Proceedings of the Ninth Annual Meeting of the Georgia Association of Mathematics Teacher Educators

October 14, 2015
Rock Eagle
GAMTE Proceedings 2015

Georgia Association of Mathematics Teacher Educators (GAMTE)

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Purposes and Goals of GAMTE

The purpose of GAMTE is to encourage and facilitate the improvement of mathematics teacher education across the state of Georgia. The goals of the organization are to: facilitate communication and collaboration among mathematics teacher educators between and within all educational levels; coordinate activities and work collaboratively with other associations, organizations, and governmental (national, state, and local) units to strengthen the mathematical, pedagogical, and clinical preparation of mathematics teachers at all levels (P-college); facilitate collaboration among mathematics teacher educators who are members of different academic units, such as departments of mathematics and departments of education; promote leadership among mathematics teacher educators in the broader mathematics education community; encourage research related to mathematics teacher education, especially which identifies factors that contribute to improving the preparation and professional development of mathematics teachers at all levels; encourage and organize programs and meetings focusing in issues related to the preparation and professional development of mathematics teachers; and foster the incorporation of appropriate technology into teacher education programs and professional development opportunities in mathematics at all levels (P-college).
Letter from the President

It is my honor to present the Proceedings of the 2015 Georgia Association of Mathematics Teacher Educators (GAMTE) Annual Conference. GAMTE is a unique and invaluable organization in the state of Georgia that provides mathematics teacher educators an opportunity to meet and discuss matters of importance in our career field. The Proceedings papers curated here represent current topics of interest to GAMTE members and should have broad appeal to mathematics teacher educators everywhere.

The task of organizing the GAMTE Annual Conference is a tremendous one, and I am grateful for the excellent stewardship offered by this year’s Conference Committee: Conference Chair Sharon Taylor (Georgia Southern University) and committee members Deborah Gober (Columbus State University) and Ha Nguyen (Georgia Southern University). Their hard work ensured a diverse and interesting assembly of presentations.

Great appreciation is also due to the Co-chairs of the 2015 GAMTE Proceedings, Don Brown (Middle Georgia University) and Tamara Pearson (Clayton State University). They, along with the review committee of Angel Abney (Georgia College and State University), Jill Drake (University of West Georgia), Deborah Gober (Columbus State University), Nikita Patterson (Kennesaw State University), Jennifer Williford (University of North Georgia), and myself (Mercer University), helped create a lasting product of this year’s conference.

I would also like to thank the Board of Directors who served GAMTE this past year:
- Treasurer: Susanna Molitoris Miller, Kennesaw State University
- Secretary: Dianna Spence, University of North Georgia
- Member-at-Large: Angel Abney, Georgia College and State University
- Member-at-Large: Tamara Pearson, Clayton State University
- Member-at-Large: Ha Nguyen, Georgia Southern University

Teresa Banker, who recently retired from Kennesaw State University, also served as Secretary for part of the year. Their service on the Board of Directors in 2014-2015 helped keep the GAMTE organization running smoothly, and I extend my sincere gratitude to them.

Finally, I would like to thank two past presidents of GAMTE: Gregory Chamblee, who manages the GAMTE website and helped situate me in my current position, and Sharon Taylor, who provided wonderful guidance in managing this year’s election and conference. Their mentorship was truly appreciated.

Clearly, the management of GAMTE requires the hard work of many dedicated professionals, and I am grateful for their service and support. Their great interest in GAMTE reflects the importance of this organization to mathematics teacher educators across the state, and I look forward to continuing the GAMTE mission.

Jeffrey Hall
GAMTE President
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ENGAGING IN LESSON STUDY AT GEORGIA COLLEGE

Angel Abney, Georgia College

Brandon Samples, Georgia College

Doris Santarone, Georgia College

Abstract

A lesson study cycle is a professional development process that integrates research and reflection through collaboration. The cycle allows a group to refine a lesson based on these collaboration efforts such as interaction with students and the post-lesson discussion. Secondary pre-service teachers in a mathematics methods course engaged in a lesson study cycle through collaboration between in-service teachers, Georgia College professors, and students in a local high school classroom. We systematically investigated this process to determine that through preparing, enacting and reflecting on their practice, Pre-service Teachers (PST) developed insight, reasoning, and understanding of the mathematics that they taught.
ENGAGING IN LESSON STUDY AT GEORGIA COLLEGE

Students in the Methods of Secondary Mathematics Teachers course at Georgia College participated in a lesson study project. In this course, students examined research on instructional strategies, assessment techniques, lesson planning, multicultural and gender issues, beliefs, and student learning in mathematics. These pre-service teachers (PST) worked in groups in order to develop a lesson based on research. Through collaboration with an in-service secondary mathematics teacher (IST) at Georgia College’s Early College (GCEC), PST observed his class, created a lesson plan, taught the lesson, rewrote the lesson plan, and retaught the lesson. In this article, we investigate how engaging secondary PST in a lesson study will inform their perceptions of research, practice and students’ mathematics.

Background

Lesson study is a professional development opportunity originally used in Japan where teachers collaborate in order to study the teaching and learning of a particular mathematical concept (Tolle, 2010). Since the Third International Mathematics and Science Study (TIMSS) in 1995, American teachers have been engaging in the process to some degree. The TIMSS study highlighted the mathematical success of Japanese students and determined that teaching was a cultural activity of which lesson study was a significant part (Van de Walle, 2013). Tolle (2010) suggested that “the spirit of lesson study embodies collaboration—‘collaborating with fellow teachers to plan, observe, and reflect on lessons’” (p. 182). An important thing to note is that the goal is to improve both teaching and learning. The result is a living lesson plan that can continue to progress as more is learned rather than a finished document. The most significant part of the lesson study cycle is the post-lesson discussion, where participants discuss the learning and
engagement opportunities afforded for students and reflect on how the lesson can be changed in
order to improve those opportunities (Tolle, 2010). The process of lesson study has been found
to help teachers learn mathematics in a deeper way as well as learn how students develop
mathematical ideas, which aligns with the National Council of Teachers of Mathematics’
(NCTM) Teaching Principle (2000).

NCTM (2000) suggested that assessment should not be something that we do to students,
but rather something we do for students. Performance-based assessments should provide
opportunities for students to learn and for instructors to monitor student progress and modify
their instruction based on the results of the assessment. This project achieved all of this. We
believe that this project was a powerful learning opportunity for the PST, while also allowing for
a valuable collaboration between teachers at GCEC and GC professors. This project fostered the
students’ mathematical knowledge for teaching and their knowledge and use of research in the
teaching and learning of mathematics. Our goals for PSTs’ in the lesson study project were:

1. The PST will reflect on their own mathematical knowledge and how their mathematical
   knowledge and approaches might be different than others’.
2. The PST’s instructional decisions will be informed by their research framework.
   Instructional decisions include: planning, choosing tasks, spontaneous decisions,
   questioning, discussion and reflection. Thus, there will be an opportunity to connect
   theory to practice.
3. The PST will allow the students’ mathematical thinking to inform their instructional
decisions. Through this experience we want the PST to learn to listen to and learn from
   their students from diverse backgrounds.
4. The PST will value collaboration with other professionals in their discipline and see it as an important part of continuous improvement and professional development.

