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Policies and Practices Influencing Algebra I Student and Teacher Placement in Indiana

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The issue of access to algebra has garnered national attention, as it is a gatekeeper and predictor for future success in mathematics and post-secondary schooling (Adelman, 1999) and has also been identified as a civil right (Moses, Kamii, Swap, & Howard, 1989). In fact, Moses, et al. (1989) called for all eighth-grade students to have access to a high-quality Algebra I course. This movement gained momentum as schools across the nation implemented eighth-grade Algebra I programs (Cogan, Schmidt, & Wiley, 2001; Loveless, 2008; 2013). However, this simultaneous call for access and quality was never fully realized on a national scale (Loveless, 2008). This could have been partially due to lackluster curricular planning, as Carraher and Schliemann (2007) note that "early algebra" does not necessarily mean algebra taken earlier. When implemented well, "early algebra" refers to the weaving of age-appropriate algebraic ideas into the elementary, middle, and secondary curricula. Thus, merely requiring all eighth-grade students to take Algebra I will not result in positive outcomes for students unless the elementary- and middle-school curricula prepare them accordingly.

We are familiar with this trend of enrolling more students in eighth-grade Algebra I, and we also are aware of the approaches schools take to remediate students in Algebra I once they are already in the course (e.g., doubling time for students in Algebra I, remediation for low-achieving students, opportunities for all students to attend remediation sessions) (Stein, Kauffman, Sherman, & Hillen, 2011). Courses can also be offered in various tracks, such as remedial, regular, and enriched (Cogan, et al., 2001). It is important to examine the factors that determine how students are not only placed in Algebra I itself, but in the specific track appropriate for their needs.

To further complicate matters, what was considered algebra when Moses, et al. (1989) were calling for "algebra for all" is not necessarily what modern mathematics educators consider algebra. Kiernan (2007) details a decades-long shift from viewing algebra as a study of symbolic manipulation to more of a complex subject through which students acquire strategies for real-world problem solving, including the use of technology as a problem-solving tool. In apparent agreement with the more modern conceptions of algebra and "early algebra," the National Council of Teachers of Mathematics [NCTM] (NCTM, 1989; 2000) has continually called for algebra to be woven throughout the preK-12 curriculum so as to ensure that all students are provided with opportunities to succeed in algebra (NCTM, 2014). The *Indiana Academic Standards [IAS]* (Indiana Department of Education, 2015) and nationally-prevalent *Common Core State Standards for Mathematics* [CCSSM] (National Governors Association Center for Best Practices & Council of Chief State School Officers [NGA & CCSSO], 2010) also consider algebra a critical component of the secondary curriculum. In addition, the IAS contain a strand for "algebraic thinking" that begins in third grade, and the CCSSM's "algebraic thinking" strand begins in Kindergarten.

Although this movement towards requiring algebra classes earlier in the curriculum is a seemingly positive reaction to the work of Moses, et al. (1989)—and the parallel testing initiatives are meant to hold schools accountable for robust implementation of these curricula—it has resulted in several unintended consequences for student learning. Loveless (2008) describes how mandated eighth-grade algebra has not been a solution for the estimated 120,000 students "lost" in the course. These are students who enter Algebra I grievously underprepared and, in some cases, are estimated to be testing at as low as a second-grade level in mathematics. In studying this phenomenon, Loveless (2008) notes, "Almost nothing is known about the students who are taking these courses" (p.4). He also notes that the teachers teaching Algebra I to these underprepared students may hold lower qualifications and have fewer years of experience than their better-prepared counterparts—even though NCLB requires teachers of core subjects (e.g., mathematics, science) to be highly-qualified (Loveless, 2008). "Highly-qualified" teachers are required to pass high-stakes testing for licensure; yet, testing is not necessarily a predictor of teacher quality since other factors, such as student enrollment and class size, come into play (Wilson, 2007). Cogan, et. al. (2001) note the differences in algebraic foci (e.g., variation in time spent on a given topic) from teacher to teacher and the impact those could have on student achievement. Investigating how teachers are chosen to teach a high-stakes course such as Algebra I can further inform us about the decision-making processes involved at the district and school levels.

Recent trends at both the national and state levels suggest that accountability measures are being positioned as key components of modern educational culture. Starting in 2000, just ahead of the *No*

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About the Journal

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The *Indiana Mathematics Teacher* is a peer-reviewed publication of the Indiana Council of Teachers of Mathematics. The *Indiana Mathematics Teacher* provides a forum for mathematics teachers from pre-kindergarten through college to present their ideas, beliefs, and research about mathematics teaching and learning. We are currently seeking manuscript submissions, and welcome them from preK–12 teachers, university mathematics educators, professional development providers, graduate students, and others with a vested interest in mathematics education. Manuscripts should be written for an audience of K–16 mathematics teachers and should be limited to approximately 1500–3000 words. For more information and full submission guidelines see *ictm.onefireplace.org* or contact the editors at *djmohr@usi.edu* and *rhudson@usi.edu*. If you are willing to serve as a peer reviewer to provide feedback on potential articles, contact one of the editors.

