Mathematics Teachers' Views of Accountability Testing Revealed through Lesson Study

Connie H. Yarema
Abilene Christian University

The practice of lesson study, a professional development model originating in Japan, aligns well with recommendations from research for teacher professional development. Lesson study is also an inductive research method that uncovers student thinking and, in parallel, grants teacher-educators the opportunity to study teachers' thinking about related issues. One issue for teachers in North America is the focus on student achievement measured through accountability testing. The purpose of this article is to describe how lesson study elicits teachers' views, knowledge, and practices. To illustrate how teachers' thinking emerges during lesson study activities, the paper will outline four different views of accountability testing revealed by grades 6-10 mathematics teachers from nine different independent school districts in West Texas during various phases of lesson study. In addition, how each view influenced the teaching of students, as noted by teachers during post-lesson discussions from three different lesson studies during 2006 – 2009 is reported. Descriptions of interactions among these teachers and higher education faculty housed in mathematics and teacher education departments at a local university and teachers' self-reported reflections along with changes in practice are included.

"Teach to the test!" For mathematics educators, the phrase carries both positive and negative connotations. Some view "teaching to the test" as a narrowing of the curriculum; that is, assessment items on past tests become the basis for the curriculum. For others, the phrase conveys alignment of assessment with curriculum (Cohen & Ball, 1999). Either way, "teaching to the test" correlates to measuring student achievement by testing as a gauge of accountability for schools. What views, then, do mathematics teachers hold about accountability testing? How do their views influence instructional choices in their classrooms? What changes in practice do teachers who discuss their views with other teachers and mathematics teacher-educators on an ongoing basis report?

Grades 6-10 mathematics teachers in West Texas offer answers to these questions as they participated, along with local university mathematics and teacher education faculty, in three different year long Lesson Studies during 2006 – 2009. The purpose of this paper is to describe teachers' views about accountability testing, its influence on teaching choices, and how the lesson study process elicited their thinking on this topic. In doing so, the paper provides an illustration of how Lesson Study activities grant mathematics teacher-educators the opportunity to study teacher's thinking and, at the same time, to challenge teachers to reflect on their views within the setting of a community devoted to instructional improvement.

Theoretical Framework

Lesson Study as Professional Development

Lesson Study is a professional development model originating in Japan whereby teachers collaboratively research the effects of a lesson on student learning of some difficult topic. Educators in Western countries became aware of Lesson Study through an account of the 1995 Third International Math and Science Study (TIMMS) (Stigler & Hiebert, 1999) and other writings that explain Lesson Study and its use in Japan (Fernandez, 2003; Fernandez & Chokshi, 2002; Fernandez & Yoshida, 2004; Isoda, Stephens, Ohara & Miyakawa, 2007; Lewis & Tsuchida, 1998; Lewis, 2002a; Takahashi, 2000). In essence, teachers participating in a Lesson Study process complete eight activities: 1) set goals; 2) investigate curriculum; 3) plan a unit and develop a research lesson; 4) teach the research lesson to their students while others observe and gather data, 5) debrief during a post-lesson discussion; 6) revise the lesson; 7) repeat the teach-observe-debrief-revise cycle; and 8) write a final report about what was learned (Lewis, 2002b; Perry, Lewis & Akiba, 2002; Takahashi & Yoshida, 2004). The collaborative nature of Lesson Study activities, as witnessed by Yarema, who participated in Global Educational Resources' 2007 Lesson Study Immersion Program in Japan (http://www.globaledresources.com/events.html), exemplify the practice of a community of educators (teachers at local schools, teachers from surrounding school districts, their administrators, and university faculty from both mathematics and teacher education) whose members, together, seek knowledge about student learning.

