Piloting a Co-Teaching Model for Mathematics Teacher Preparation: Learning to Teach Together

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In the field of mathematics, numerous recent reports and policy documents have stated clearly the need for mathematics learning to shift away from an overemphasis on the memorization of facts and mimicking of procedures and toward activities that engage students in developing an understanding of the relationships among mathematical ideas and between mathematics and the real world through the processes of reasoning and sense making (National Council of Teachers of Mathematics [NCTM], 2000, 2009; National Governors Association, 2010). Observational studies of mathematics classrooms in the United States over the past 30 years, however, have found these classrooms to be dominated by teacher talk aimed at transmitting fixed knowledge

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to students and teachers assessing how well it was received (Stigler & Hiebert, 1997; Stodolsky, 1988; Weiss, Pasley, Smith, Banilower, & Heck, 2003). The vast majority of mathematics lessons continue to focus on low-level thinking, "emphasizing the acquisition and application of skills" (Stigler & Hiebert, 1997, p. 18). This situation has only worsened over the past decade with the overuse of standardized assessments focused primarily on rote factual and procedural knowledge (Au, 2007). This presents a challenge for teacher preparation; namely, how will the next generation of teachers be trained to support learning that promotes a focus on conceptual understanding through processes of reasoning and sense making?

This study offers insights from an initial pilot of a co-teaching model for mathematics teacher preparation developed both to support experienced teachers in shifting their practice toward the vision set forth by NCTM and the Common Core State Standards for Mathematics (National Governors Association, 2010; NCTM, 2000, 2009) and to provide opportunities for preservice teachers of mathematics to gain experience with teaching practices better aligned with the new standards. Co-teaching is emerging as an alternative to the traditional student teaching experience, in which teacher candidates gradually assume full responsibility for instruction, assessment, and management in their field placement settings, a model that has not changed significantly in more than 50 years (Bullough et al., 2003).

Based on effective practices in special education (Cook & Friend, 1995), co-teaching involves two teachers sharing the planning, teaching, and assessment of groups of students in the same physical space. In the context of special education, the two teachers are a general educator and special educator. Much has been written about these co-teaching partnerships and the benefits for students with special needs who are served in general education classrooms, and it is not uncommon to see a special educator working alongside a general educator in elementary and secondary classrooms, including mathematics classrooms (Hunt, 2010; Magiera, Smith, Zigmond, & Gebauer, 2005; Mastropieri et al., 2005). In the context of teacher preparation, the co-teachers are a teacher candidate and the cooperating teacher. In this model, the teacher candidate is involved in teaching from the first day in the classroom, and the cooperating teacher maintains a high level of involvement throughout the experience.

One impetus for the interest in co-teaching in teacher preparation is the work of Bacharach and colleagues at St. Cloud State University (Bacharach & Heck, 2012; Bacharach, Heck, & Dahlberg, 2010). Their work has received national attention (National Council for Accreditation of Teacher Education [NCATE], 2010), and a consortium of teacher

preparation institutions supports the expansion of co-teaching (Bacharach & Heck, 2012). Although there is limited research on the impact of co-teaching on student learning and teacher candidate learning, the researchers at St. Cloud found that elementary students in classrooms that utilized a co-teaching model of student teaching outperformed peers in other classrooms on measures of reading and mathematics achievement (Bacharach et al., 2010). Additionally, they noted high levels of satisfaction among cooperating teachers and district administrators, who valued the closer partnerships promoted by a co-teaching model (Bacharach & Heck, 2012). Co-teaching is intuitively appealing to many because it makes maximum use of the human resources in the classroom, which enables teachers to better meet the diverse needs of their students through a smaller student-to-teacher ratio and more individualized support and attention (Graziano & Navarrete, 2012).

Administrators and faculty at the institution in which three of the authors work have expressed a strong interest in co-teaching as an alternative to traditional student teaching. Similarly, school districts in the region have indicated enthusiasm for working with the university's teacher preparation programs to adopt a co-teaching model. Several teacher education faculty in 2011 attended a workshop in the region, where they were trained in co-teaching by St. Cloud faculty (Bacharach & Heck, 2011), and, since that time, co-teaching has gradually been implemented within the university's elementary, secondary, and special education programs in partnership with local schools. Because we find the work on co-teaching compelling and believe that it has the potential to advance student learning as well as to promote professional collaboration and shared responsibility, we chose to implement it in a federally funded mathematics teaching program in which we are involved and to explore its perceived usefulness to the middle school and high school mathematics teachers with whom we partner. In this article, we report on the use of a co-teaching model developed and implemented specifically in foundational level mathematics courses in high-need schools.

Mathematics Teaching Project Description

Funded for six years by the National Science Foundation Robert Noyce Teacher Scholarship Program, the California State University, Fullerton, Mathematics Teacher and Master Teacher Fellows (MT2) Project is a collaborative effort of a large comprehensive university, a feeder community college, two high-need school districts, and the National Board for Professional Teaching Standards. The project's aim is to encourage talented STEM (science, technology, engineering, and mathematics)

majors to become middle school or high school mathematics teachers and to prepare them to work in high-need urban schools.