Child Left Behind Act of 2001 [NCLB] (2002), Indiana required students to pass a Graduation Qualifying Exam [GQE] in order to receive a diploma (Bilber & Gilman, 2003). The GQE was modified in 2004-2005 to include more algebra content than in previous years (Spradlin, et al., 2005) and then underwent changes again with the graduating class of 2012 when the mathematics portion of the required graduation exam took on the form of an End of Course Assessment (ECA) students were to take after completing their Algebra I course (Center on Education Policy, 2011). In Indiana, all students working to receive a diploma were required to pass the Algebra I ECA (Indiana Department of Education, 2014, April). This exam was only given to those students currently or previously enrolled in the course, which meant students could have been taking their graduation qualifying exam before they entered high school. A shift, however, has occurred in the 2015-2016 school year from students taking the Algebra I ECA exam to taking a "college-and-career-readiness" graduation exam in tenth grade; this eliminates the varying grade levels in which students would have taken the ECA. According to a memorandum sent out by Indiana's Office of Student Assessment Director Dr. Michelle Walker on December 8, 2014, this exam will assess student mastery as well as serve as an accountability measure for schools (Indiana Department of Education, 2014, December). Indiana is following national trends of increasing high-stakes testing in mathematics, yet tests of this scale (e.g., state-wide) are subject to errors in scoring, reliability, and validity (Wilson, 2007). Because of the potential consequences of students being misplaced in Algebra I (Loveless, 2008), we need to know more about how schools place students into Algebra I—particularly, whether or not they are using these tests to place students in the course.

In light of this body of research calling for student access to algebra with highly-qualified teachers both at the national and state levels, we ask, "What policies and practices shape Algebra I programs in Indiana?" To answer this, we specifically ask: (1) How do schools determine who will teach Algebra I, when students will take it, and in what format they take it? (2) Who is involved in making these decisions?

This information will provide insight into the current state of Indiana's algebra policies and practices, namely telling us more about the placement of students and teachers in these courses and how schools structure them; it will also reveal the extent to which these policies vary across the state. Beyond this, we also hope this study will contribute to the national discussion regarding Algebra I policies and practices by serving as an example of what it looks like to take the temperature of Algebra I at the state level.

Methods

In order to describe a broad picture of algebra program structures in Indiana, we surveyed the 292 public, non-charter school districts across the state. The survey was created by and administered with Qualtrics® software. A link to the survey was emailed to the districts' superintendents in the majority of cases, with a request made that the person with the most knowledge of the Algebra I policies and practices be asked to complete it. If unable to reach the superintendent for each district, we contacted the next accessible administrator or mathematics department chair.

The survey was comprised of 19 items; three items requested background information or other contacts for more information, eight items were on the structure of the school and/or course, five items on the teaching of the course, two items on when students are taking it, and one item was left for any additional information they wanted to share. Several of the multiple-choice items allowed respondents to describe options that were not listed (e.g., What criteria determine who teaches Algebra I?).

Below, we present the survey results with regards to the structure of Algebra I, when students are placed in the course, and who is chosen to teach the course—all while discussing who is making these decisions. We conclude with a brief discussion regarding the implications of these findings.

Survey Results

Our survey had a response rate of 43% (N = 292), with 54% (n = 126) of those responses indicating their willingness to participate in an interview to further discuss their district's Algebra I policies and practices. Of those that completed the survey, 63% (n = 126) were leaders at the local level (38% local administrators, 25% teachers/department chairs), 31% at the district level (e.g., Superintendent, Director of Mathematics/Curriculum), and 6% did not respond to this item. Eighty-nine percent (n = 126) of the responding schools operated on two-semester schedules, and 11% were on a trimester system. Sixty-six percent had a traditional 6 (or more) period day with classes averaging 50 minutes in length, 17% were on a block schedule with a 4- period day where each class averaged 90 minutes, and 17% were on a combination of the two schedules. Because participants were able to choose which questions they answered, not every item had the same number of respondents. In some questions, respondents were able to select more than one option. For such questions, the percentages may not add up to 100.

Structure of the Algebra I course: There exists little variation in the average class size in the Algebra I classroom (M=22.56, SD=3.65). Only 26% (n = 123) of respondents indicated separating classes by grade level. While many classrooms may not be separated by grade level, there still exists some separation between special education and general education students, as only 83% (n = 115) reported being fully inclusive. Results showed that 80% (n = 114) of respondents' students spent six hours or less in the classroom per week; 73% (n = 113) of respondents indicated having a mathematics enrichment course paired for at least some of the students in Algebra I.

