, although this bias was minimized through feedback from others during the creation and piloting of the survey. Also, given the variation in teachers, not every teacher is going to interpret every part of the survey in the exact same way. Again, the survey was written and piloted in order to minimize ambiguity, but of course it will still exist to some degree. In particular, some of the seemingly inconsistent results on teachers' self-reports on whether they do a lot of PSEAs or not could be due to ambiguity of the question as mentioned previously. However, the data was analyzed and interpreted in a way that this problem was mitigated. These self-reported survey results are also limited because of the bias and limitations

of the teachers taking the survey. Self-reported data always has limitations, and in this particular study, teachers' perceptions on their own time allocation could differ from what they really do in the classroom.

Future Research

Based on the results of this study, on average teachers spend about 10% of their class time on SC activities. One possible place of future research for this study could be to look at the trends in the SC variable over time. This research could be done by repeating this study in future years and comparing the results on the SC variable over time. It could also be done by selecting particular teachers who are attempting to become more SC teachers, and tracking their individual ratings on the SC variable over time. I think it would be interesting to see if the average rating on the SC variable increases over time as teachers become more familiar with teaching from a SC perspective, as teacher education evolves to become more SC, and as more SC curriculum resources are developed to help minimize preparation time.

It would also be helpful to know how teacher time allocation relates to student success rates. While some research may already exist on this subject, comparing student test scores to teacher ratings on the SC variable would be particularly insightful. This research could help teachers identify not only the basic types of activities that would be most helpful for them to use in the classroom, but also the nature of those activities (whether SC or TC).

Further research could also be done on teacher time allocation in other areas of the United States and even other parts of the world. There may be differences in ratings on the SC variable in particular for these different groups of people.

Another place for future research could be in looking at the effects of class size and level of student ability on teacher time allocation and rationale. These were two items that multiple

teachers mentioned in the additional comments section of the survey that were not directly analyzed in this study. Teachers mentioned that since their class size is so large, they can't do as many PSEAs or other activities as they would like. Also, there were some teachers who were teaching remedial classes or in largely at-risk schools who mentioned that these factors affected their time allocation, and in particular was a reason why they chose not to do PSEAs in their classroom.

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Appendix A

Interview Questions

1) In your class you (explain how they allocated time). Is this how you typically allocate time for your math classes? Have you always allocated classroom time this way, or has it changed over the years?

2) In your class you (explain how they allocated time) [Or just follow-up of question 1]. Why would you say that you have chosen to allocate time this way?

3) During your class you spent ____ minutes on ____ … why did you choose to allocate so much/little time to that?

4) What kinds of things do you consider or think about when you are deciding how to allocate your time in the classroom?

5) How much would you say time influences your lesson planning? In what ways does it influence your lesson planning?

6) Are there other types of activities that you would like to do more often in your class but don't? If so, why do you not do them more often?

7) If a student asked a question or made a comment in whole group discussion that seemed to either be a little off topic or even slightly incorrect, but could still lead to a good mathematical discussion, how would you respond to that? (Ex: tell them you will talk to them about it later, talk about it then and go into a big discussion, have a small discussion about it, explain to the student that it is off topic/incorrect and move on)

→ How much time would you spend? Why?

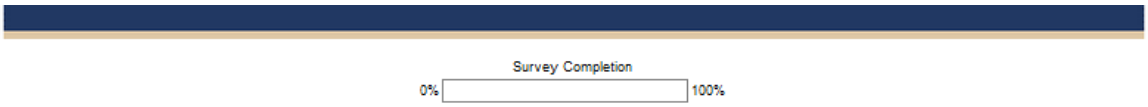
8) Some teachers claim that they don't have their students do <u>exploration activities</u> because they don't have enough time. Do you agree with this justification? Have you had experiences to

support this claim? Do you think there could be other reasons for teachers not doing exploration activities? If so, what could these other reasons be?

9) Some teachers claim that they don't have their students justify claims or explain concepts for classmates because they don't have enough time. Do you agree with this justification? Have you had experiences to support this claim? Do you think there could be other reasons that teachers do not have their students justify claims or explain concepts for classmates? If so, what could these other reasons be?

Appendix B

Final Survey Questions



D1. How many years have you taught mathematics? Include years taught at any level.

D2. Have you taught any subjects in public schools other than mathematics?

- Yes
- No

D2-B. Which other subjects have you taught?

D3. Mark the level of your current primary teaching responsibilities.

- Junior High/Middle School
- High School

D4. Please mark the math classes have you taught.