Interested students applied to the MT2 Program and were selected through a competitive process that included a review of their undergraduate coursework, an interview, a written personal statement that provided evidence of their commitment to working with traditionally underserved students and their experience related to working in high-need schools, and letters of recommendation. Applicants selected for participation demonstrated academic merit, a commitment to working with traditionally underserved students, and potential for success in a rigorous program of study. The project supports these "Teaching Fellows" in their achievement of a mathematics credential and master's degree in Secondary Education, with an emphasis on teaching foundational mathematics, both financially and through mentoring from project staff and experienced mathematics teachers ("Master Teaching Fellows"). Teaching Fellows are partnered at their field placement sites for their two-semester (30-week) student teaching fieldwork with the Master Teaching Fellows.

Experienced mathematics teachers from the twoi partner school districts applied to the MT2 Program to serve as Master Teaching Fellows and were selected through a competitive process that included a review of self-selected artifacts that demonstrated their effectiveness as a teacher of mathematics in high-need schools, an interview, a written personal statement that included evidence of their commitment to mentoring teacher candidates and to growing professionally through pursuit of National Board Certification, and letters of recommendation that addressed skills and experiences as collaborators and leaders within their school site and district. Applicants selected for participation demonstrated strong evidence of their positive impact on student learning, an interest in working with student teachers, collaboration skills, and a willingness to be challenged to grow as a professional and a leader.

The Master Teaching Fellows are prepared during annual summer institutes and monthly meetings to serve as mentors to the Teaching Fellows and as teacher leaders in their districts and the larger professional community. Additionally, they receive support and funding for working toward National Board Certification as a form of professional growth (Humphrey, Koppich, & Kough, 2005). Teaching Fellows and Master Teaching Fellows each receive an annual $10,000 scholarship or salary supplement for five years of participation in the project. Teaching in a high-need district is a condition of ongoing participation in the project, which is currently in its third of five years of implementation.

Partner Agencies

California State University, Fullerton, is the largest public institution of higher education in the county in which it resides and one of the largest in the state, with an enrollment of more than 37,000 students. Like the community it serves, it has no ethnic majority. Approximately 33% of the students are Hispanic, 29% are European American, 21% are Asian American or Pacific Islander, and 3% are African American. Similarly, Santa Ana College is the largest public two-year institution in the county and also among the largest in the state, with more than 29,000 students, of whom approximately 47% are Hispanic, 29% are European American, 14% are Asian American or Pacific Islander, and 2% are African American. Both the university and the college are identified by the Hispanic Association of Colleges and Universities as Hispanic-Serving Institutions.

Each of the two partner school districts serves both a high proportion and a large number of underrepresented minority students, especially Hispanic students. Anaheim Union High School District serves 33,700 students at 24 middle schools and high schools, 62% of whom are Hispanic and 28% of whom are classified as English learners. Further, 52% of the students participate in free or reduced-price meal programs. Norwalk-La Mirada Unified School District serves approximately 21,000 students at 28 elementary, middle, and high schools, 76% of whom are Hispanic and 23% of whom are classified as English learners. Of its students, 58% participate in free or reduced-price meal programs.

The non-profit organization National Board for Professional Teaching Standards, which offers advanced certification for teachers of mathematics based on standards that are well aligned with research-based best practices, also serves as a partner with this project by providing access to resources and expertise to support the Master Teaching Fellows as they work toward earning National Board Certification and, once certified, develop skills as candidate support providers for National Board candidates.

The Fellows

Two cohorts of Teaching Fellows, totaling 20, were selected and are participating in the program. The first cohort completed the requirements for a foundational-level mathematics credential in Spring 2012, and all but one Fellow, who is substitute teaching, obtained a mathematics teaching position. The second cohort completed the credential program in Spring 2013, and all but two Fellows, who are substitute teaching, obtained a mathematics teaching position. Nine of the Teaching Fellows are male, and 11 are female. The group ranges in age from 22 to 49 and is ethnically diverse, with six Hispanic, seven Asian American, two African American,

four European American, and one Persian American Teaching Fellow.

Ten experienced mathematics teachers, who teach at eight sites in the target districts, serve as Master Teaching Fellows. Six teach at the junior high or middle school level, and four teach at the high school level. Six are female and four are male, and they are ethnically diverse and include five Asian Americans, three Hispanics, and three European Americans. Their teaching experience ranges from 5 to 12 years.