When students take Algebra I: Respondents utilized a wide range of criteria for determining when students take Algebra I in their academic program (see Table 1).

Table 1

Factors Influencing When Students Take Algebra I

Factor	Percent of Respondents
Age/grade level	79%
Grades in previous mathematics classes	75%
Current math teacher recommendation	70%
Test scores	60%
Parent choice	35%
Student choice	34%
Other reasons	12%
Other faculty recommendation	9%

Teaching of the course: Our survey respondents indicated that 52% of their high-school teachers (n = 116) teach Algebra I, while 37% of their middle-school teachers (n = 101) teach the course. In deciding which faculty members teach Algebra I, nearly all (96%, n = 118) respondents indicated that the building administration had a voice in this decision; department heads (64%) and individual teachers (59%) also have a say, though clearly less often. The criteria for choosing which faculty teach Algebra I was less uniform. As we summarize in Table 2, the most common criteria used were student needs (66%, n = 119) and scheduling constraints (65%). The only other criterion used by more than half of the respondents was faculty preference (56%). Less common criteria included teacher evaluations (34%) and teacher seniority (15%). Thirty percent of respondents indicated refusal of or hesitation towards placing student teachers in the Algebra I classroom.

Table 2

Factors Influencing Who Teaches Algebra I

Factor	Percent of Respondents (n = 119)
Student needs	66%
Scheduling constraints	65%
Faculty preference	56%
Teacher evaluation	34%
Teacher seniority	15%
Other	15%

Discussion

These results provide a glimpse into the various formats in which Algebra I is offered, the criteria used to place students in Algebra I—in part, answering a call from Loveless (2008) to know more about these students—and the placement of teachers in the course. We will discuss these three focus areas in turn: structure of the course, when students take the course, and teaching of the course.

Structure of the course: The enrichment courses offered for Algebra I seem to be a blend of two types of approaches described by Stein et al. (2011). Comments about these courses indicated that they are typically positioned as either extra practice or remediation options, showing that school districts in our study still use ability tracking, as mentioned by Cogan et al. (2001), to group students. Of remedial courses, one school district reported, "We have implemented ALEKS into [our] Alg[ebra] I and Alg[ebra] remediation programs. We find it is a good supplemental tool for individualizing instruction and practicing math assessments on the computer." Multiple respondents reported plans to revamp their programs next year; one district in particular reported specific information about the changes they were planning. This district reported that, in response to the accountability measures and new ISTEP+ exam, instead of double-blocking Algebra I students next year, they will be double-blocking sophomores in Geometry, which is the year they will take the graduation exam.

Another district reported, "[If] a student does not pass the Alg[ebra] ECA, they remain in 'Repeater Alg[ebra] 1 Lab class' until they pass it or become a 'Senior.' At that point, we offer an Algebra ECA Remediation (during homeroom time OR through Khan Academy)." The use of ALEKS and Khan Academy indicated that some schools are attempting to incorporate technology to assist in remediation for Algebra I students.

When students take the course: The fact that 66% of respondents indicated dividing sections of Algebra I by ability (with only 43% at the high-school level) may be a result of the requirement for high-school students to take the course in order to receive the most basic diploma. By the time they reach high school, many students are placed in Algebra I regardless of ability. Thirteen separate districts referenced a version of scheduling constraints to determine how students are divided.

More than 35% of respondents mentioned no other criteria influencing who takes Algebra I than the four listed in Table 1. Unexpectedly, several respondents reported offering Algebra I to sixth- and seventh-grade students. No explicit reasons for this offering were provided, but this is a topic worth investigating in the future. Perhaps it could be due to the desire to provide students with the opportunity to pursue a mathematics curriculum that enables them to earn college credits near the end of their high-school careers.

Over half of the respondents (60%) admitted to using test scores to at least partially determine when students take Algebra I; ISTEP was reported as the test score used in half of those cases. CTB-McGraw Hill has worked with the Indiana Department of Education [IDOE] to create an online version of ISTEP for schools to administer. It was assumed that an online exam would allow a shorter turnaround time for providing feedback than did the previous method of exam booklets that had to be mailed back to the IDOE and hand-graded. However, in 2013, schools experienced many glitches with the computer system, even after server tests were done prior to the ISTEP exam dates. These glitches led Fort Wayne Community Schools to cancel online testing for the next school year (Glavan, 2014). This incident had even caused state superintendent Glenda Ritz to order schools to halt testing after two days of interrupted tests and students being kicked out of the exam (MacAnally, Kirschner, & Milz, 2013). Using such possibly unreliable data from ISTEP scores to determine when students take Algebra I can be problematic, as Wilson (2007) warns. A student may be placed in remediation based off of the technology crashing—not off of their actual performance on ISTEP. This could be especially true considering how one district reported that "next year['s] students scoring below 50 points of the ISTEP+ cut score or previously earning a D or F will have an enrichment course."