This community-oriented aspect to Lesson Study differs from many forms of professional development in Western countries, such as the United States. Traditionally, teachers participate in "one-shot, random workshops" (Wiburg & Brown, 2007, p. 20) or in "teacher-trainings" by which paid experts disseminate knowledge of research and leave teachers in isolation to implement in their classrooms what they learned (Corcoran, 1995; Wiburg & Brown, 2007). However, as professional development evolves to the concept of professional learning communities, Lesson Study emerges as a framework by which learning communities gain knowledge and implement changes in instructional practices (Wiburg & Brown, 2007). In this regard, Lesson Study aligns to professional development described in the National Council for Teachers of Mathematics (NCTM) Principles and Standards (2000) that envisions the involvement of various stakeholders in mathematics education in the professional development of mathematics teachers.

Lesson Study embodies elements of effective professional development as identified by U.S. research (Perry, Lewis, & Akiba, 2002). It incorporates principles for effective professional development, defining effective in terms of student outcomes, outlined by Timperley (2008) and based on a synthesis of ninety-seven studies from countries around the world. These principles state that teachers participating in effective professional development: 1) focus on students' learning, 2) integrate theory and practice in regard to curriculum and

instruction, 3) learn about students' knowledge and skills in deep ways, 4) develop trust as they participate in multiple opportunities to learn and practice, 5) discuss and reflect on new learning with colleagues, and 6) consult knowledgeable others. Elements of these principles appear in Lesson Study as teachers increase their knowledge of students' development and learning through in-school research (Baba, 2007; Lewis, 2002b; Okubo, 2007; Yoshikawa, 2007) with others observing including university professors (Lewis, 2002b; Okubo, 2007) and discuss with each other details for implementation of the curriculum to advance student learning (Yoshikawa, 2007). In addition, increases in scores on state mathematics tests in New Mexico by students of teachers who participated in Lesson Study suggest a relationship between Lesson Study and "effective" professional development as measured by student achievement on state accountability tests (Wiburg & Brown, 2007). Thus, for teachers, Lesson Study is professional development based on research that seeks knowledge about student thinking which, in turn, informs their instructional practices.

Lesson Study as Research Methodology

Lesson Study provides a structure by which a learning community can gain knowledge (Wiburg & Brown, 2007). However, models focusing on community learning are typically difficult to formulate and describe (Barab, Barnett & Squire., 2002; Barab, MaKinster, & Scheckler, 2003; Barab, Schatz, & Scheckler, 2004; Hung, Chee, & Hedberg, 2005; McConnell, 2005). Little's (2003) qualitative research of community learning influenced other researchers to approach documentation of community activities using qualitative methods. Accounts based on this type of inductive research linked communities to building a sense of inquiry (Snow-Gerono, 2005) and increasing changes in study and practice among members (Sierra & Folger, 2003). In Japan, Lesson Study is a model for a community of practitioner-teachers to follow as they study student thinking for the purpose of improving instructional practices in their own classrooms, thus utilizing Lesson Study as an approach to inductive, qualitative research (Lewis, 2002a; Lewis, Perry, & Murata, 2006; Lewis & Tsuchida, 1997; Okubo, 2007; Wiburg & Brown, 2007).

However, just as a well-planned research lesson developed during Lesson Study promotes more explicit student thinking, Lesson Study activities also encourage more explicit teacher thinking. Groth, Spickler, Bergner, and Bardzell (2009) describe a research model based on Lesson Study whereby the depth of a group of teacher's knowledge as it related to technological pedagogical content knowledge (TPACK) could be examined. In addition, Lewis, Perry, and Hurd (2009) report evidence using a North American Lesson Study group as a case of Lesson Study providing a theoretical model consisting of four components (investigation, planning, research lesson, and reflection) that promotes changes in teachers' knowledge, professional community, and teaching-learning resources. Thus, another aspect to Lesson Study as a qualitative method of research is that it offers the opportunity for teacher-educators to study teachers' thinking in a community setting.