Methods

Participants and Data Collection

In the Fall semester of 2014, eleven PST in the mathematics methods course worked through a sequence of activities that represented the essential elements of a lesson study. These activities involved setting a goal, which was determined once the PST, IST and GC professors discussed the needs of the classroom. Then, the PST examined research on the determined content. A lesson plan was developed based on the research so that the content goals were met. The PST then conducted the lesson to the GCEC students in a format where some PST observed while others taught the lesson; GC professors also took field notes during both lessons. At the post-lesson discussion between the PST, GC professors, and IST, a conversation took place about the opportunities afforded for the students and how the lesson could be improved. In the redelivery of the lesson, the PST switched teaching/observation roles. This allowed PST to be involved in the entire process, which provided a richer discussion during the final debriefing session. A revision of the lesson plan followed and allowed for a full circle of meaningful reflection.

PST developed lesson study portfolios which included the following:

1. A write up of the research used and how it informed their lesson plans and other instructional decisions.
2. A record of the group’s collaboration, including the number of times the teams met to discuss and plan the lessons, how the team debriefed after the lesson, how the modifications to the lesson were determined and how the roles were established.

3. Written Lesson Plans (original and modified) including all handouts and activities.

4. Observation notes during the enacted lessons (initial lesson and redelivery).

5. Individual and Group Reflections on the lesson study process.

PST presented lessons in the mathematics methods course as a way to practice prior to implementing their lessons in the GCEC classroom. Feedback was given during this process by their peers, the IST, and GC professors. There was also a final presentation of the entire lesson study process. The above mentioned tasks were part of a required assignment for the course, although the analysis of their documents for GC faculty research was voluntary. One group presented their lesson study experience at a university undergraduate research conference.

At the end of the lesson study experience, PST completed a survey about collaborating in a diverse environment. The IST was also interviewed about his experience in the collaboration, particularly concerning his role in the experience and the impact on his students.

Data Analysis

To qualitatively analyze the effectiveness of the lesson study project, we used several sources of data including the field notes taken during the enacted lesson, the interview with the IST, surveys completed by the PST, presentations given by the PST, and the portfolios submitted by the PST. A rubric was developed to assess both the portfolios and the presentation of the portfolios (Appendix A).
Findings

Theory to Practice

We provided the PST with a field experience that integrated research and practice in a collaborative setting. Many PST stated that this was their first time working with students in the classroom. They indicated that they will continue to use research in the classroom, use a lesson study approach in their future departments, and pay specific attention to students' responses and feedback. One PST stated, "before the lesson study, I was hesitant to believe that research would help us in preparing the lessons, but after this assignment I think differently." Some of the specific references to research that the PST made in their reflections were Driscoll’s (1999) Doing and Undoing, Questioning from both Reinhart (2000) and Driscoll (1999), Wait time by Reinhart (2000), Journal writing by Kostos and Shin (2010), Cooperative Learning by Johnson and Johnson (1988), Cognitive Demand by Stein et. al (2000), and articles on Lesson Study (Lewis & Tsuchida, 1998; Tolle, 2010).

Changing Instruction to be Responsive to Students’ Thinking

All PST indicated that, for whatever reason, they underestimated the mathematical abilities of the GCEC students. One PST wrote, "I underestimated the students at first. I didn't give them the credit, but they blew me away, and we weren't prepared for that. My attitude as a future teacher is that [sic] to never underestimate a student, build a base, and build up from there." This PST is suggesting that in order to teach to everyone's level in the classroom that you begin presenting content in a very accessible way, and then "move forward with harder problems." In their portfolio reflections, all PST suggested that they had to change the level of the content in their redelivery to make the mathematics more challenging for these students.
Changes in Teaching Views

This project showed the potential to be generative in the PSTs’ future school systems. One group of PST discussed making shifts from "private practice to collaborative practice, teaching as telling to teaching for understanding, teaching based solely on the textbook to teaching based on research, and teaching as tradition (content) to teaching for improvement (professional development)." The PSTs' realization of these shifts goes a long way toward helping them become culturally relevant teachers, who tend to be successful with ALL students, including populations who are often marginalized in mathematics. Ladson-Billings (2009) found that math teachers who were successful, specifically with African American students, see themselves as "part of the community and teaching as giving something back to the community" (p.38). These teachers typically encourage students to do the same. She also found that teachers who are successful with African American students have shifted from teaching as "putting knowledge into," like a bank deposit as opposed to teaching as "pulling knowledge out" like mining for gold (p.38). The PST engaged in the project indicated similar shifts in their portfolios and presentations. In particular, one PST indicated that as a result of doing an activity, students "were able to construct their own definition." This indicates that she was "pulling out" a definition as opposed to telling the students a definition. This same PST stated, "this method of teaching will help the students remember and better understand the material."

Mutually Beneficial Experience

From the perspective of the IST, "It was a useful and beneficial experience for ALL." He stated, "Your students [the PST] gained classroom experience while my students learned stuff in multiple styles, through technology, hands-on, traditional, and discovery. They did it all!"
reported that students liked the activities that the PST provided. He mentioned that the variety of methods used to teach mathematics was beneficial for both the students and for him. He also mentioned that he valued the collaboration with the GC mathematics education professors. From our perspective (GC professors), we found immense value in having input from an IST and using real students to provide our PST with an authentic classroom experience.

**Discussion & Implications**

*Challenges*

In their reflections, the PST mentioned several challenges concerning classroom dynamics. For instance, with their lack of classroom experience, they saw classroom management and pacing their instruction appropriately as challenges. They noted difficulties in keeping students on task without distracting others. A few of the PST mentioned a need for deeper content knowledge to be able to explain it adequately to students. This lack of the PSTs’ content development was, in part, due to another challenge of scheduling. The topics from which the PST chose were not available until relatively close to the time that they had to teach. With the time constraints, it was difficult to connect the content knowledge and research on how students learn that particular content, which was a major goal of the project and the course as a whole. On the other hand, there may have been too much time between the redelivery lesson and the initial lesson causing issues with the continuity of the content development for the high school students. The last challenge indicated by a few PST was coordinating their meeting times and incorporating their different perspectives into a coherent lesson. However, the PST also noted the positive aspects of collaborating with other teachers.
Potential for broad impact

Through this project, the PST became more aware of how students learn particular content. Knowledge of mathematics and how students learn mathematics have been identified as the most important aspects of successful mathematics teachers (Van de Walle, 2013). It has been noted that competence in mathematics opens doors to productive futures while a lack of such keeps those doors closed (NCTM, 2000). Through our PSTs’ work with the students at GCEC, we believe that students had the opportunity to begin to see mathematics as a field to pursue. The PST appreciated working in a classroom in the community with a diverse group of students. One indicated, "The makeup of the classroom was much more diverse than the population of GCSU, so we were able educate ourselves about how to interact..." with this population. The PSTs’ work with the students may have broadened the mathematical pipeline by providing access and interest to those who may not have been interested in the subject before. All students should have opportunities to engage in worthwhile mathematical tasks, where they will have the potential to learn mathematics with depth and understanding (NCTM, 2000).