Teaching of the course: Overall, 43% (n = 97) of the respondents' mathematics teachers teach Algebra I, whether in the high school (52%) or middle school (37%). One district reported, "All teachers in our corporation teach some form of Algebra I (ECA Lab, Math Support Lab, Algebra Enrichment). We feel that these students at times can be some of our least-motivated students, so by everyone sharing the work load no one (young) teacher gets burned out." While we did not see concern of the qualifications held by teachers, as Loveless (2008) reported, we did see some districts prefer experienced teachers in the Algebra classroom. One district reported, "We don't put our newest teachers in charge of the lowest levels of courses."

One respondent volunteered, "We have a special education teacher license[d] in math who is assigned to the math department exclusively." With 83% (n = 115) of respondents reporting that all students are taught Algebra I in an inclusive classroom, it is natural to wonder how many schools also employ this strategy in supporting their Algebra I students had we explicitly asked about special education teacher collaboration in the mathematics classroom.

These results give us a glimpse into the criteria used to place students in Algebra I, in part answering a call from Loveless (2008) to know more about these students, particularly those placed in middle school. The most common criteria used in determining who teaches Algebra I were student needs (66%) and scheduling constraints (65%), demonstrating our respondents' desires to balance two factors that sometimes conflict. Faculty preference (56%) was also considered at a relatively high level, confirming that, more often than not, teachers have a voice in deciding who teaches the course. The fact that a low number (34%) of districts reported using teacher evaluations could be a result of the relative newness of the reformed teacher evaluation system in Indiana, which was revealed in 2011.

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Regarding the placement of student teachers in Algebra I classrooms, supporting comments such as "too much at stake" and "we place them in non-tested areas over tested areas" accompanied the responses of the 30% that admitted hesitation towards the idea. Multiple respondents expressed a desire for models such as co-teaching or careful and strict supervision of the student teacher in the Algebra I classroom, keeping the veteran teacher in the room at all times and using the student teacher as a resource.

One district said they would allow student teachers in Algebra I classrooms "with caution and common sense considering the high-stakes nature," highlighting the desire for schools to perform well on accountability measures. These measures determine school letter grades and can impact district funding and teacher salary. The effects of state-imposed measures emerge in another district's statement, "For accountability purposes, it is very difficult to put a student teacher in this position. However, with historical data on the student teacher (grades in content areas, passing scores on content licensure exams, written recommendations), it may be possible." Accountability measures make it challenging for young teachers to practice teaching in high-stakes areas, which our results show is a task they will likely be asked to do upon entering the field as a classroom teacher.

Conclusion

The response rate for our survey suggests that school personnel in our study are ready to partake in conversations about the policies and practices shaping the opportunities students and teachers have to participate in Algebra I programs in Indiana.

In deciding which teachers should teach Algebra I, our results suggest that administrators almost always have a say in the issue, with teachers and department heads often having a voice in the matter—although less often. Although nearly half of secondary mathematics teachers teach Algebra I, our results raise questions about the opportunities student teachers have to gain experience in teaching the course. A non-negligible number of our respondents reported that they may hesitate to allow student teachers to fully engage in teaching the course, with many respondents citing concerns about school accountability.

Our data suggest that, at this time, a majority of school districts determine who teaches and takes Algebra I by considering student needs and scheduling constraints. Standardized tests were not reported to be the most popular method of determining students' placement in Algebra I; but, they still have a strong presence as a determining factor, a tactic that could result in an unreliable test (Wilson, 2007) placing students in the course. These responses begin to address Loveless's (2008) concern about the lack of knowledge of students placed in Algebra I. Some districts use these measures to determine what types of support to offer students, with many of them offering teacher-based or technology-based enrichment courses as a form of support. High-stakes policies enforced by potentially unreliable standardized measures of "ability" cast a broad shadow on algebra policies and practices, which runs directly counter to the goal of providing access to Algebra I for all learners (NCTM 2014; Moses, et al., 1989).