Lesson Study and Accountability Testing

The power of Lesson Study to extract teachers' thinking in a group setting became apparent during professional development projects designed by Yarema and funded by the Texas Teacher Quality Grants Program (TQGP). The goal of these professional development projects was to increase teacher capacity, such as through gains in knowledge of subject matter, pedagogy, curriculum, student learning (Cohen & Ball, 1999), and challenges to teachers' beliefs or views (Goertz, Floden, & O'Day, 1996). As teachers participated in multiple Lesson Study professional development projects, they revealed, during some phase of the process, four different views of accountability testing and its impacts on their instructional practices to mathematics teacher-educators who assisted them as "knowledgeable others."

Accountability testing in Texas began in the 1980s as part of reforms in the educational system of the state but became increasingly tied to "high stakes" for students, teachers, and principals (McNeil, 2000; McNeil & Valenzuela, 2001). Texas was the first state to implement accountability testing throughout its system, and the state's system was used as the model for the United States' federal education policy, known as No Child Left Behind (NCLB) (McNeil, Coppola, Radigan, & Vasquez Heilig, 2008). Trends towards accountability testing have occurred globally (Butland, 2008; Lemke, Sen, Pahlke, Partelow, Miller, Williams, Kastberg, & Jocelyn, 2004). Studies conducted on the effects of accountability testing revealed a change in classroom practices as teachers tended to "narrow the curriculum" by choosing test-prep materials as curriculum (Butland, 2008; McNeil & Valenzuela, 2001; Smith & Fey, 2000).

Although accountability testing affected curriculum choices by teachers, its effect on other classroom practices may not be so easily observable. However, the reflective nature of the lesson study process provided an avenue to investigate more deeply other effects of accountability testing as teachers communicated their thinking about the topic. As teachers from the same geographic area participated in multiple lesson studies, views pertaining to accountability testing emerged during various stages of the eight-component Lesson Study model previously described. This model included community participation by teachers, higher education faculty and, to a lesser degree, principals, who question each other about choices made while teaching.

Research Setting

Stipulations set by the funding agency, TQGP, required each Lesson Study to continue for one year and to focus on a particular content topic. One Lesson Study addressed probability and statistics; another targeted algebraic thinking and Algebra 1; and the third focused on rational numbers and operations. Teachers knew the content topic before applying to a study. In total, thirty-one different teachers, from nine different independent school districts in West Texas, participated of which four took part in two Lesson Studies and another four joined all three Lesson Studies. Within each of these Lesson Studies, teachers

subdivided themselves into smaller working groups by schools and grade levels (about 4-8 teachers per group). Thus, repeating teachers were never in the same group during all three Lesson Studies. Groups did observe the teaching of each other's research lessons at least once during the year and participated in the post-lesson discussions that followed the teaching.

Teachers met approximately once to twice per month. Data in the first two Lesson Studies were collected through video recordings and still photographs of teachings and post-lesson discussions. However, during the third Lesson Study, additional data were collected through voice recordings of each meeting and communications of teachers with each other and with mathematics teacher-educators on a blog. In addition, the Plan to Guide Learning highlighting information related to the research lesson and the final report about what was learned from their research that was compiled by each Lesson Study group provided data.

Findings Emerging from the Lesson Study Process

Accountability Testing as a Means to Learn about Students' Content Knowledge

As teachers' set goals for each Lesson Study, their perceptions of accountability testing remained undetected. To formulate a goal for their study, teachers collaboratively discussed student outcomes in terms of life-skills and made a list of desirable characteristics for students who are products of their school. After an analysis of what characteristics they currently see in their students, teachers in all three Lesson Studies consistently wrote goals related to students' lack of problem solving skills and personal responsibility. Teachers deliberated on these life-skills type goals as they structured and designed each research lesson.