Through this process of continuous improvement and reflection, our PST produced worthwhile mathematical tasks and lesson plans that can continue to be used by their peers, the faculty, and other mathematics teachers. After reflecting on the project as a whole, the PST were able to come up with personal and broad implications. In particular, one group of four PST was able to synthesize the lesson study cycle into a visual representation for their presentation at the Georgia College Undergraduate Research Conference. The continued collaboration between GC faculty and GCEC faculty benefits all stakeholders, including the Georgia College students and faculty and the GCEC students and faculty.
Conclusions

Overall, the PST who participated in the lesson study project indicated that the experience as a whole has forever changed their philosophy of the teaching and learning of mathematics. Their research supported lessons that they delivered in the high school classroom and their dissemination at later conferences indicated they understood that it is imperative to incorporate theory into their instruction. In addition, the PST indicated that being responsive to students’ mathematical thinking is imperative to effective mathematics instruction. This is an essential element to the Teaching and Learning Principle that states, “An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically” (NCTM, 2014, p.5). PST discussed that collaboration offered many benefits, but came with a few challenges. When we engage PST in the lesson study process again, we will be more intentional about meeting with the IST in selecting times and topics that work for the PST. We will also provide more articles with cases where students are engaged in a research-based task, and give PST more opportunities to observe the students prior to the lesson. What did work well with implementing the lesson study is giving PST class time to work on the lesson study as well as having them log outside of class time meeting with their group, allowing the PST to present their initial ideas and their lesson to the methods course prior to instructing the high school class, and working closely with the IST throughout the lesson study process. We believe that this carefully constructed field experience has a powerful impact on PSTs’ views about students, teaching, research and collaboration.


References


Using TI-Nspire to Engage Preservice Mathematics Teachers in an Exploratory Geometry Module

Alesia D. Mickle and Pier A. Junor Clarke
Georgia State University

In the mathematics classroom, most preservice mathematics teachers possess basic skills to use technology as an instructional strategy in communicating content standards. However, today’s demands for preservice teachers to engage in a variety of “best teaching practices” in their preservice teaching and edTPA requirements can oftentimes place the acquisition of technical skills and integration of new technology in content curriculum far from the forefront of their minds. Ertmer, Conklin, Lewandowski, Osika, Selo, and Wignall (2003) acknowledged preservice teachers’ desires to gain the adequate technical skills necessary to use technology in teachers’ daily tasks of facilitating and managing their classrooms. They suggested that “in order to translate these skills into practice, teachers need specific ideas about how to use these skills to achieve meaningful learning outcomes under normal classroom conditions” (p. 96). Preservice teachers need guidance and information about “how, as well as why, to use technology in meaningful ways” so they can “develop their own visions for, or ideas about, meaningful technology use” (p. 96). Thus, the instructional aid of technology integration in the mathematics classroom must look to address specific uses of technology to help preservice mathematics teachers build awareness and confidence to implement innovative teaching approaches to enhance student learning.

One example of new technology that is currently used in high school mathematics classrooms is the TI-Nspire CX CAS handheld calculator. In an effort to demonstrate the use of
this particular device and receive reflective feedback, preservice secondary school mathematics (PSSM) teachers engaged in an exploratory geometry module to manipulate and discover different mathematical concepts used to assist with writing geometry proofs. In the module, PSSM teachers bridged previously acquired technical skills with that of new skills to incorporate TI-Nspire technology in the teaching and learning of mathematics. The mathematics teacher educators compiled PSSM teachers’ reflections from a small cohort of five PSSM teachers at a southeastern, urban institution in hopes to provide teacher educators with a reflective insight into PSSM teachers’ experiences as they worked through a TI-Nspire incorporated geometry module. In particular, the focus of this reflection (1) analyzes the PSSM teachers’ content enhancement in writing geometry proofs with the use of TI-Nspire technology and (2) looks at the effect of the integration of TI-Nspire technology on PSSM teachers’ ability to implement and enrich the teaching and learning of mathematics, such as the observed benefits and challenges.

Significance

It is without a doubt that technology influences, for better or for worse, both the teaching and learning of mathematics. For example, Thomas and Hong (2013) performed a study that analyzed teachers’ integration of calculator technology in the mathematics classroom. Some teachers and students identified calculator use as a “procedural, button-pushing emphasis in the lesson, rather than an emphasis on the mathematics” (p. 75). Those not familiar with the calculator technology had to focus on the operational facets, which hindered their concentration on the mathematics. On the contrary, others viewed calculators as interactive, time-saving tools that allowed teachers to cover more material and help students build conceptual understandings of mathematics through its visuals. To reap the benefits and limit the challenges of teachers and students using technology in the mathematics classroom, it is necessary to critically analyze
research addressing technology use. Additionally, it is imperative that time and space is reserved to reflect on the exploratory experiences of integrating technology in the teaching and learning of mathematics.

The National Council of Teachers of Mathematics (NCTM) supports the use of appropriate technology in the mathematics classroom when it serves as a tool to teach and learn mathematics. As described in NCTM’s *Principles and Standards for School Mathematics* (2000), technology can assist with visualizing mathematical ideas, organizing and analyzing data, and communicating results by applying mathematical reasoning and problem-solving skills. The graphical power of calculators and computers provides students with opportunities to explore mathematical content in several different representational forms that might be otherwise too challenging and time consuming to perform by hand. As a result, technology tools provide students with affordable access to visual models that can aid in students’ conceptualization of mathematical ideas.

To effectively make use of technology in the mathematics classroom, teachers need to be equipped with adequate training and on-going instructional assistance. Teachers need to have an understanding of the technology’s capabilities and how it can be used to advance student learning. This means that “teachers should use technology to enhance their students’ learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently [through graphing], visualizing, and computing” (NCTM, 2000, pp. 25-26).