- Math 7
- Pre-Algebra
- Algebra
- Geometry
- Algebra II
- Pre-Calculus
- Calculus
- Secondary I
- Other:

D5. Please complete the following statement:

I currently teach in a school that has _____.

- A block schedule (70 to 90 minute class periods that meet every other day)
- A daily schedule (45 to 50 minute class periods that meet every day)
- Other: (please describe)

D6. How many minutes long is a typical math class period that you teach?

D7. Describe the textbook series that you use for most in your math classes (ex: Name, Author, Publisher, etc.)

Survey Completion

0% 100%

Q1. During a typical math class period, approximately how much time do you devote to each of the following activities? Please make sure that the sum of the minutes is _____ minutes (as entered previously).

(It may be helpful to briefly look over all of the categories and then answer the question)

	Number of Minutes
Problem of the day	0 minutes
Daily quiz	0 minutes
Reviewing previous material	0 minutes
Going over previous night's homework	0 minutes
Teacher doing examples to explain a new concept (can include some help from students)	0 minutes
Teacher explains new concepts (definitions, formulas, etc) at the board while students listen and ask questions if needed - Do not include doing examples here	0 minutes
Student exploration of a task posed by the teacher **prior** to an explanation of the concept	0 minutes
Students solve problems posed by the teacher **after** an explanation of the concept	0 minutes
Class discussion driven by students sharing solutions or ideas	0 minutes
Students working on homework in class	0 minutes
Other:	0 minutes
Other:	0 minutes
Total	0 minutes

Q2. Referring to the typical class period that you described in the previous question, mark the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My classroom time allocation is similar to that of most other math teachers in my school.	○	○	○	○	○
My classroom time allocation is similar to that of most math teachers that I had when I was taking those same math classes.	○	○	○	○	○

Q3. To what extent do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
How much class time a certain type of activity or style of teaching takes greatly influences whether or not I choose to do it in my class.	○	○	○	○	○
I devote **most** of my class time to going over examples and having students work on homework because I believe it is a problem if students leave the class not knowing how to solve all of their homework problems.	○	○	○	○	○
It is valuable to have students solve math problems **before** they have been shown similar problems and solutions.	○	○	○	○	○
I feel like I don't have enough time to teach all of the material that the Utah Core requires in the way that I would want because I spend so much of my class time on reviewing concepts from previous years.	○	○	○	○	○
Over the course of the school year, I typically leave out some of the material from the Core in order to spend more time talking about certain topics more in depth.	○	○	○	○	○

Q4. To what extent do you agree or disagree with the following statement?

There are some activities or styles of teaching that I would like to do in my classroom, but I don't do them because they require too much class time.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

Q5. To what extent do you agree or disagree with the following statements?

I choose to spend my class time on the activities that I do because _____.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The activities keep students working hard mathematically	○	○	○	○	○
The activities keep students motivated because they are fun	○	○	○	○	○
I have seen others teach using those activities (including co-workers and your past teachers)	○	○	○	○	○
I have always taught using those activities and I feel comfortable with them	○	○	○	○	○
It is easier to do preparation and planning for those activities	○	○	○	○	○
Those activities make it easier to manage the class in terms of rowdiness or discipline	○	○	○	○	○
Those activities will help the students with their end of level tests	○	○	○	○	○
There are a lot of curriculum resources available for those activites	○	○	○	○	○

Q6. Given twice the amount of time to teach each class (still teaching the same number of school days), there are many things that teachers would do differently. To what extent do you agree or disagree with the following statements?

Please think of what you actually would do, not what you think you should do.

If I had twice the amount of time to teach each class, I would _____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Start the next section	○	○	○	○	○
Increase practice or homework time	○	○	○	○	○
Review more	○	○	○	○	○
Do more exploration or problem solving activities	○	○	○	○	○
Cover topics that are not included in the common core	○	○	○	○	○
Do more daily quizzes	○	○	○	○	○

Q6-B. Are there other activities not listed in the previous question that you would do if you had twice the amount of time to teach each class? If so, please list them in order of preference, with the first one listed having the highest priority.

- ○ No, I would not do any activities other than the ones listed in the previous question
- ○ Yes, I would do the following activities:

Q7.
Which of the following best describes your time allocation to problem solving exploration activities in your math classes?

- I do not want to do problem solving exploration activities in my classes
- I would like to do more problem solving exploration activities in my classroom, but don't because of certain reasons
- I already do a lot of problem solving exploration activities in my class, I find it challenging to do them (either in class or preparing for them)
- I already do a lot of problem solving exploration activities in my class, and I do not find it challenging to do them (either in class or preparing for them)

<< >>

IF choice 1 on Q7 →

Q8. As a follow-up to your response to the previous question, please indicate to what extent you agree or disagree with the following statements.