In the second phase of Lesson Study, investigating curriculum, teachers' views of accountability testing materialized. In an email dated November 20, 2009, Elizabeth C. Powers, director of the Texas Teacher Quality Grants Program, characterized accountability testing in Texas as "those tests … used to determine if campuses met the accountability standards outlined in their state plan under No Child Left Behind (NCLB)," the main federal policy governing education in the United States (2001). Teachers in these Lesson Studies described accountability testing in a more personal sense stating that it was a measurement of their students' learning for which they were accountable. Therefore, they naturally turned to the state's accountability test to ascertain their students' deficiencies in mathematics. Teachers examined results from the previous year's state-wide-accountability test to determine on which objectives past students showed strengths and weaknesses. Analyzing together results for vertically aligned objectives, upper elementary, middle school, and high school teachers identified trends in student outcomes that indicated what mathematical topics needed more attention as students moved from grade to grade through school districts. To find out if current students demonstrated similar strengths and weaknesses, teachers compiled a pre-post test consisting of accountability test-like questions that were aligned to student learning objectives.

At the beginning of the school year, teachers administered the pre-test to students, disaggregated the data, and analyzed the results. Teachers noted objectives with the highest scores and lowest scores for each individual student and each class that they taught. Then at their next meeting, they combined all their results to determine objectives with highest and lowest scores overall. Finally they compared the performance of current students on this pre-test to the performance of past students on the state-wide-accountability test and used these results to finalize the topic for the research lesson. After the determination of the research topic, they analyzed textbooks for presentation of the content, read articles pertaining to student learning of the content, and discussed lessons with university faculty housed in mathematics and teacher education departments. In essence, their view of accountability testing as a means to learn about students' content knowledge complemented the process of lesson study as it assisted them in making an objective decision about the content topic of their research lesson.

After the selection of the research lesson's content topic, teachers planned a unit and developed the research lesson. In this part of Lesson Study, teachers aligned each lesson in the unit to state content standards that serve as the basis for the accountability tests' objectives. Following the model seen by Yarema in Japan, the Texas teachers created a problem-solving lesson and anticipated student solutions to the problem. In so doing, their research lesson related to mathematical processes, another accountability testing objective. During the next phase of Lesson Study, teaching the research lesson with others observing students, teachers did not voice any type of view about accountability testing. However, during the post-lesson discussions, they frequently cited accountability testing as they deliberated about observations and justified instructional choices.

Accountability Testing as a Means to Learn Mathematical Content

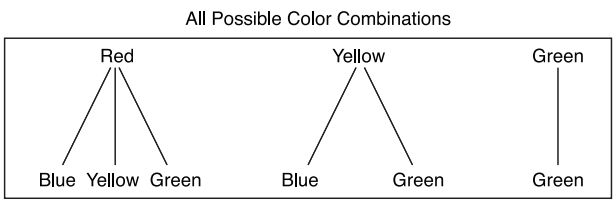
In the probability and statistics Lesson Study, teachers determined that sixth grade students exhibited weaknesses in drawing, reading, and understanding tree diagrams. Therefore, the content goal for their research lesson desired students to understand terminology; gather and organize data; and read, interpret, and construct diagrams. Their problem asked students to count the number of "outcomes" for playing four, five, and n different songs at a school dance. Teachers intended to use students' solution methods to teach tree diagrams, and promote understanding of the diagram by linking the branches to a sample space and to the Fundamental Counting Principle.

Accountability testing surfaced when the teacher of this research lesson proposed during the post-lesson discussion that unfamiliarity with the term "outcomes" hindered some students from understanding the problem and thought the word "combinations" a better term to use. Once questions from observers were allowed, a university mathematics faculty member asked why she preferred the word "combinations" since its everyday and mathematical meanings sometimes differ. For example, the problem asked students to count

"arrangements" or "permutations" of songs and not "combinations" of songs. Another teacher replied that tree diagrams visualized "combinations" because the state's accountability test always places the two together. She shared how she told her students that a tree diagram represented a combination, so when they saw the word "combination to think tree diagram." Thus, this teacher viewed accountability testing as a source for learning mathematical content and terminology, and, in turn, conveyed this knowledge to her students. Later she supplied the questions in Figures 1 and 2 from past accountability tests as examples.