Several education companies offer exceptional technology resources that have found their way into the hands of teacher educators and students. Since the integration of TI-Nspire CX CAS in a geometry module is the main focus of this reflection, it is essential to comment on the research supporting this technology of interest. As addressed by Texas Instruments (2015), TI-
Nspire technology offers functionality and innovative visual content representations to advance students’ understandings of mathematics concepts by means of exploration. TI-Nspire supports its technology products with research that indicates a need for supportive teaching tools to accelerate the understanding process by highlighting visualized geometric, algebraic, and graphical representations. The technology is also designed to allow for dynamically linked multiple representations such that users can observe cause and effect relationships of different representations.

More specifically, a geometry application is offered in the TI-Nspire CX CAS handheld that provides users with a setting to construct and manipulate geometric figures and animations. In addition, the calculator offers applications to explore graphs of functions, analyze data through statistical operations, build graphical representations, and much more. As Ozgun-Koca and Edwards (2009) observed in their research on mathematics teachers’ views of using TI-Nspire, the calculator “allows students to dynamically manipulate the graph and observe the immediate effects of that manipulation on the symbolic form” (p. 1). To further examine the influence and significance of using TI-Nspire, the mathematics teacher educators observed the benefits, challenges, and overall experiences of the PSSM teachers working with this technology.

Participants

Participants in this study included two mathematics teacher educators and a cohort of five PSSM teachers. The PSSM teachers were enrolled in an initial teacher preparation program with a concentration in secondary mathematics education at a large, urban university in the southeastern region of the United States. One of the PSSM teachers returned to school for a second career, while the other four PSSM teachers completed their first degree in mathematics-related fields and went straight to work on their masters in secondary mathematics education.
Overall, the participants can be described as a diverse group that varies in gender, race, culture, socioeconomic backgrounds, and ideas of technology (see Table 1).

Table 1

<table>
<thead>
<tr>
<th>PSSM Teachers’ Gender, Race, and Academic Background</th>
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</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Abbey</td>
</tr>
<tr>
<td>Chelsea</td>
</tr>
<tr>
<td>Monica</td>
</tr>
<tr>
<td>Tamesha</td>
</tr>
<tr>
<td>Kyle</td>
</tr>
</tbody>
</table>

After receiving IRB approval to perform the research, all five PSSM teachers in the cohort volunteered to participate in the summer of 2015. The research took place over the course of one summer semester methods course with a pretest and a posttest occurring the first and last day of class, respectively. Throughout the semester, the mathematics teacher educators collected coursework and reflections, which served as part of the data collection. Once the semester ended, a graduate research assistant organized the data and performed interviews with the participants. Data analysis did not begin until the start of the following semester to not interfere with the PSSM teachers’ and the mathematics teacher educators’ evaluations.

Identifying PSSM Teachers’ Needs

As the PSSM teachers engaged with mathematical content and teaching pedagogy in their methods course, the mathematics teacher educators exposed the PSSM teachers to teaching and learning modules that were reflective of their future experiences in the mathematics classroom. Zhao and Bryant (2007) found that to effectively infuse technology in the classroom, teachers needed to participate in intensive curriculum-based technology training that addressed more than just the development of basic technology skills. Thus, it was the goal of the mathematics teacher
educators to model and teach the PSSM teachers how to incorporate calculator technology into a geometry module. By designing a geometry module that incorporated a technology component, the mathematics teacher educators were able to gather insights into the PSSM teachers’ successes and challenges as they engaged in learning situations similar to those of their future students.

Since the PSSM teachers were preparing to teach in geometry classrooms for their student teaching experiences, the mathematics teacher educators wanted to review key geometry concepts along with teaching pedagogy in the mathematics methods course. The mathematics teacher educators also knew from teaching previous methods courses that some PSSM teachers experienced trouble in recalling geometry content, especially skills involved with geometric proof writing. As a result, the mathematics teacher educators assigned a brief pretest (see Appendix Curriculum Content Pre/Posttest) that assessed the writing of right triangle and rectangle proofs at the beginning of the semester.

In the pretest (see Table 2), only two out of five participants were able to correctly prove the first problem addressing a right triangle. The participants who attempted the proof used mathematical concepts like negative reciprocal slopes, right angle, the distance formula, the Pythagorean Theorem, and plotting points on a graph. In the second problem that asked to prove a rectangle, only one out of five participants was successful at providing a correct proof. The participants who attempted the proof used mathematical concepts like four right angles, two sets of parallel lines, two slopes of negative reciprocals, plotting points on a graph, and equal opposite side lengths and angles.
Table 2

<table>
<thead>
<tr>
<th>PSSM Teachers’ Pretest Results</th>
<th>Question 1</th>
<th>Right Triangle Proof Concepts</th>
<th>Question 2</th>
<th>Rectangle Proof Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey</td>
<td>Correct</td>
<td>Negative reciprocal slopes; right angle</td>
<td>Correct</td>
<td>Four right angles; two sets of parallel lines; two slopes of negative reciprocals</td>
</tr>
<tr>
<td>Chelsea</td>
<td>Incorrect</td>
<td>Plotting points</td>
<td>Incorrect</td>
<td>Opposite side lengths equal; opposite sides parallel; right angles</td>
</tr>
<tr>
<td>Monica</td>
<td>Correct</td>
<td>Distance formal; Pythagorean theorem</td>
<td>Incorrect</td>
<td>Opposite side lengths equal; opposite angles equal</td>
</tr>
<tr>
<td>Tamesha</td>
<td>Incorrect</td>
<td>Plotting points; Pythagorean theorem</td>
<td>Incorrect</td>
<td>Opposite side lengths equal</td>
</tr>
<tr>
<td>Kyle</td>
<td>Incorrect</td>
<td>Plotting points</td>
<td>Incorrect</td>
<td>Opposite side lengths equal</td>
</tr>
</tbody>
</table>

The mathematics teacher educators collected the pretest and analyzed the findings. The PSSM teachers did not review their pretest until after the posttest given at the end of the semester. The mathematics teacher educators did not want to influence the PSSM teachers’ performance by reviewing the pretest before the posttest. Given the PSSM teachers’ performance and previous knowledge observed in the pretest, the mathematics teacher educators designed an exploratory geometry module to engage the PSSM teachers in review of the mathematical content addressed in the pretest and additional problem-solving strategies that would aid in content conceptualization.

Right after administering the pretest, the mathematics teacher educators also assigned a learning style inventory assessment for the PSSM teachers to complete. The learning style inventory assessment (see Appendix B) was administered to provide the mathematics teacher educators with information pertaining to how the PSSM teachers learn. The learning style inventory assessment also served as a modeled activity for the PSSM teachers to complete with
their future students. Based on the PSSM teachers’ results on the learning style inventory assessment (see Table 3), the mathematics teacher educators found that all five PSSM teachers were classified as visual learners.