I do not want to do problem solving exploration activities in my math classes because _____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I do not think that they are valuable					
It is an unrealistic way to teach math concepts because it takes too much class time to develop the concepts					
It is too difficult for students to discover complex math ideas on their own					

IF choice 2 on Q7 →

Q8. As a follow-up to your response to the previous question, please indicate to what extent you agree or disagree with the following statements.

I would like to do more problem solving exploration activities in my math classes, but don't because _____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
There aren't enough curriculum resources available for teachers					
I haven't seen good examples of what it is and how it can be done					
I am not sure that I can handle the concepts or student questions that may arise					
There is too much planning time involved					
Other teachers aren't doing problem solving exploration activities					
It is harder to manage the class in terms of rowdiness or discipline					
It does not teach what the students will be tested on for end of level tests					
It is too hard to do on a block schedule					

(or daily/other entry schedule based off of D5)

Parents would get upset and complain					
It may be too difficult for the students to transition to doing problem solving exploration activities					
It is much more difficult to teach in that way					
It takes too much class time to develop the concepts					
It is very difficult for students to discover complex math ideas on their own					

IF choice 3 on Q7 →

Q8. As a follow-up to your response to the previous question, please indicate to what extent you agree or disagree with the following statements.

I already do a lot of problem solving exploration activities in my class, and I find it challenging to do them because _____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
There aren't enough curriculum resources available for teachers					
I haven't seen good examples of what it is and how it can be done					
It is difficult to handle the concepts or student questions that may arise					
There is too much planning time involved					
Other teachers aren't doing problem solving exploration activities					
It is harder to manage the class in terms of rowdiness or discipline					
It does not teach what the students will be tested on for end of level tests					
It is hard to do on a block schedule					

(or daily/other entry schedule based off of D5)

Parents get upset and complain					
It is difficult for the students to transition to doing problem solving exploration activities					
It is much more difficult to teach in that way					
It takes too much class time to develop the concepts					
It is difficult for students to discover complex math ideas on their own					

Final questions for all survey takers

Q9. To better understand your time allocation to problem solving exploration activities, please rate the following statements as to the extent with which you agree or disagree with them.

Mathematics problem solving exploration activities _____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Are fun for most of my students	○	○	○	○	○
Are easy to manage in terms of student behavior	○	○	○	○	○
Can be used as a primary method of teaching Utah Core math concepts	○	○	○	○	○
Should be used mainly for teaching supplementary math concepts (not in the Utah Core)	○	○	○	○	○
Are accessible for most students in terms of difficulty	○	○	○	○	○
Are easy to find curriculum resources for	○	○	○	○	○

Q10. Please provide any additional comments you have on how you choose to allocate time in your math classroom.

<< >>

Appendix C

First Draft Survey Questions

1) What kinds of things do you consider when you are determining how much time to spend on each activity you do during a lesson?
2) How much would you say time influences your lesson planning? In what ways does it influence your lesson planning?
3) As you make decisions about what activities you want to do in a lesson, what role does time play in making those decisions?
4) If your class time was shortened significantly for a day, and you only had 15 minutes of class time available, what would you do to teach students the material? Whole group instruction of formulas? Concepts? Practice HW? Problem solving?
   -- Why?
5) If you spent five minutes on each of the following activities, which would be the most helpful for the students? Why?
6) If you only had one student to teach, what would you do differently? Would your time allocation change? Are there things that you would stress more or spend more time on?
7) If you only had 15 minutes to teach a lesson on linear functions, what would you do? What would you emphasize/teach and how? Why?
8) If you had twice the amount of time to teach each day, what would you do differently? Why? (I want you to honestly tell me what you think you would do, not what you think you should do.) → Possible answers: Start the next section, increase practice/hw time, review, more exploration or problem solving activities, unrelated mathematics enrichment activities, etc
   -- Is this different than what you would you *Want* to do? Is this different than what you think you *Should* do? If these three are different, why?
9) On average, what percentage of the sections in the textbooks do you try to cover each year? If this is not the full textbook, then what are your top 3 reasons for not covering the full textbook? (ex: go slower through the material so that students understand more → not enough time for some sections, some sections don't really seem relevant/important, some sections are too difficult for the students, some sections are too easy for the students (review from previous years), etc) **→ These questions get more at yearly time-allocation & time constraints…**
10) Given a 60 minute class period, on an average day, how much time would you devote to each of the following activities?
    - Problem of the day or review from previous days
    - Going over previous night's homework
    - Developing concepts (meaning introducing students to the new ideas for that lesson so that they are then prepared to do that night's homework. This does not include going over examples, but can include working on tasks)
    - Going over examples
    - Students work on homework in class

    -- In each section below, say "In question ___ you said that given a 60 minute class period, on an average day, you would devote ___ minutes to _(activity)_. Why would you devote this amount of time to _(activity)_? Why do you feel that this is not too much or too little time?