Charlie had 1 red marble, 1 blue marble, 1 yellow marble, and 1 green marble in a bag. He picked 2 marbles at random from the bag. Which diagram shows all the possible colour combinations of the 2 marbles that Charlie picked?

F



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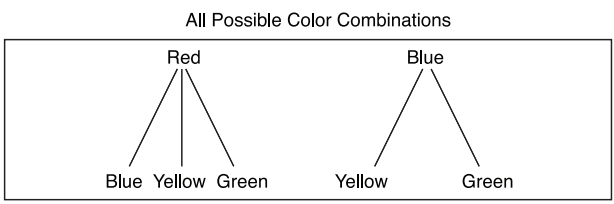

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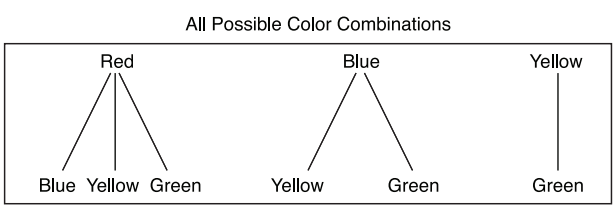

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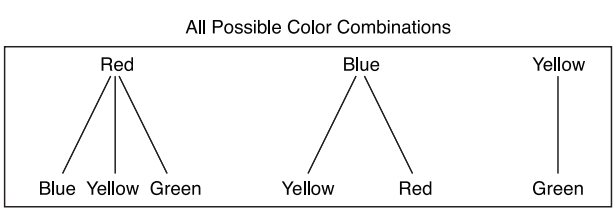

Figure 1. Question 22 and copied tree diagrams from 2003 Texas Assessment of Knowledge and Skills (TAKS) test: An unconventional tree diagram depicting a mathematical combination

A customer at Steven's Sub Shop can choose from white, wheat, and rye bread. The customer can also choose from American and Swiss cheese. Which diagram shows all the possible combinations of 1 type of bread and 1 type of cheese?

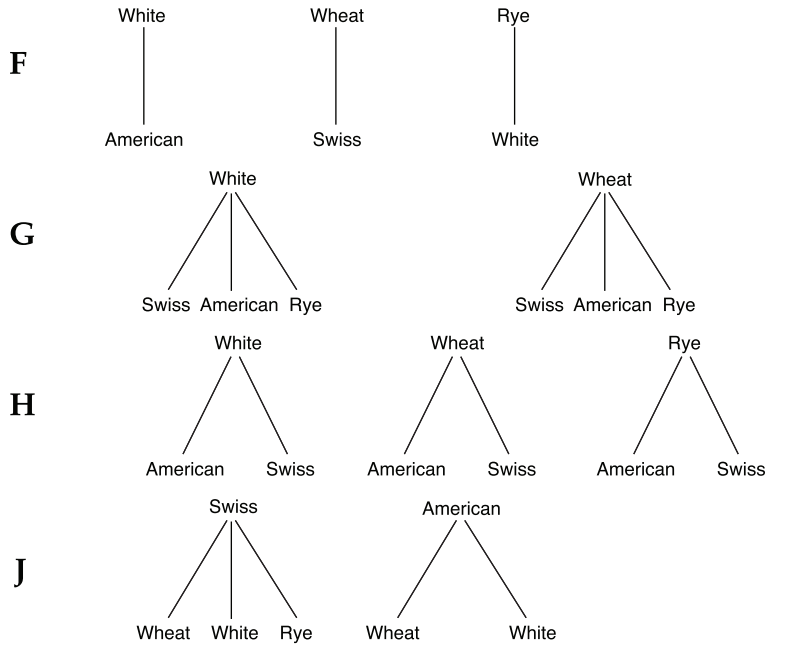

Figure 2. Question 6 and copied tree diagrams from 2006 Texas Assessment of Knowledge and Skills (TAKS) test: A conventional tree diagram illustrating the Fundamental Counting Principle

Although both questions utilized tree diagrams and the term combinations, the 2003 test item illustrated a mathematical combination with an unconventional tree diagram, whereas the 2006 question applied the Fundamental Counting Principle depicting it with a conventional tree diagram. In subsequent meetings of the Lesson Study group, university mathematics faculty engaged teachers in an activity to assist them in understanding the differences in counting techniques. Ultimately, Lesson Study afforded mathematics teacher-educators opportunity to draw out teachers' thinking about the content they teach and to address their misconceptions.