Table 3

<table>
<thead>
<tr>
<th>PSSM Teachers’ Learning Style Inventory Analysis</th>
<th>Visual Score</th>
<th>Auditory Score</th>
<th>Tactile Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey</td>
<td>34</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Chelsea</td>
<td>32</td>
<td>17</td>
<td>28</td>
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<tr>
<td>Monica</td>
<td>36</td>
<td>30</td>
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<tr>
<td>Tamesha</td>
<td>28</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Kyle</td>
<td>32</td>
<td>22</td>
<td>18</td>
</tr>
</tbody>
</table>

Using the PSSM teachers’ learning style inventory analysis, the mathematics teacher educators knew that there was also a need to provide the PSSM teachers with situated-learning tasks that appealed to their visual learning needs. Additionally, the PSSM teachers commented that they learned best by working with material through collaboration and hands-on activities. Thus, it was imperative that the PSSM teachers were exposed to teaching and learning experiences that encompassed techno-kinesthetic, visually-based learning activities. The first instructional tool that came to mind was a TI-Nspire calculator activity to address this need.

Since geometry is very visual, it only makes sense to integrate technology that enriches reasoning, problem-solving, and visual awareness. As noted by Tabor (2014) in an article addressing the benefits of calculator use, “there is a place in mathematics classrooms for activities and lessons that have a curricular basis and that emphasize the kinesthetic and visual learning styles” (p. 626). The specific technology integrated into the geometry module used the TI-Nspire CX CAS handheld. Texas Instruments (2015) indicated that this graphing handheld was equipped with a powerful Computer Algebra System that offered users a system to build a deeper understanding of abstract concepts found in mathematics.
The mathematics teacher educators discussed the design and implementation of a geometry module with TI-Nspire. The geometry module utilized two technological advances of TI-Nspire: the document application and the device mechanism to manipulate multiple representations of the material. By using TI-Nspire technology, PSSM teachers were able to create a geometrical diagram by manipulating sliders that revealed measurements used to conjecture cause and effect relationships. Explorations in the new applications of TI-Nspire calculators enabled the mathematics teacher educators to not only address the pedagogy of calculator use but also observe its impact when used in the mathematics classroom.

**Designing and Implementing a Geometry Module with TI-Nspire**

To engage PSSM teachers in an exploratory geometry activity that helped with the recollection of geometric concepts and used new technology in an unfamiliar way, the mathematics teacher educators selected two geometry tasks (see Appendix C) that utilized TI-Nspire CX CAS technology from Texas Instruments’ classroom activities. The tasks, along with several other classroom activities that can be used in the K-12 and college setting, were open to the public and free to download. The mathematics teacher educators integrated the TI-Nspire activity because several PSSM teachers had never used the technology. Although most PSSM teachers have used and owned TI-83/84 calculators, none of the PSSM teachers had personal experience using TI-Nspire technology. The mathematics teacher educators capitalized on this inexperience and lack of exposure to this device to model a learning situation that was reflective of the PSSM teachers’ future teaching experiences.

The PSSM teachers were assigned the geometry module’s Task 1 and Task 2 midway through the summer semester methods course. Task 1: Proving Right Triangles took place over one class session, while Task 2: Proving Rectangles was administered the next class session.
Prior to the geometry modules, the PSSM teachers learned about different co-teaching methods and how the emersion of strengths from two or more teachers can work together to better meet students’ learning needs (Bauwens, Hourcade, & Friend, 1989; Walsh, 1992). Despite the variety of approaches used in co-teaching methods, the PSSM teachers studied specific co-teaching models like team teaching, station teaching, supplemental teaching, and parallel teaching. The mathematics teacher educators strategically incorporated the geometry module’s Task 1 and Task 2 as possible activities to integrate in a co-taught classroom. With extra hands to distribute, facilitate, and assist with the TI-Nspire technology, the mathematics teacher educators took advantage of modeling innovative instructional strategies to enhance PSSM teachers’ teaching and learning experiences.

Both tasks in the geometry module addressed the Georgia Standards of Excellence (GSE) Analytic Geometry content standard of MGSE9-12.G.GPE.4, which referred to using coordinates to prove simple geometric theorems algebraically. In Task 1: Proving Right Triangles, the mathematics teacher educators used parallel teaching to instruct the PSSM teachers how to write a geometry proof addressing a right triangle. Thus, the PSSM teachers were split into two groups (back-to-back) as the mathematics teacher educators taught the same lesson. The lesson addressed an example proof that was designed after the first question in the pretest. Mathematical concepts like perpendicular slopes, the distance formula, and the Pythagorean theorem were reviewed. The latter half of the lesson incorporated a technology extension that required the PSSM teachers to complete an adapted lesson from Texas Instrument’s (2011) *The Pythagorean Theorem-and More* (see Appendix C). In this activity, the PSSM teachers used the document application of the TI-Nspire CX CAS calculator to construct triangles to explore the relationship between angles and side measures to classify different types of triangles, such as
acute, obtuse, and right. To successfully manipulate the triangles, it was necessary for the PSSM teachers to have the technological skills to drag the vertices of each triangle to observe the change in the triangles’ measurements.

The last part of the task’s technology extension required the PSSM teachers to observe the areas of three squares whose vertices met to form a right triangle. Upon increasing or decreasing one square’s area, the other squares changed accordingly to demonstrate one visual proof of the Pythagorean Theorem. These multiple representations of mathematical concepts provided the PSSM teachers with opportunities to develop further insights in writing proofs.

In Task 2: Proving Rectangles, the mathematics teacher educators designed a rotating stations activity that aligned with the Georgia Standards of Excellence (GSE) Analytic Geometry content standards of MGSE9-12.G.CO.11, which referred to proving theorems about parallelograms. Station 1 addressed writing a geometry proof using concepts of slope and the distance formula to prove a rectangle. Station 2 approached a geometry proof using mathematical concepts like diagonals and midpoints. In station 3, the PSSM teachers worked through application problems that required content knowledge of properties of rectangles. Lastly, station 4 required the PSSM teachers to complete a technology extension that was adapted from Texas Instrument’s (2014) Exploring Diagonals of Quadrilaterals (see Appendix C).

To complete the task’s technology extension station, the PSSM teachers had to know how to manipulate and drag endpoints and intersection points of two diagonals. The first part of the task provided a visual representation to observe what quadrilateral resulted when diagonals bisected each other (or one was the perpendicular bisector of the other), bisected vertical angles, or were congruent in length. The last part of the task determined whether special quadrilaterals
could be formed given knowledge about the diagonals. Throughout the task, the up arrow could be used within the document to add more information on the screen, such as the angle or side measurements. This tool provided users with an opportunity to justify their conclusions with the aid of measurements. It was important to note that there were “tech tips” embedded throughout the instructor’s guide to help teachers and students tackle the unfamiliarity of the device.