11) Think of a lesson from the last day that you taught. During that lesson, what percentage of the time would you say was devoted to each of the following activities?
    - Problem of the day or review from previous days
    - Going over previous night's homework
    - Developing concepts (meaning introducing students to the new ideas for that lesson so that they are then prepared to do that night's homework. This does not include going over examples, but can include working on tasks)
    - Going over examples
    - Students work on homework in class

12) What percentage of class time would you say is taken up by each of the following:
    - Teacher talking about math
    - Students talking about math
    - Students working on problems as part of concept development (doesn't include homework)
    - Students working on problems as part of homework

13) If you had as much time as you wanted to teach a given lesson (time not being a limiting factor), would your time allocation in your lesson designs stay the same or change? If it would change, in what ways and why? What kinds of activities would you spend more/less time on.

14) Rank the following activities based on what you view as the most valuable activities for helping students learn mathematics.
    - Going over previous homework
    - Reviewing past material
    - Students working on problems <u>individually</u> **<u>before</u>** they have been shown similar problems/solutions
    - Students working on problems in <u>groups/pairs</u> **<u>before</u>** they have been shown similar problems/solutions
    - Teacher providing definitions and formulas for students
    - Teacher explaining examples of a learned formula/concept
    - Students justifying/explaining their thinking/reasoning to a partner or to the class
    - Students working on homework problems **<u>after</u>** they have been shown similar problems/solutions
    - (OTHERS??)

<u>Class Activities</u>

<u>HW review</u> **<u>(TC/SC)</u>**

15) In the time that you spend going over homework, who talks most of the time? Who gives the solutions? Do you spend time as a class talking about *why* <u>all</u> of the answers are correct, just the <u>difficult</u> questions are correct, or just go over answers to all of the problems without discussion of why?

<u>Concept development (doesn't include doing examples)</u>

16) Would you say that practice is more important or concept development? Why? (Also under practice)

17) What is the nature of the whole-class discussions/explanations in your class? Are they usually:
    - Students explaining their thinking or discussion mathematics

- Teacher explanation with frequent moments of student input (solving problems & explaining, or teacher just asking what 20/4 is and students say 5…)
- Teacher explanation with little or no student input

*** What is the rationale behind this choice?

18) How do you present new material and develop concepts?

19) What percentage of the time spent developing concepts would you spend on each of the following activities? (does not include students working on homework or time doing examples)
- Teacher providing definitions
- Students discussing or providing suggestions for definitions
- Students working on problems or tasks *in groups/pairs* with little or no teacher input
- Students working on problems or tasks *individually* with little or no teacher input
- Teacher providing formulas
- Students creating or discovering formulas

→ Student's sharing thinking and/or student exploration (group or class) **(SC)**

20) If a student asked a question or made a comment in whole group discussion that seemed to be off topic but could still be fruitful mathematically, how would you respond to that? (tell him you will answer it later, answer it then, tell him that does not relate to the current lesson, etc).

-- How much time would you be willing to devote to a student question/comment during whole-group instruction?

-- Why?

→ Teacher explanation **(TC)**

21) Some teachers claim that they don't have their students do exploration activities because they don't have enough time. Do you think that this is the reason why some teachers don't do exploration activities, or do you feel that there are other reasons?

22) Some teachers claim that they don't have their students justify claims or explain concepts for classmates because they don't have enough time. Do you think that this is the reason why some teachers don't have their students justify claims or explain concepts for classmates, or do you feel that there are other reasons?

23) Other than time, what factors influence your decision of whether you are going to explain a concept or have students explain and/or explore?

Doing examples **(TC)**

24) How important would you say it is to do examples for or with the students? Why?

25) How many examples do you usually go over and how long does each one usually take? Why do you do this many of examples?

26) What kinds of things do you usually focus your time on when going over examples? Do you mainly focus on the list of steps needed to solve the problem, or on the meaning behind the process?

Practice (doing HW) **(TC/SC)?**

27) Would you say that practice is more important or concept development? Why? (Also under concept development)

You said in question ___ that in a 60 minute class, you would spend ___ minutes on homework…

28) How long do you expect students to work on homework outside of class each night?

29) What are the benefits of having students do homework in class?