Preparation for Co-Teaching

Teaching Fellows and Master Teaching Fellows were initially prepared for co-teaching in a half-day workshop at the beginning of the Teaching Fellows' student teaching experience. Training included lessons and discussions that pertained to the rationale, research base, and components of co-teaching; explanations and examples of the seven co-teaching strategies (as seen in Table 1); the necessity of clear and

Table 1
Co-teaching Strategies

Strategy	Description
One Teach, One Observe	One teacher assumes instructional responsibility, and the other conducts agreed-upon targeted observations of the students or the co-teacher.
One Teach, One Assist	One teacher assumes primary instructional responsibility, and the other provides assistance.
Team	Both teachers have instructional responsibility and are actively involved in the lesson.
Parallel	Each teacher teaches half the class. The lesson and materials are the same.
Station	Students rotate to different stations where different instruction and activities are occurring. Each co-teacher leads a station, and there may be independent stations or student-led stations as well.
Supplemental	One teacher works with students who are at grade level, and the other works with a group of students who have already met the standard to offer enrichment or with students who need remediation.
Alternative	Both teachers address the same objectives but use different approaches, based on the needs of the learners.

Note. Adapted from Bacharach, Heck, and Dahlberg (2010), p. 7.

open communication, accompanied by opportunities to practice communication skills through role playing; and strategies for building positive relationships between co-teachers. The workshop was followed by electronic communications, sent to participants, that included reviews of the purposes and components of co-teaching, responses to frequently asked questions, discussions of co-teaching myths, and links to videos of co-teaching in action.

In addition, as part of their credential program coursework, Teaching Fellows participated in a once-weekly, three-hour general pedagogy seminar taught by an instructor knowledgeable about co-teaching, who monitored their progress as they implemented the co-teaching strategies in their fieldwork. Cohort 2 Teaching Fellows also took part in a workshop conducted by a Cohort 1 Teaching Fellow, who shared her experiences with co-teaching and insights gained as a student teacher and as a first-year teacher. She helped the new Teaching Fellows reflect on creating and implementing co-teaching lesson plans. The Master Teaching Fellows participated in monthly meetings with two of the project directors; the meetings included discussions about their successes and challenges with co-teaching and Fellows' responses to hypothetical scenarios on co-teaching that included issues brought to the attention of the project directors.

Co-teaching was new to all participants. Although several of the Master Teaching Fellows had worked with special educators in the classroom for a number of years, none had received training in how to best take advantage of having two teachers in the classroom. Typically, the special educator served as an assistant in the classroom and provided individualized support to students during a lesson.

An Example: Station Teaching as a Co-teaching Strategy

Developing acuity in using linear equations is a critical skill in any algebra class. In alignment with an emphasis on conceptual learning, the primary outcome of this lesson was for students to be able to recognize the structure of different forms of linear equations (point-slope, standard, slope-intercept) and the relationship of these to both graphical representations and real-world contexts. For this lesson, the co-teachers (the last two authors) decided that the Station Teaching strategy would work well to support the learning goals that they had in mind, which included a focus on students' precise use of academic language to express their reasoning and students' fluency with moving between the different forms of linear equations.

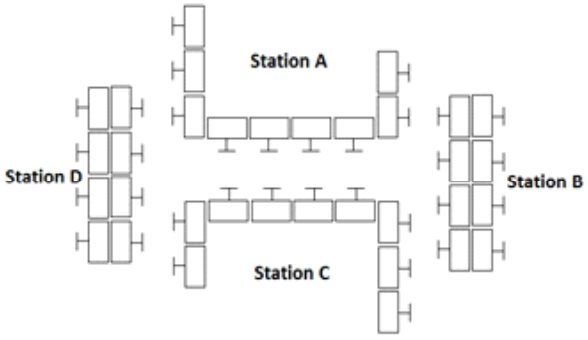
This lesson was conducted at a large urban high school with a student population that is 95% Hispanic, of whom 40% are English language learn-

ers. In Algebra 1, students often have trouble with the academic language. To support their development of mathematical proficiency, as described in NCTM standards and Common Core State Standards for Mathematics, teachers designed lessons to foster students' mathematical thinking and require students to communicate their reasoning orally and in writing.

The classroom was divided into four stations, with the desks in stations A and C set up in two U-shapes around white boards and stations B and D along either side of the room, as depicted in Figure 1. Students at Stations A and C were teacher-led, and, at Stations B and D, students either worked independent of a teacher or were student-led . This formation allowed each co-teacher to quickly look over the work of students at their station while also having a clear view of each of the independent stations. In this way, both co-teachers were able to monitor all activities within the class. The lesson took place over two 50-minute periods. Students started in one of the four stations then rotated to a new station halfway through each period. The specific activity for each station is presented in Table 2.

Although the impact of this specific lesson on student learning was not compared with the impact of a more traditional approach, it is notable that the co-teachers involved reported that their use of co-teaching strategies throughout the school year helped them to better conceptualize the collaborative lesson structure and activities; the Master Teaching Fellow reported having never used stations before becoming involved with the co-teaching model. As a way to gain additional insight into the experiences of the participants with this new model of teacher preparation, we sought the perceptions of the co-teachers in their use of the co-teaching strategies.