In both tasks’ technology extensions, the PSSM teachers had to know how to access, download, and perform technical functions to complete requirements of the task. An understanding of the calculator’s applications and keys were necessary to manipulate the visual models. Additionally, manipulating the geometric figures in both tasks allowed for the PSSM teachers to review characteristics of each figure in a kinesthetic and visual manner.

**Results**

At the end of the semester, the mathematics teacher educators presented the PSSM teachers with a posttest assessment (the same as the pretest assessment) to track advancements made in the PSSM teachers’ geometry content understanding (see Appendix Curriculum Content Pre/Posttest). The mathematics teacher educators also asked the PSSM teachers to reflect on a prompt that asked for the PSSM teachers to identify the observed benefits and challenges of integrating TI-Nspire technology in a geometry module. The PSSM teachers’ reflections served as a way for teacher educators to understand the PSSM teachers’ struggles and successes using technology to advance grades 6-12 students’ content knowledge and learning experiences in the classroom. Gaining these understandings can enable teacher educators to guide PSSM teachers’ experiences as they explore, reflect, and adopt this form of technology in their teaching.

**Impact on Content Knowledge**

The posttest analysis (see Table 4) revealed improvement in the PSSM teachers’ content
knowledge in their ability to write geometric proofs addressing right triangles and rectangles. All five participants were able to correctly prove the first problem addressing a right triangle. Participants either used methods of slopes or distances to prove the right triangle. In the second problem that addressed proving a rectangle, three out of five participants were successful in correctly completing the proof. The two who did not complete the proof correctly made calculation errors in finding the length of the rectangle’s diagonals. However, all participants commented on the properties of rectangles, including information about the rectangle’s diagonals.

Table 4

<table>
<thead>
<tr>
<th>PSSM Teachers’ Posttest Results</th>
<th>Question 1</th>
<th>Right Triangle Proof Concepts</th>
<th>Question 2</th>
<th>Rectangle Proof Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey</td>
<td>Correct</td>
<td>Negative reciprocal slopes; right angle</td>
<td>Correct</td>
<td>Diagonals of equal length</td>
</tr>
<tr>
<td>Chelsea</td>
<td>Correct</td>
<td>Perpendicular lines; negative reciprocal slopes; right angle</td>
<td>Correct</td>
<td>Opposite sides lengths equal; opposite sides parallel; perpendicular slopes; right angles</td>
</tr>
<tr>
<td>Monica</td>
<td>Correct</td>
<td>Distance formal; Pythagorean theorem; negative reciprocal slopes</td>
<td>Incorrect</td>
<td>Diagonals bisect at midpoint; two slopes of negative reciprocals; right angles</td>
</tr>
<tr>
<td>Tamesha</td>
<td>Correct</td>
<td>Negative reciprocal slopes; right angle</td>
<td>Incorrect</td>
<td>Opposite sides parallel; diagonals of equal length</td>
</tr>
<tr>
<td>Kyle</td>
<td>Correct</td>
<td>Negative reciprocal slopes; right angle</td>
<td>Correct</td>
<td>Diagonals of equal length; diagonals bisect at midpoint</td>
</tr>
</tbody>
</table>

Unlike the pretest (see Table 2), the posttest (see Table 4) indicated the PSSM teachers’ content understanding of diagonals of rectangles. The PSSM teachers recalled observations reviewed in the Texas Instrument’s (2014) Exploring Diagonals of Quadrilaterals task to accurately construct a geometric proof. For example, Kyle was successful at writing about the
rectangle’s diagonals of equal length and the fact that they bisected each other at the same midpoint, concepts never mentioned in any of the PSSM teachers’ pretest. Although the mathematics teacher educators would have liked for all of the PSSM teachers to complete the second question correctly, the minor miscalculations of Monica and Tamesha indicated computational errors that may have been caught by the PSSM teachers if they reviewed their work. Overall, the PSSM teachers’ exploration in the geometry module’s tasks and technology extensions contributed to the advancement in the PSSM teachers’ content knowledge of writing right triangle and rectangle geometric proofs. The TI-Nspire challenged the PSSM teachers to form conjectures, experiment with manipulating geometric figures, and engage in problem-solving activities.

**Preservice Mathematics Teachers’ Reflections**

Methods courses should provide PSSM teachers with opportunities to work with technology and see how it can be used in their teaching. It is essential for PSSM teachers to reflect on their beliefs, views, and experiences working with technology (Zhao & Bryant, 2007). The mathematics teacher educators asked the PSSM teachers to respond to an open-ended reflection prompt that followed the TI-Nspire geometry module. The guiding question for reflection was, ‘What benefits and/or challenges did you encounter in the geometry module when using the TI-Nspire?’

After the PSSM teachers reflected on their experiences, the mathematics teacher educators compiled a list of the PSSM teachers’ responses (see Table 5). Overall, it was noted that incorporating the TI-Nspire was beneficial for visual learners and enhanced the learning experience. The PSSM teachers additionally observed the value of teaching a concept in multiple ways in a co-teaching learning environment. Despite observed benefits to using TI-Nspire in the
geometry module, there were some concerns and challenges. Some of the PSSM teachers encountered technological challenges with not having enough experience working with the calculator.

Table 5

**PSSM Teachers’ Reflections**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Challenges</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey</td>
<td>-“The TI-Nspire was interesting.”</td>
<td>-“The TI-Nspire worksheet took too long and I felt I learned about the calculator instead of the math.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-“I felt the TI-Nspire slowed the lesson down and we could have gotten more done by simply drawing.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-“Technology is great in the classroom as long as it doesn’t keep you from covering everything.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-“It was helpful to learn about co-teaching because I will use it during my preservice.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-“I liked having experiences from multiple instructors.”</td>
</tr>
<tr>
<td></td>
<td>-“Technology is great in the classroom as long as it doesn’t keep you from covering everything.”</td>
<td>-“It was helpful to learn about co-teaching because I will use it during my preservice.”</td>
</tr>
<tr>
<td></td>
<td>-“I felt the TI-Nspire slowed the lesson down and we could have gotten more done by simply drawing.”</td>
<td>-“I liked having experiences from multiple instructors.”</td>
</tr>
<tr>
<td></td>
<td>-“I got a little frustrated at times.”</td>
<td>-“The co-teaching models demonstrated through the geometry lesson were very instructional and helpful.”</td>
</tr>
<tr>
<td>Chelsea</td>
<td>-“Using the TI-Nspire was nothing but helpful for me.”</td>
<td>-“Challenges I encountered would be not having enough experience with the TI-Nspire.”</td>
</tr>
<tr>
<td>Monica</td>
<td>-“I liked having different ways of completing the same type of problem.”</td>
<td>-“Having the different mathematics educators gave me different viewpoints.”</td>
</tr>
<tr>
<td></td>
<td>-“The benefit of using TI-Nspire is that it shows the student the image that he or she is working on.”</td>
<td>-“Having the different mathematics educators gave me different viewpoints.”</td>
</tr>
<tr>
<td>Tamesha</td>
<td>-“Using the TI-Nspire enhanced the learning experience. It was a great tool to be included in the module.”</td>
<td>-“Provided us with a great example on how to co-teach a lesson.”</td>
</tr>
<tr>
<td>Kyle</td>
<td>-“Incorporating the TI-Nspire was a nice addition for visual learners.”</td>
<td>-“The parallel teaching approach to right triangles helped by lowering the student/teacher ratio.”</td>
</tr>
<tr>
<td></td>
<td>-“The main benefits were that it (a) helped</td>
<td>-“The station teaching approach was helpful”</td>
</tr>
</tbody>
</table>
me visualize the concepts at issue, and (2) added a fun new aspect to the lesson to keep it fresh and hook the students.”
-“Learning two different ways to prove that a polygon is a right triangle is helpful.”