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Student Teaching and Co-Teaching: A Win-Win Opportunity for Middle and Secondary School Mathematics

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Research (Borko & Mayfield, 1995; Graham, 2006) has shown that one of the strongest influences on a teacher candidate's development is the cooperating teacher during student teaching. Therefore, the importance of having high-quality cooperating teachers in mathematics is crucial (National Council of Teachers of Mathematics, 1991; 2000). However, many highly-qualified mathematics teachers in Indiana now are hesitant to take a student teacher due to the weight of high-stakes mathematics tests. We have found teachers worried that giving up their instructional time to inexperienced student teachers may result in lower mathematics test scores, thus affecting the schools' rankings and teachers' pay.

Specifically, the primary purpose of *Principles to Actions* (NCTM, 2014) is to fill the gap between the adoption of rigorous standards and the enactment of practices, policies, programs, and actions required for successful implementation of such standards. A cooperating teaching model (co-teaching), first developed for the inclusion of special needs students in the late 1990s at St. Cloud College (Heck, Bacharach & Dahlberg, 2007), may be one method to bridge this gap. Co-teaching methods, unlike those of the traditional student teaching model, concurrently focus on student learning and teacher development. The traditional student teaching experience begins with the teacher candidate sitting in the back of the classroom and observing the cooperating teacher. The teacher candidate gradually assumes more responsibilities while learning to teach as an individual teacher, with the eventual complete release of the classroom to the candidate. This model, according to Guyton and McIntyre (1990) and Heck, Bacharach and Dahlberg (2007), has not changed significantly in most universities since the 1900s. A study conducted by the National Council for Accreditation of Teacher Education reported this traditional experience to be arbitrary (NCATE, 2010). The increasing complexity of today's classroom (e.g., Response to Intervention, English Language Learners, Common Core State Standards) calls for a model that encourages two professional partners to work collaboratively to meet the diverse needs of all students (Heck, Bacharach, & Dahlberg, 2007).

In the co-teaching model, the cooperating teacher and teacher candidate collaboratively plan and deliver instruction from the onset. Cooperating teachers, now called P-12 clinical educators, make their instructional decisions explicit to communicate invisible workings of the classroom to the teacher candidate. As the experience continues, the partnership alternates between assisting or leading the planning, teaching, and evaluation. The cooperating teacher partners with, rather than relinquishes responsibility to, the candidate. This enhances the learning opportunities by combining the knowledge, abilities, and skills of both professionals (Heck, Bacharach, & Dahlberg, 2007). These practices also mimic the collaboration of PLCs (Professional Learning Communities) that are considered best practices in many school corporations. Co-teaching encourages, and hopefully demands, critical self-reflection from each professional, which creates a fertile space for creative lessons, curricula designs, and instructional implementations. Self-reflective teachers become highly receptive, modeling life-long learning (Lester, 1998) and initiating instructional changes in response to students' needs.

Models of Co-Teaching

Co-teaching originated from Special Education for the inclusion of special needs students into the general classroom. The two teachers in the classroom worked collaboratively for the benefit of the special needs students. The Special Education specialist often assisted all students in the classroom when the opportunity arose (Hang & Rabren, 2009); thus, applying the different models of co-teaching from Special Education to general education only seemed logical. This then began the promising idea of using co-teaching in the student teaching environment.

There exist numerous academic publications on co-teaching (Friend, Embury & Clarke, 2015). Critics point out, though, that most of these articles are anecdotal descriptions rather than research-based findings on co-teaching effectiveness in regular classrooms (Solis, Vaughn, Swanson & McCulley, 2012). However, research papers about the positive effects of co-teaching in the general classroom environment are now emerging (Friend, Embury & Clarke, 2015; Walsh, 2012). A specific four-year study comparing a co-teaching to a non-co-teaching model of student teaching found positive statistical significance in the mathematics and reading skills of elementary students (Bacharach, Heck, & Dahlberg, 2010).

The seven original co-teaching models taken from Special Education and adapted to the clinical practice of the student teaching experience (Cook & Friend, 1995; Friend, 2015) are described below.

- *One Teach, One Observe* – One teacher has primary instructional responsibility while the other teacher gathers specific observational information on students or the instruction.
- *One Teach, One Assist* – One teacher has primary instructional responsibility while the other teacher assists students with their work, monitors behaviors, or plans assignments.
- *Station Teaching* – The co-teaching pair divide the instructional content into parts and the students into groups. Groups spend a designated amount of time at each station.
- *Parallel Teaching* – Each teacher instructs half of the students. The two teachers are addressing the same instructional material and present the lesson using the same teaching strategy, thus improving the student-to-teacher ratio.
- *Supplemental Teaching* – This strategy allows one teacher to work with students at their expected grade level, while the other teacher works with students who need the material extended or remediated.
- *Alternative/Differentiated Teaching* – The two teachers present alternative teaching strategies or two different approaches to teaching the same material. Although the instructional methodology is different, the learning outcome is the same for all students.
- *Team Teaching* – Well-planned, team-taught lessons exhibit an invisible flow of instruction with no prescribed division of authority. Using a team teaching strategy, both teachers are actively involved in the lesson. From a student's perspective, there is no defined head; both teachers share the instruction, free to interject information, and are available to assist students and answer questions.