Figure 1
Station Teaching Room Arrangement



Questions and Data Collection

Of primary interest to us in the early stages of implementing co-teaching were the Fellows' perceptions of this alternative to traditional student teaching. With which strategies did they feel successful? Which were their most and least liked strategies, and why? Did the experienced teachers and teacher candidates have the same perceptions?

The collected survey data focused on Fellows' ratings of their success with implementing each of the seven co-teaching strategies and their perceptions of their most and least favorite strategies. The survey,

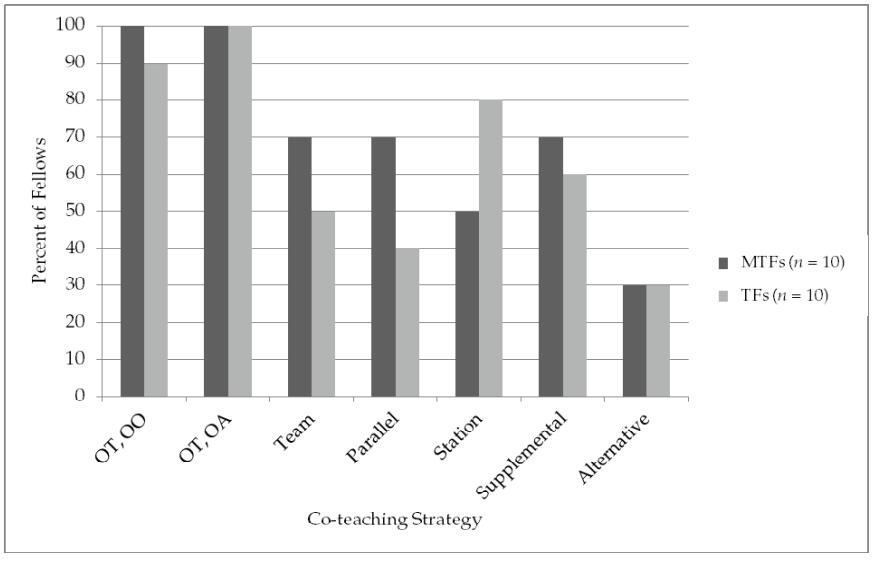
Table 2
Activities for a Station Teaching Lesson on Linear Equations

Station A: Teacher-led Instruction (Sort equations and identify parts) The focus of this station is to help students identify the three different graphing forms (point-slope, slope-intercept, and standard). Students will be asked to sort several equations and then to identify specific components of each equation, such as the slope, the y-intercept, the x-intercept, or points on the line. The intent is for students to recognize structure and clearly identify components of an equation, their use, and their representation on a coordinate plane.	*Station B: Independent* (Pairs, share a card) This station will require students to work with a partner. Each student will be dealt a card that has a coordinate plane with an equation graphed on it. The back of the card identifies key characteristics of the equation (e.g., slope, y-intercept). One student holds up a card, and the other student has to identify the criteria that are important to describe the linear relationship shown on the graph. Because each card contains the answers on the side that faces the one who holds it, this is a good way to have partners assess one another.
Station C: Teacher-led Instruction (Applied problems) The teacher will present two to three applied problems and read the problems with the students. This station will expose students to more contextualized problems and help them to identify relevant information, set up mathematical expressions, and apply their understanding of linear relationships to find a solution that makes sense.	*Station D: Independent* (Matching graphs to equations) Students will be given several graphs and equations and will be asked to match the correct graph with each equation. Students already have had some exposure to this station, so it will serve as more of an independent practice.

presented in the Appendix, was administered to the Master Teaching Fellows near the end of their second year of co-teaching implementation and to the Cohort 2 Teaching Fellows near the end of their two-semester student teaching experience. In addition, seven Master Teaching Fellows and two Cohort 1 and eight Cohort 2 Teaching Fellows voluntarily participated in small-group or individual unstructured interviews, which enabled the authors to obtain richer insights into the Fellows' thinking about the implementation of co-teaching strategies. Fellows were selected based on convenience and availability.

We also wanted to ascertain the Fellows' overall impression of the value of co-teaching as a model for student teaching. In particular, we sought their responses to the question of whether co-teaching is a realistic model, given feedback that we had received anecdotally from university supervisors, master teachers, and teacher candidates, who expressed concern that the teacher candidates will most likely not have co-teachers in their future classrooms and, thus, may be disadvantaged by participating in a co-teaching model. This question was posed during the unstructured interviews.