because it allowed us to learn the same concept from multiple different instructors through different activities.” -“I would definitely use parallel and station teaching to help students with different learning styles.”

In the mathematics teacher educators’ observations of the PSSM teachers’ experiences, most of the PSSM teachers appeared motivated and excited to engage with the technology. Initially PSSM teachers had trouble maneuvering around the document and manipulating the geometric figures by dragging their vertices. However, there was observed improvement in using the technology between the first and second task. PSSM teachers were also impressed when they learned about the interactive features and applications of the TI-Nspire. Some of the PSSM teachers even expressed their wish to have had this instructional tool when they first learned about triangles and rectangles in geometry. Overall, the PSSM teachers acknowledged the benefit of the TI-Nspire’s visual and kinesthetic approach to increasing their engagement and conceptualization of geometric concepts to aid in writing proofs.

Conclusive Remarks

In conclusion, the lessons learned through the exploratory experiences of the PSSM teachers were eye-opening and encouraging in that the mathematics teacher educators’ plans for preparing the PSSM teachers with more conceptual and procedural understanding appeared to make a difference. When the PSSM teachers were faced with the routine problems in the geometry module, the mathematics teacher educators learned that their memory recall was sparse. Despite having the qualifications to enroll in a secondary teacher education program, the
recent graduates and career changer seemed to have limited recall of some mathematics concepts and procedures. Therefore, the mathematics teacher educators employed an exploratory approach using the TI-Nspire CX CAS on some of the same concepts within the routine problems, asking the questions in different ways. By providing a collaborative learning space for the PSSM teachers to use the TI-Nspire calculators, the PSSM teachers enriched their conceptual understanding of writing geometric proofs addressing right triangles and rectangles. The advancement of the PSSM teachers’ mathematics knowledge was evident in the pretest and posttest comparisons and confirmed with the research literature (Ertmer et al., 2003; Ozgun-Koca & Edwards, 2009; Thomas & Hong, 2013).

The PSSM teachers were provided with a geometry model that incorporated the TI-Nspire CX CAS that aligned with the Georgia Standards of Excellence (GSE) efforts to initiate technology integration across the curriculum. Based on the PSSM teachers’ feedback, the mathematics teacher educators quickly realized that many of the PSSM teachers believed that single-handily using a Promethean or SMART Board would suffice as a sufficient form of technology integration needed within the curriculum. However, technology must include tools, such as handheld calculators, where students have direct access to technology. This realization of the PSSM teachers’ thinking was clear to the mathematics teacher educators that technology integration must be intentional from the beginning to the end of the preparation program with appropriate mentorship to effectively use the technology.

**Implications for Future Exploration**

As new technology fills the classrooms, teachers of all experience levels can be overwhelmed with finding time and resources to learn about new technology devices and how the devices’ capabilities can be tied to teaching and learning content curriculum (Thomas &
Hong, 2013). The mathematics teacher educators focused on two tasks in a geometry module that used different aspects of the TI-Nspire device to model and bridge technology and curriculum content. PSSM teachers were able to explore downloading TI-Nspire documents and manipulating geometric figures. The geometry module’s tasks served as an activity to expose PSSM teachers to the TI-Nspire CX CAS technology.

The mathematics teacher educators plan to continue the integration of technology as a component of the PSSM teachers’ methods courses. The mathematics teacher educators wish to continue researching the benefits and challenges of using technology in the mathematics classroom. A proactive approach to working with PSSM teachers will provide opportunities for PSSM teachers to learn how to efficiently and effectively use technology to meet the needs of mathematics’ learners.

Mathematics teacher educators must think about how to promote continued advocacy for the advancement in the application and mentorship of technology integration in the mathematics classroom. Based on what the mathematics teacher educators have observed and experienced, the following are critical issues to address.

Mathematics teacher educators should:

1. Reflect on their beliefs, views, and experiences working with technology;
2. Be proactive and intentional in providing their students (PSSM teachers) with opportunities for appropriate use of handheld technologies, such as the TI-Nspire CX CAS and/or others;
3. Consistently discuss the rationales for utilizing the technology;
4. Use the technological tools to enhance PSSM teachers’ mathematics knowledge and understanding of concepts and procedures in their teaching
practices and for their future careers.

Cooperating mathematics teachers (clinical practice) should:

1. Have access to the handheld technology to assist their assigned PSSM teachers;

2. Engage in professional development to enhance their knowledge of handheld technology;

3. Be willing to share their experiences and/or allow PSSM teachers to explore with the integration of technology.

Overall, mathematics teacher educators need a system of horizontal expertise across not only content but in the reinforcement of technology use across college and school campuses, which includes the mathematics teacher educators, university supervisors, and the PSSM teachers. Teacher education programs should invest time in incorporating technology integration opportunities that strongly encourage and inspire PSSM teachers to continue to expand their use of new technology in the mathematics classroom.
References


Appendix A

Curriculum Content Pre/Posttest

Please complete the following questions to the best of your ability. Remember to justify your mathematical reasoning process.

1. Prove (or disprove) that the polygon with vertices A(5, 6), B(8, 5), and C(2, -3) is a right triangle.

2. Prove (or disprove) that the quadrilateral with vertices W(2, 1), X(1, 3), Y(-5, 0), and Z(-4, -2) is a rectangle.

Appendix B

Learning Style Inventory
Assessment

What is your learning style? Everyone learns differently. Knowing your individual combination of strengths will help you to study and succeed academically.