Win-Win-Win-Win Benefits of the Co-Teaching Model

In a classroom environment where co-teaching is understood, accepted, and properly implemented, there are benefits to the P-12 student, the classroom mathematics teacher, the teacher candidate, and the higher education institution. A traditional student teaching experience may have many of the same benefits, but co-teaching plans, trains, and expects these outcomes.

Potential Benefits to the Mathematics Student

First and foremost, students receive more individual attention under the co-teaching model to help their understanding. The classroom becomes a more structured environment where their questions are answered with greater precision and speed. Administrative functions such as feedback, grading, and parental contact are more efficient. All of these factors contribute to higher academic achievement.

Potential Benefits to the Classroom Mathematics Teacher

Co-teaching allows the classroom teacher to address the diversity of students in the classroom, and it provides increased options for individual differentiation for every student. Enhanced classroom management and improved academic performance of students have been observed under this model.

Training for co-teaching provides support and professional development for cooperating teachers to strengthen their communication, collaboration, and mentoring skills. As stated in *Principles to Action*, professional isolation exists in too many schools and severely undermines attempts to significantly increase professional collaboration, openness of practice, and continual learning (NCTM, 2014). We have found that co-teaching rejuvenates the love of teaching in experienced teachers.

Potential Benefits to the Teacher Candidate

The structured, planned model of co-teaching possibly poses the most benefits for the inexperienced teacher candidate. The model creates a non-threatening environment to plan, teach, and evaluate. It provides more opportunities to teach, improves classroom management skills, increases collaboration skills, and helps develop knowledge, skills, and dispositions of pedagogy. Co-teaching promotes a deeper understanding of content-area curriculum and offers more opportunities for reflection.

Potential Benefits to the Higher Education Institution:

Planning and implementing co-teaching constructs a system for teacher candidates and cooperating teachers to build strong relationships, providing mentoring and guidance immediately and throughout the clinical experience. We have observed stronger connections between universities and school partners. The model allows for exposure to innovative teaching practices and understandings on both sides. For the university, co-teaching provides increased opportunities for placements in superior schools with quality teachers.

Possible Challenges In Co-Teaching

Co-teaching presents possible problems in classroom environments where the model is misunderstood, poorly accepted, improperly implemented, or is missing essential elements of collaborative planning, communication, partnership relationship, classroom applications, co-teaching knowledge base and approaches (Chang, 2016). In these situations, the teacher candidate:

- receives a less-rigorous clinical teaching experience, as the practicing teacher does all the planning;
- acquires little communication, collaboration, and mentoring if one person is teaching while other sits and watches or even leaves the classroom, thus recreating the original problem inherent in older models of student teaching;
- misses out on learning experiences when the practicing teacher's ideas must prevail regarding what and how lessons are taught.

Progressing from a Student to a Teacher via the Co-Teaching Model

Chang's research (2016) on teacher candidates and P-12 clinical educators identified a progression from certain types of co-teaching models to others. At first, he identified the *One Teach, One Observe* and the *One Teach, One Assist* models; however, as the semester progressed, the models of *Parallel Teaching, Alternative/Differentiated Teaching,* and *Team Teaching* were utilized. These models were recognized as more challenging to implement but were also acknowledged as more effective in increasing student achievement. In other words, the clinical educator and the teaching candidate both moved from a focus on learning how to best teach to a focus on how to best facilitate students in their own learning.

Co-Teaching in the Mathematics Classroom

At our institution, we require our teacher candidates to work within a year-long professional preparation experience. During this time, members of the secondary mathematics methods faculty regularly observe and evaluate the teacher candidates' progress in their public school classrooms.

We have seen the co-teaching model work well in the mathematics classroom (for example, in an algebra lesson on slope) specifically with an eager, novice mathematics teacher candidate (Griggs, Sullivan-Losey & Zollman, 2016). The candidate's previous experience as a student was being presented with the definition of slope being "rise over run." In general methods at the university, we discussed scaffolding new knowledge to previous material and teaching for understanding with measurable, student-centered behavioral objectives. In specific mathematics education methods, we again strive for developing student understanding by building the students' real-world familiarity through manipulatives and having students construct their skills and abilities on finding, applying and conjecturing about slope.