Figure 2
Percentage of Master Teaching Fellows and Cohort 2 Teaching Fellows Who Reported Success with Each Strategy



Findings

Perceived Success with Strategies

Figure 2 displays the percentage of the 10 Master Teaching Fellows and 10 of the 11 Cohort 2 Teaching Fellows who reported feeling successful in their implementation of each co-teaching strategy. In both groups, very high percentages of Fellows rated their implementation of the One Teach, One Observe and One Teach, One Assist strategies as successful, with 100% of the Master Teaching Fellows' reporting success and 90% and 100% of the Teaching Fellows' reporting success with the two strategies, respectively. Smaller percentages, ranging from 30% to 80%, of Fellows indicated success with each of the other strategies, with at least 50% of the Master Teaching Fellows' reporting success with every strategy except Alternative Teaching and at least 50% of the Teaching Fellows' reporting success with every strategy except Parallel Teaching and Alternative Teaching. With the exception of One Teach, One Assist; Station Teaching; and Alternative Teaching, more Master Teaching Fellows than Teaching Fellows reported success with the strategies. Equal percentages reported success with One Teach, One Assist and Alternative Teaching, and 80% percent of the Teaching Fellows claimed success with Station Teaching compared to only 50% of the Master Teaching Fellows. Alternative Teaching was identified as successful by the smallest percentage of Fellows, at 30% for both groups. Comments on the survey revealed that several Fellows had failed to try it, largely because, in the words of one Teaching Fellow, "it seems so challenging."

Most- and Least-Liked Strategies

The Fellows were asked on the survey to identify two strategies that they liked the most and two that they liked the least, based on whatever criteria are important to them. Combined data for the two groups (10 Master Teaching Fellows and all 11 of the Cohort 2 Teaching Fellows) are presented in Figure 3, where it can be seen that all strategies were selected as both most and least favorite by at least one Fellow and no strategy was selected as most or least favorite by all Fellows. Team Teaching received the most responses, having been selected by nearly 70% of the Fellows as either a strategy that they liked the most (43%) or the least (24%). Parallel Teaching was the only strategy that was selected by more Fellows as least favorite (33%) than most favorite (19%).

Data for the Master Teaching Fellows and Teaching Fellows are disaggregated in Figures 4 and 5. As in the combined data, responses were distributed across the strategies, and all strategies were deemed a favorite by at least one Master Teaching Fellow and one Teaching Fellow.

Figure 3
Percentage of Master Teaching Fellows and Teaching Fellows (Combined) Who Selected Each Strategy as Most and Least Favorite (n=21)

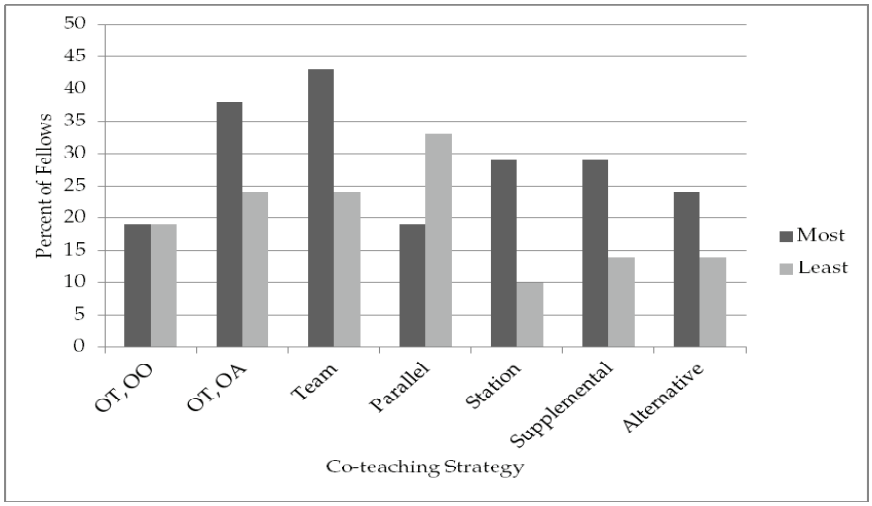


Figure 4
Percentage of Master Teaching Fellows and Cohort 2 Teaching Fellows Who Identified the Strategy as One of Two that They Liked the Most