To better understand how you prefer to learn and process information, place a check in the appropriate space after each statement below: Often (O), Sometimes (S), Rarely (R).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>O</th>
<th>S</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I can remember best about a subject by listening to a lecture that includes information, explanations and discussion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I prefer to see information written on a chalkboard and supplemented by visual aids and assigned readings.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I like to write things down or to take notes for visual review.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I prefer to use posters, models, or actual practice and other activities in class.</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>I require explanations of diagrams, graphs, or visual directions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I enjoy working with my hands or making things.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>I am skillful with and enjoy developing and making graphs and charts.</td>
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<tr>
<td>8</td>
<td>I can tell if sounds match when presented with pairs of sounds.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I can remember best by writing things down several times.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I can easily understand and follow directions on a map.</td>
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<td></td>
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<tr>
<td>11</td>
<td>I do best in academic subjects by listening to lectures and tapes.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>I play with coins or keys in my pocket.</td>
<td></td>
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<td></td>
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<tr>
<td>13</td>
<td>I learn to spell better by repeating words out loud than by writing the words on paper.</td>
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<tr>
<td>14</td>
<td>I can understand a news article better by reading about it in the newspaper than by listening to a report about it on the radio.</td>
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<tr>
<td>15</td>
<td>I chew gum or snack while studying.</td>
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<tr>
<td>16</td>
<td>I think the best way to remember something is to picture it in your head.</td>
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<tr>
<td>17</td>
<td>I learn the spelling of words by &quot;finger spelling&quot; them.</td>
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<tr>
<td>18</td>
<td>I would rather listen to a good lecture or speech than read about the same material in a textbook.</td>
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<td></td>
</tr>
</tbody>
</table>
19. I am good at working and solving jigsaw puzzles and mazes.

20. I grip objects in my hands during learning periods.

21. I prefer listening to the news on the radio rather than reading about it in the newspaper.

22. I prefer obtaining information about an interesting subject by reading about it.

23. I feel very comfortable touching others, hugging, handshaking, etc.

24. I follow oral directions better than written ones.

**Scoring Procedures**

Now place the point value for your selections on the line next to the corresponding item below. Add the points in each column to obtain the preference score under each heading.

OFTEN = 5 points      SOMETIMES = 3 points      RARELY = 1 point

<table>
<thead>
<tr>
<th>VISUAL NO.</th>
<th>PTS.</th>
<th>AUDITORY NO.</th>
<th>PTS.</th>
<th>TACTILE NO.</th>
<th>PTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>____</td>
<td>1</td>
<td>____</td>
<td>4</td>
<td>____</td>
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<td>22</td>
<td>____</td>
<td>24</td>
<td>____</td>
<td>23</td>
<td>____</td>
</tr>
</tbody>
</table>

Visual Preference = ____  Auditory Preference = ____  Tactile Preference = ____

**If you are primarily a VISUAL learner,** by all means be sure that you look at all study materials. Use charts, maps, filmstrips, notes, videos, and flash cards. Practice visualizing or picturing words and concepts in your head. Write out everything for frequent and quick visual review.
If you are primarily an AUDITORY learner, you may wish to use tapes. Tape lectures to help fill in gaps in your notes. But do listen and take notes - and review your notes frequently. Sit in the lecture hall or classroom where you can hear well. After you have read something, summarize it and recite it aloud. Talk to other students about class material.

If you are primarily a TACTILE learner, trace words as you are saying them. Facts that must be learned should be written several times. Keep a supply of scratch paper on hand for this purpose. Taking and keeping lecture notes is very important. Make study sheets. Associate class material with real-world things or occurrences. When appropriate, practice role playing.

Adapted from http://www.reading.ac.uk/ssc/resource-packs/UbosDvd/Module_6/M6_Session_01+02/Learning_Style_Inventory.doc
Appendix C

Geometry Module Task 1: Technology Extension

The Pythagorean Theorem—and More

Problem 1 – Investigating side lengths
Use page 1.2 to explore the following questions.

What is the relationship between $c^2$ and $a^2 + b^2$ when $\triangle ABC$ is a right triangle?

What is the relationship between $c^2$ and $a^2 + b^2$ when $\triangle ABC$ is an acute triangle?

What is the relationship between $c^2$ and $a^2 + b^2$ when $\triangle ABC$ is an obtuse triangle?

Use page 1.3 to determine whether a triangle with the given side lengths is acute, right, or obtuse.

1. 3 in., 7 in., 8 in.
2. 3 ft, 5 ft, 5 ft
3. 8 cm, 15 cm, 17 cm
4. 7.9 m, 11.5 m, 15.4 m
5. 26.2 in., 36 in., 48.1 in.

Problem 2 – Using squares
Explain how the diagram on page 2.1 demonstrates the Pythagorean Theorem.

Problem 3 – Extension
Use the diagram on page 3.1 to prove the Pythagorean Theorem by substituting expressions into the following equation. Then simplify each side.

\[
\text{Squares} = \text{Squares of triangles} + \text{Squares of squares}
\]
Geometry Module Task 2: Technology Extension

Exploring Diagonals of Quadrilaterals
Student Activity

Open the TI-Nspire document *Exp_Diagonals_of_Quads.tns.*

What type of quadrilateral can you create if you know the diagonals are perpendicular bisectors of each other? What if the diagonals were mutually bisecting? What if they were perpendicular? In this activity, you will investigate these different possibilities to determine the characteristics of diagonals of various quadrilaterals.

Move to page 1.2.

1. The two diagonals on this page are special because they always bisect each other. Drag any open point to make a quadrilateral. To see the quadrilateral, select $\triangle$ on the screen. Drag a point. To see angle measurements or side lengths, select $\triangle$. Then drag a point.

   a. Can you create each of the quadrilaterals in the table below? Record your findings in the table.

<table>
<thead>
<tr>
<th>Parallelogram (not rectangle, not rhombus)</th>
<th>Rectangle (not square)</th>
<th>Rhombus (not square)</th>
<th>Kite (not rhombus)</th>
<th>Square</th>
<th>Trapezoid</th>
<th>Quadrilateral with four different side lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes or No?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Why or Why not?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. What special quadrilaterals can be formed with bisected diagonals?
### Exploring Diagonals of Quadrilaterals

**Student Activity**

Each of the remaining problems in the file contains two diagonals that have some special property. Move through pages 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1, and 5.2.

2. What special quadrilaterals can be formed? Record your findings in the table below.

<table>
<thead>
<tr>
<th>Pg</th>
<th>Diagonal Properties</th>
<th>Parallelogram</th>
<th>Rectangle</th>
<th>Rhombus</th>
<th>Kite</th>
<th>Square</th>
<th>Trapezoid</th>
<th>Quadrilateral with four different side lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>Diagonals bisect each other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>One diagonal is a perpendicular bisector of the other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Diagonals bisect vertex angles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Diagonals are congruent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Diagonals are perpendicular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Return to page 1.2.

3. a. If the diagonals bisect each other, then the quadrilateral must be what type of figure?

b. Justify your answer.

---

Adapted from