The structure of co-teaching that we utilize helps create lessons for mathematical understanding. In the first step, we have the teacher candidate and the classroom teacher co-plan the lesson: How does one take the state standard and the school's mathematics curricula and resources (e.g., textbook, technology, and manipulatives) to plan a successful lesson – without spending days writing a lesson plan? We have the teacher candidate physically write the lesson plan while the two co-plan. Here, the discussions are very valuable. We want the teacher candidate to talk about teaching for understanding while the classroom teacher demonstrates "Understanding by Design" (Backwards Design) planning. The classroom teacher typically focuses upon student learning outcomes while the teacher candidate tries to include the content, materials, and methods from one's university training.

We propose a "one-model – one-follow" co-teach prototype (Griggs, Sullivan-Losey & Zollman, 2016) in which the classroom teacher demonstrates a lesson in *one classroom period* so the teacher candidate can see the application and the pacing of the lesson plan in action. Again, the teacher candidate normally wants to rush the lesson in order to get to the portion where students are graphing straight lines and determining slope from the definition of "the change in vertical over the change in horizontal." The classroom teacher introduces the lesson, however, by asking (instead of telling) students about what velocity is, e.g., the ratio of number of miles per the number of hours. The teacher demonstrates how to integrate the technology of the SMARTBoard and graphing calculator. Hopefully, the teacher and the candidate have an opportunity to reflect after the lesson.

It is during the *next classroom period* that the teacher candidate then teaches the same lesson to a new class of students. Many times, we

Continued...

observe that the teacher candidate picks up on the velocity idea but extends the discussion for mathematical precision of language: what is a velocity, e.g., the ratio of number of miles per the number of hours. By planning, discussing, and reflecting, both instructors build a better and more precise, more student-centered lesson. This model allows the candidate to see individual students' thinking. Here, each instructor has the time to probe for the misunderstandings of such ideas as: "How can it be a ratio if the slope is 5, or 0, or undetermined (vertical)?" The candidate gets to see and then practice the lesson plan that was written, applying it within the classroom with the practical use of formative assessments, Bloom's taxonomy questioning, use of technology, and classroom management.

Reflection

The student teaching experience is one of the most influential and powerful stages of teacher preparation for prospective teachers. The fact that education is in a constant state of evolution warrants a thoughtful look at the process of student teaching. As we develop new learning theories, new practices emerge that align pedagogy and knowledge. Currently, there is a large body of research that recognizes the importance and benefits of mentoring new teachers as they enter the field (New Teacher Center, 2005; Darling-Hammond, 2000). The student teaching experience has long been accepted as the rite of passage from "college student" to "licensed professional." We need to support and mentor these teacher candidates as they begin their clinical practice of this profession (Heck, Bacharach, & Dahlberg, 2007).

Teaching has increasingly become a complex, demanding profession (Cochran-Smith, 2003; Danielson, 1996). Co-teaching models can provide the teacher candidate with a professional educational environment that can make the transition from student to teacher much smoother and more meaningful. By shifting from a traditional model of student teaching to a co-teaching model of clinical practice, we no longer expect our teacher candidates to learn the complex art of teaching by letting them "sink or swim." Instead, we can provide them with the involvement, preparation, leadership opportunities, modeling, and coaching they need to enter their future classrooms with confidence and skill (Heck, Bacharach, & Dahlberg, 2007).

The cooperating teacher often views traditional student teaching as a "service to the profession." They receive little financial gain from the extra time required for mentoring the student teacher. With the increased emphasis on high-stakes testing as an evaluation of the individual classroom teacher, mathematics teachers are especially reluctant to allow a novice teacher to work with their students. Washut-Heck and Bacharach state in *Educational Leadership* (2015, p. 29), "Although difficult, the change from a more traditional model to a co-teaching model of student teaching will provide a stronger, more powerful learning experience for everyone." When a cooperative teaching model is correctly implemented within a mathematics classroom, students' achievement can be increased (Bacharach, Heck, & Dahlberg, 2010). The benefits are not just for the teacher candidate; they extend to the P-12 student, the clinical educator, and the school. Griggs, et al. (2016) state:

> Co-teaching offers the knowledgeable assistance and emotional support to transform a "teacher" to an "educator." Co-teaching provides the P-12 student instructional encouragement and affective guidance to transfigure a "pupil" to a "learner." Co-teaching imparts the involvement, preparation, leadership opportunities, modeling, and coaching to develop a "student teacher" to a "teacher candidate." (p. 4).

In a co-teaching model, the learning opportunities double for students by having two quality mathematics teachers in the classroom. It is a win-win opportunity.

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Supporting Sense Making with Mathematical Bet Lines

This discourse strategy helps students understand story problems by revealing the task in stages and having learners adjust their predictions.