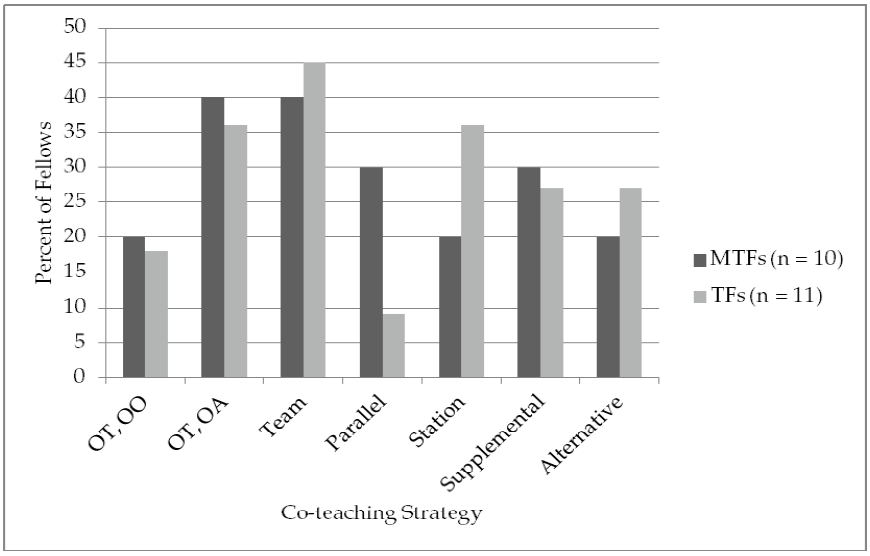
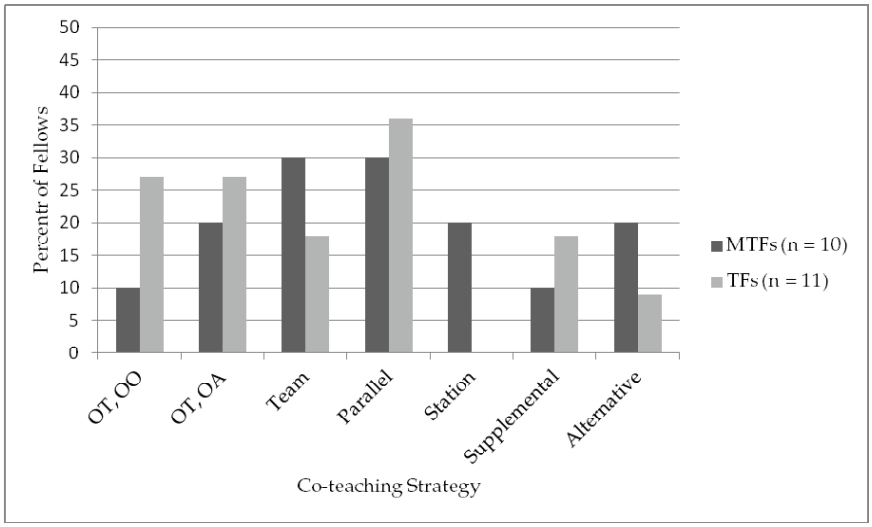


Figure 5
Percentage of Master Teaching Fellows and Cohort 2 Teaching Fellows Who Identified the Strategy as One of Two that They Liked the Least



Similarly, all strategies were selected as least favorite by at least one Master Teaching Fellow, although only six of the seven strategies were selected as least favorite by at least one Teaching Fellow. The exception was Station Teaching, which was not selected as a least favorite by a Teaching Fellow. The greatest difference between Master Teaching Fellows and Teaching Fellows was in their selection of Parallel Teaching as a favorite strategy, with 30% of the Master Teaching Fellows' selecting it as a favorite in contrast to only 9% of the Teaching Fellows' doing so.

Perception of the Value of Co-Teaching

During the unstructured interviews, six of the seven Master Teaching Fellows interviewed shared that they found co-teaching to be an effective and realistic student teaching model that supported their co-teacher's development as teachers, enhanced their own teaching, and enriched learning opportunities for their students. They generated numerous examples of how co-teaching could be useful in their own and their Teaching Fellows' future classrooms, including enhancing their ability to work with teaching assistants, special education colleagues, and other general education colleagues, as well as with those who teach in other content areas. The one Master Teaching Fellow interviewed who did not enthusiastically support the co-teaching model stated that she had not

sufficiently practiced the full range of strategies with her Teaching Fellow co-teacher to feel successful and, thus, was not in a position to judge the usefulness of the co-teaching model for future classroom experiences.

In contrast, during the interviews, three Cohort 2 Teaching Fellows expressed concern about whether they would have opportunities to co-teach when they obtain teaching positions. The majority, however, including the Cohort 1 Teaching Fellows who were now teaching in their own classrooms, felt that the co-teaching experience better prepared them for teaching foundational-level mathematics due to the rich co-planning opportunities that accompanied the co-teaching experiences and the variety of pedagogical approaches that they explored with their Master Teaching Fellow partners. They expressed a belief that the co-planning and co-teaching skills that they acquired during their teacher preparation would benefit them in interactions with specialists and colleagues at their sites and, one day, with student teachers of their own. Additionally, several noted that co-teaching gave them an edge in job interviews because districts in the region are increasingly interested in the model.

Discussion

The survey and interview data that we collected provided a means to understand our experienced teachers' and teacher candidates' perceptions of co-teaching, including their success with each of the seven co-teaching strategies, their attitudes about each of the strategies, and their response to co-teaching as a student teaching model. The Fellows' perspectives will help us refine and extend our efforts to prepare teachers to work in foundational-level (grade 7 through geometry) mathematics classrooms.

Perceived Success with Strategies

Not surprisingly, 100% or nearly 100% of the Fellows felt successful with the One Teach, One Observe and One Teach, One Assist strategies. These strategies most closely parallel a traditional student teaching model and, thus, were likely not a stretch for either group of Fellows. Many of the Master Teaching Fellows had served as cooperating teachers in the past and had developed skills in observing and assisting student teachers as well as in being observed and assisted by student teachers. All Teaching Fellows had spent time in secondary classrooms during their undergraduate years, prior to entering the credential program, and, thus, had similarly engaged in observing and assisting. One Master Teaching Fellow captured the commonly held perception that these strategies are "the easiest to implement"; several Teaching Fellows noted that they use these strategies often in their work in the schools.