Accountability Testing as a Means to Learn about the Teaching of Content

Teachers in the rational numbers and operations Lesson Study wished to learn what sixth grade students knew about the addition of fractions with unlike denominators. The content goal for the research lesson addressed student skills in adding and subtracting fractions, solving problems, and justifying solutions. The problem asked students to design an advertisement page showing advertisements bought by local entertainment, food, and apparel businesses then to find the fraction of their designed page that was covered by entertainment advertisements. An answer to a second question generated a non-simplified fraction for students who used manipulatives as part of their solution method. Teachers wanted to use student responses to this question to review equivalent fractions. During the second teaching, the teacher of the research lesson told students that non-simplified fractions were "wrong" and to make these fractions correct, they needed to "break down by dividing."

The post-lesson discussion generated a question by an observing algebra teacher from another group asking the teacher to explain the process of simplifying fractions as "breaking down by dividing" and for considering an equivalent, but non-simplified fraction a "wrong" answer. The teacher clarified her teaching choice referencing accountability-testing stating that test items offered equivalent fractions as answers such as 3/4 as one choice, 6/8 as another, and the simplified version was the "correct" answer. Her students struggled with vocabulary on the test, so she told them that "simplify" meant "to break down by dividing." When asked if the accountability test actually posed multiple-choice questions with two equivalent fractions as answers to a single question, another teacher offered to provide examples from old accountability tests or literature. After a search, she emailed the group that no examples existed.

After this teacher justified her choices concerning mathematical vocabulary and correct answers with accountability testing, participants began to discuss how words such as "factor" that connect to algebra better describe the process of simplifying fractions. Upon conclusion of the post-lesson discussion, the teacher of the research lesson posted to the Lesson Study group's blog, further explaining the need to make teaching choices based on accountability testing. Her post prompted other Lesson Study participants, teachers and university faculty (teacher education and mathematics) to further discuss this topic, posting twenty comments deliberating on whether students' study of mathematics in subsequent years provided a better reason for choices made while teaching.

> Post by Teacher of Research Lesson: Our group got into "TAKS questioning" and wording [on] the test … all my students received little or no instruction last year and this year I am having to teach what they should have already come in with as well as what they need to know this year. That is TOO much information for their brains to try and hold onto … I have to teach to the test, as do all of you, however this year is the first year they have to take the same test as everyone else, and have to do just as well. I have my hands tied in that I need

> them to know how to solve problems, but not always why and what makes the correct answer. Sometimes the … details of vocabulary are lost on them and I need them to just know what I want them to do (simplifying a fraction).
>
> Response by Teacher-Educator: I would also like to compliment [teacher] regarding the immediate response of her students when she used the phrase "break down". They knew what mathematical action to take when she used the phrase. Students associate the action they are to take with word(s) you use. Students do not know what "break down" means in a mathematical sense until they see what the teacher does when he/she uses this phrase. Therefore, I encourage you to use the word factor in place of "break down" as they will take this same action when the word factor is used in algebra. First, this will give the students a head start when factoring in algebra. Second and more importantly, students with greater ability realize as they see what their algebra teacher does when he/she uses the word factor that it is just the same mathematical operation as "break down". Students with lesser ability do not make the connection so they [must] learn a whole new procedure for the word factor.

Again Lesson Study provided the occasion for teachers to ask each other about their teaching practices. In doing so, it provided mathematics teacher-educators the chance to hear teachers' thinking and to offer suggestions. In this instance, Lesson Study allowed a community of mathematics educators the opportunity to reflect on criteria for choices made while teaching content.

Accountability Testing as a Means to Learn about Classroom Learning Environments

A fourth view of accountability testing emerged during a post-lesson discussion in the algebraic thinking and algebra Lesson Study with middle and high school teachers. The content goal aimed for students to generalize patterns expressing them with algebraic symbols. One group of high school teachers chose to see if students applied content taught in previous lessons of the unit, so they placed the research lesson at the end of the unit. Their problem described a vehicle travelling in Michigan south from the Mackinaw Bridge at a constant speed and another one travelling north from Flint at a different constant speed. The problem asked students to determine when and where the two vehicles met. Observers noted that students worked in groups during the teaching of the research lesson; yet immediately after the lesson ended, teachers in the high school group moved desks back into rows.

After the third teaching of this research lesson (the grant funding agency required classroom observation of all participating teachers) during the post-lesson discussion, a teacher education faculty member asked why classrooms were always rearranged after each teaching. Teachers responded that since students worked in isolation during the state's accountability testing, their students needed to learn algebra independently. Thus, a problem-solving, collaborative-learning lesson taught during a Lesson Study necessitated rearrangement of the desks since it was easier to ensure independent work with

students sitting in rows of desks. Hence, this post-lesson discussion elicited teachers' thinking about their classrooms' learning environments. Discussion about their view, which posed accountability testing as a learning model, followed with all five high school teachers in this group indicating apprehension about changing the learning environment of their rooms due to this test.

Interaction and Discussion to Reflect and Promote Change

In the final report phase of each Lesson Study, teachers wrote about what they learned. These reports included a summary of the research process, findings from their research, implications of the findings for each individual teacher, recommendations to others who might use the lesson, and a conclusion. As part of their findings, teachers reported strengths and weaknesses in student content knowledge that still remained, as ascertained from the post-tests administered after the instruction of the unit, and suggested topics for future Lesson Studies. An analysis of the implications section indicated that discussions and interactions with fellow teachers and higher education faculty increased reflection and, to some degree, a change in practice. This result supports Lewis' et al. (2009) work that proposed Lesson Study activities (investigation, planning, research lesson, and reflection) promote changes in teachers' knowledge, professional community, and teaching-learning resources.

Although they did not explicitly mention any of their views concerning accountability testing, teachers made implicit references to them. The following examples from each Lesson Study were chosen to exemplify the thinking of the teacher of the research lesson that prompted the accountability testing conversation. They also include the thinking of a teacher from another group who observed the research lesson and participated in that particular post-lesson discussion. The intention of these accounts is to provide more insight into teachers' thinking following interactions among members of each lesson study community.

The teacher of the probability and statistics research lesson (a middle school teacher) noted how the discussion about "combinations" prompted further conversations with language arts teachers. She described how she incorporated new knowledge about word origins into the teaching of mathematics to help her students better understand the meanings of mathematical vocabulary. Then she provided examples of further research that she undertook.

> I believe the most revealing thing I learned through this year's Lesson Study was the importance of vocabulary. Because of incorrect usage [by me] while teaching on arrangements, my eyes have been opened to the language of math. So many math words have more than math meanings in the English language … Because of this eye opening experience, I had many discussions with Language Arts teachers about Greek and Latin root words-prefix and suffix meanings. [I have become] a better teacher because I researched the meanings of the vocabulary words we use in math. This has crossed curriculum and helped my students make connections where there had been none previously.

Similarly, a high school teacher present in that particular post-lesson discussion also referenced new ideas about vocabulary that originated from teachers' discussions with each other and higher education faculty stating, "I am more deliberate … in my choice of language … [when] discussing topics in probability and statistics."

The teacher of the research lesson in the fractions Lesson Study who used accountability testing as the criteria for determining "correct" answers provided another example of reflection. A month after the teacher posted to the blog, she sent an email to Yarema. In that communication she stated, "I am more aware of how I am asking questions, making sure to not be vague and assume the children can read my mind. I am more willing to let a child get an answer and explain what they got or how they got it before I tell them they are wrong."