A majority of Master Teaching Fellows reported success with Team Teaching, Parallel Teaching, and Supplemental Teaching. Several noted that Team Teaching was highly effective once they developed a rhythm with their co-teaching partner. Students, they felt, were more attentive and engaged when both teachers were fully involved in the lesson together. Further, they valued that students enjoyed the benefit of hearing two explanations of the material. Many Teaching Fellows stated that it took a bit of time for their Team Teaching to become seamless, but when it happened, the result was highly positive. The Teaching Fellows who felt less successful with Team Teaching expressed a concern about "knowing when to talk," and one admitted to being too shy to interject a comment when her co-teaching partner was teaching.

Master Teaching Fellows and Teaching Fellows who felt successful with Parallel Teaching noted that the decreased student-to-teacher ratio and the planning of a single lesson made this strategy easy to plan and implement, although some commented that the noise level and related management issues could be difficult. The success reported for Supplemental Teaching by both Master Teaching Fellows and Teaching Fellows may be related to recent emphases on differentiation in teacher preparation programs, induction programs, and professional development experiences offered by school districts. Fellows were well informed about the importance of and strategies for meeting the needs of the range of learners in their classrooms. In addition, the opportunity to have a second teacher in the classroom to offer remediation or enrichment to small groups as needed was grasped and utilized frequently.

It is not surprising to us that the experienced teachers in our project generally felt more successful with the co-teaching strategies than did their co-teaching partners. These experienced teachers were coming from positions of pedagogical strength, or they would not have been selected for this project, and were able to adopt new strategies with some ease. In addition, they were in their second year of co-teaching, having first learned and implemented the strategies with Cohort 1 Teaching Fellows and, thus, had more experience than did the Cohort 2 Teaching Fellows who participated in this study. Station Teaching was the exception, however, with more Teaching Fellows than Master Teaching Fellows reporting success, although fully half of the Master Teaching Fellows did indicate success with this strategy. Those who did not indicate success with Station Teaching commented on the difficulty of monitoring student progress at all stations and of managing rotation transition time to make best use of limited instructional time. These concerns perhaps reflect a level of sophistication about teaching that the Teaching Fellows

have not yet achieved. The Teaching Fellows may have had a narrower vision of the Station Teaching strategy, and success at their station, through which a small number of students at a time rotated, may have translated to a view of Station Teaching as successful in general.

Most- and Least-Liked Strategies

Although nearly all Fellows reported success with the One Teach, One Observe strategy, overall it was selected by the fewest number of Fellows, combined, as a favorite. In contrast, One Teach, One Assist, deemed a success by all Fellows, was selected by many Fellows as a favorite. Even so, comments included the following:

- "While observing and assisting are good, it feels like a teacher is being wasted."
- "In One Teach, One Assist, I feel like I am not utilizing myself or the Master Teaching Fellow fully."
- "One Teach, One Observe and One Teach, One Assist are my least favorite. With co-teaching, there are two teachers in the classroom. It makes sense to take advantage of that opportunity and utilize the skills and knowledge of both teachers in the classroom to support as many students as possible."

Feeling successful with a strategy did not necessarily translate into its being a favorite of the Fellows. As another example, 80% of the Teaching Fellows indicated that they felt successful with Station Teaching, yet only 36% identified it as one of their two favorites, and comments revealed that planning and managing stations were issues for some.

- "This strategy took a lot of planning."
- "This strategy is tough to implement but it works."
- "Rotation transition time makes Station Teaching challenging because of our short periods."
- "We don't have enough space for students to move around."

Similarly, 70% of Master Teaching Fellows indicated success with Parallel Teaching, but it was selected as a favorite by only 30% of them, possibly due to the noise level and the potential for distraction that was expressed by some Fellows. As one Master Teaching Fellow explained, this strategy "was distracting for the students and required more classroom management skills from both the Master Teaching Fellow and the Teaching Fellow."

In contrast, however, Team Teaching was labeled a success by 70% of the Master Teaching Fellows and was identified as a favorite by more

Fellows than was any other strategy except One Teach, One Assist, which was selected by an equal number. Fellows commented that:

- "I like this the most because we are both active and the class is most engaged."
- "We work well together, interjecting ideas and comments when the other is teaching."
- "In Team Teaching, we can play off each other and the students are more engaged."

They also acknowledged the difficulty, however, in implementing this strategy.

- "Finding the time to plan together is important and can be difficult. It's challenging not to step on each other's toes without explicit planning."
- "Success depends on the relationship between the co-teachers."

As these comments show, there was variation in perceptions of the co-teaching models both within and between the two groups of Fellows. Each group had a somewhat different slant on which approaches they liked and did not like, and why. At the same time, each group recognized the value of using a co-teaching approach to create a more engaging classroom.