Referring to that same discussion, the Algebra I teacher who asked this teacher about her teaching choices posted to the group's blog reflecting on the need for educators to ask each other questions so that all experience professional development. She cited Lesson Study as a way to draw out teachers' thinking.

> I'm interested in … the questioning that happens in debriefing. Whenever these questions are asked, I find myself making more conscious decisions about how I approach certain topics with my students. For me, this is the part of Lesson Study I learn the most from. I honestly did not see where [teacher] was going with asking her students about "most correct", but now that I see why she was headed that direction, it makes more sense to me. The phrasing "best response" is used on the … test, but I've never noticed it in the context of simplifying fractions … I've heard [name] say that this is professional development for the person who is teaching that day… seems to me that we are all experiencing some level of professional development through these questions.

In the algebraic thinking and algebra Lesson Study final report, none of the high school teachers indicated any changes to their classroom learning environments. However, a few months later at the beginning of the next academic year, one of these teachers moved to a new project-based high school within the district. Here all of his students work collaboratively with peers on projects to learn content, yet his students must still take the state's accountability test. In addition, a visit by Yarema to the classroom of another one of these teachers one year later revealed students working in groups on a problem-solving activity.

On the other hand, another algebra teacher who chose to work with a group of middle school teachers during this lesson study instead of the high school group did reflect on classroom learning environments. She mentioned that her classroom setting must seem foreign to her students who come from middle school classrooms designed for group work to her high school classroom with desks in rows. Then she described changes to her teaching practices that administrators at her school confirmed.

> The research lesson that I taught gave me insight about my students. I found out that some students were not giving me all that they could … I saw [that] each one had a potential that had not been tapped or used very much. This indicated

> to me as a teacher that I needed to provide more opportunities for students to explore areas that were unfamiliar to them so that the knowledge base that each one had could be expanded. Researching and teaching this lesson has shown me that I need to step more often out of my comfort zone and try the out of the ordinary from time to time … Teaching this type of lesson has made me want to do more … Time constraints … will be a problem, but I have a goal of doing some type of lesson out of the box at least once a semester.

Conclusion

Lesson Study as professional development met criteria proposed by Timperley (2008) for effective professional development of teachers in terms of valued student outcomes. Unlike "teacher training" professional development, Lesson Study offered the potential to examine depth of and changes in teacher knowledge (Groth et al., 2009; Lewis et al., 2009). This dimension of research within the Lesson Study professional development process granted mathematics teacher-educators opportunities to study teachers' thinking in parallel with teachers' study of students' thinking, to seize upon the immediacy of the results, and to support teachers as they make changes in instructional practices.

Mathematics teachers from nine independent school districts in West Texas participating in three consecutive Lesson Studies illustrated how teachers' thinking about issues that affect classroom practices are revealed to mathematics teacher-educators during Lesson Study activities. In this case, four different views of accountability testing, each related to some aspect of teacher capacity emerged. They perceived accountability testing as: 1) a means to learn about their students' mathematical knowledge; 2) a means to learn mathematical content and to convey it to their students; 3) a means to learn about the teaching of mathematics to students in terms of vocabulary usage and correct responses; and 4) a means to learn about classroom learning environments for their students. In essence, Lesson Study activities promoted interactions among members within this community of mathematics educators that offered occasions for teachers to explicitly think about their views, influences on instructional choices, and possible changes in practice. In addition, these views emerging from multiple Lesson Studies conducted by teachers in the same geographic area along with teacher-educators served as examples for the potential of Lesson Study to uncover patterns in teachers' thinking embedded within the educational culture of a geographic region.

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Author

Connie Yarema, Department of Mathematics, Abilene Christian University, ACU Box 28012, Abilene, TX 79699-8012, USA. Email: <yaremac@acu.edu>