Perception of the Value of Co-Teaching

As a group, the Master Teaching Fellows have embraced co-teaching as an alternative to the traditional student teaching model. Most indicated that they will continue to utilize the model with future teacher candidates, and at least one is teaching colleagues how to implement co-teaching, both informally at his site and formally by sharing his experiences and providing training at professional conferences for mathematics educators (accompanied by his Teaching Fellow co-teacher). The Teaching Fellows, although somewhat less consistent in their level of enthusiasm for co-teaching, with a few who wondered how they will manage their first year of teaching without a co-teacher partner, all indicated a belief in the value of co-teaching for the students in their co-teaching classrooms.

Implications

The strong interest in co-teaching in the College of Education and, increasingly, in the College of Natural Sciences and Mathematics at our university, as well as from district partners in the region, has resulted in major efforts to include it in all of our teacher preparation programs. Through the MT2 Project, we were able to offer ongoing support to a

small number of experienced teachers and teacher candidates as they worked to implement co-teaching strategies in their middle and high school mathematics classrooms and to explore teachers' perceptions of the strategies. Although there is much to learn, including the impact of co-teaching on students' mathematical learning, we have gained some insights into co-teaching in teacher preparation, which will inform our future work.

One insight from this work was that the Master Teaching Fellows and Teaching Fellows had diverse experiences with and perspectives on the seven co-teaching strategies. Each strategy was judged a success by at least one of the Fellows and was selected as a favorite by at least one. Although, in our monthly meetings, we engaged Master Teaching Fellows in discussing their successes and concerns with one another, in the future, we will do more to develop peer-learning opportunities. Ideas shared by those who are working to achieve the same goals, in this case, success with co-teaching, can powerfully influence other teachers' practice. For example, one concern expressed about the Station Teaching was that short instructional periods would not allow for meaningful experiences at each of four stations. The concern was addressed by another Master Teaching Fellow, who explained that he spreads the station rotations over a two-day period, thus allotting more time at each station. This was an "aha moment" that was made possible by the fact that we had dedicated time to discussing our co-teaching practices on a regular basis. The Master Teaching Fellow also shared advice in regard to room arrangement that informed peers who were working to deal with management issues. As we continue this work, we will ensure that teachers have plentiful opportunities to share their experiences with their colleagues, who can share their successes in return.

Overall, this study found evidence that a co-teaching model may offer better support than a traditional model for preparing mathematics teachers who have the skills and disposition to work collaboratively with colleagues to help plan and implement lessons in which students learn mathematics through processes of reasoning and sense making. Not surprisingly, strategies that were closest to traditional approaches were more comfortable for both the master teacher and student teacher. Nonetheless, the data indicate that all of the Master Teacher Fellows broke away from traditional teacher-led instruction and tried several new instructional strategies associated with co-teaching. It was primarily through their shared experience of learning together how to successfully implement new strategies that the teachers, new and experienced, grew professionally. Despite the difficulty in changing mathematics teacher practice, the use of co-teaching in teacher preparation offers a unique method for promoting

teacher change. In addition, it is often reported in the teacher education literature that students notice a gap between the strategies that they are taught in university methods courses and the realities that they see in their field placements (e.g., Korthagen, Loughran, & Russel, 2006; Vick, 2010). The necessary collaboration required in the co-teaching model and opportunity for university faculty to work with master teachers as partners offers a model for closing this gap.

Future research could examine the processes for supporting co-teachers to feel successful with planning and implementing co-teaching strategies that are less traditional. In addition, larger scale implementation of co-teaching in mathematics classrooms would allow for the study of its impact on learning outcomes for students as well as on the performance of new teachers prepared in a co-teaching model as compared to those prepared in a traditional model.

The implementation of a co-teaching model brings into specific relief the importance of developing trusting relationships between Master Teaching Fellows/cooperating teachers and their Teaching Fellow/student teacher partners. In the mathematics classroom, this partnership is especially evident in the way that lessons are designed and delivered. In addition, with a co-teaching model, new teachers learn from the start that the profession of teaching should be built on professional collaboration rather than isolation. As the Common Core State Standards for Mathematics begin to be implemented, the co-teaching model may be especially useful for mathematics credential programs that seek to develop effective curricular implementation and meaningful professional relationships within the teaching community.

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Appendix
Co-teaching Survey

1. The co-teaching strategies have different purposes, benefits, and challenges. IN GENERAL, please indicate your success with each of the strategies by placing an "X" in the appropriate cell ("successful" or "not successful"). Write a brief explanation in each cell.

	Successful (Comment)	Not Successful (Comment)
One Teach, One Observe		
One Teach, One Assist		
Team Teaching		
Parallel Teaching		
Station Teaching		
Supplemental Teaching		
Alternative Teaching		

2. In the left column of the list above, circle the two strategies that you like the most. Why did you select these two?

3. In the left column of the list above, place an asterisk by the two strategies that you like the least. Why did you select these two?