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In the mathematics classroom, making sense of story problems can be a challenge for all students. Strategies that promote student discourse offer teachers one way to support their students' sense-making processes (Cengiz 2013; Greer 1997). Further, when embedded into teachers' daily mathematics instruction, strategies that promote mathematics discourse allow teachers to monitor the ways in which students are making sense of information (Moschkovich 1999; Sammons 2011; Soto-Hinman and Hetzel 2009).

In this article, we present a mathematical discourse strategy that was introduced to elementary school teachers during Project All Included in Mathematics (AIM), a forty-hour, yearlong professional development (PD) program focused on promoting discourse as a viable approach to support all students in developing meaning for mathematics content. The strategy is called *Mathematical Bet Lines* and was adapted from the Bet Lines with English language learners (ELLs) as a literacy strategy to develop students' ability to make predictions on the basis of their comprehension of the context (Soto-Hinman and Hetzel 2009). The Mathematical Bet Lines strategy was designed to promote classroom discourse and support sense making when teachers are launching a lesson about mathematics story problems. In this article, we discuss how teachers implemented the strategy in their own classrooms to help students make sense of story problems. We show how such strategies, designed to promote sense making and mathematical discourse, are beneficial to not only ELLs but also all students in the classroom (Goldenberg 2008; NCTM 2013).

Teachers learn Mathematical Bet Lines

In ELL literacy, the Bet Lines strategy focuses on making predictions:

> Bet Lines are key stopping points (text lines) where teachers ask students to dialogue about what they have just read and make predictions about the future. (Soto-Hinman and Hetzel 2009, p. 95)

Students draw on both their personal experiences and evidence presented in the story to predict what will happen next. In ELL literacy, the Bet Lines strategy is used as an interactive and ongoing approach to involve students with the meaning of the text. In particular, Bet Lines offer opportunities for students to "see how proficient readers think and begin to monitor their own comprehension" of the text (Soto-Hinman and Hetzel 2009, p. 96). In Project AIM, we introduced the Mathematical Bet Lines strategy with the goal of helping students make sense of story problems by articulating to themselves and others their predictions regarding what is happening in the problem.

Mathematical Bet Lines are structured as a conversation between the teacher—who begins by reading the opening phrases of a problem and stopping at a point where students are to anticipate what comes next—and students—who predict what comes next in the story problem. For example, a teacher might start a story problem as follows:

> Fifteen cars are in the parking lot, and two cars are blue; what do you think will come next in the problem?

At this point, students offer their predictions before the teacher continues to read the problem, stopping at other parts of the story for further predictions or revisions of previous ones. The teacher supports students as they learn to make predictions that serve as continuations of the story and make mathematical sense. The teacher can also attend to students who might continue to make bets, or predictions, that have no mathematical bearing on the context of the problem. For example, in the problem above, a bet of "Cars are nice because you can drive them" does not indicate that the student is attending to the story as part of a mathematical problem. With Mathematical Bet Lines, as students make bets, the teacher facilitates students' reflections on their own sense making of the story problem by asking follow-up questions.

In Project AIM, Bet Lines were first modeled as a literacy strategy with a familiar children's story. Teachers participated in a Readers' Theater, using a classroom transcript of a teacher implementing the Mathematical Bet Lines strategy. Then, teachers role played and rehearsed the strategy in small groups. Following the professional development session, teachers were asked to design, implement, and reflect on a lesson that incorporated the Mathematical Bet Lines strategy to engage all students in their classrooms with mathematics discourse, especially their ELLs. Here we discuss a lesson of one participating teacher, Kate Herrema, who, after this initial reflection exercise, made the strategy an integral part of her mathematics teaching. We then share the reflections of other teachers who implemented the strategy.

A teacher implements Mathematical Bet Lines

Herrema explained that in her classroom, the Mathematical Bet Lines strategy made word problems interactive and engaged all students in discussing the story context of a problem. She noted that a student was no longer a "bystander of a problem." Herrema found that use of the strategy allowed her students to initially be less interested in the numbers in the story problem, focusing instead on understanding the scenario. She explained that before she implemented the Mathematical Bet Lines strategy, her students would quickly pick out numbers and try to add or subtract them on the basis of a clue word they would identify in the problem. After adding the new instructional strategy to her teaching repertoire, story problems became less to her students about getting a quick answer and more about making sense of the problem.

Herrema had nineteen children in her second-grade classroom, including two ELLs. According to Herrema, one of her ELLs enjoyed participating in whole-class discussions but could be hindered by the demands of academic language in mathematics. She characterized her other ELL as shy and lacking confidence in his mathematical abilities. Herrema found that Mathematical Bet Lines allowed both ELLs to feel comfortable participating because—

> they were interacting with an "unfinished problem." There were rarely incorrect bets. … There was less stress and worry for them because it didn't come with a right or wrong answer.

The transcript (see the sidebar on next page) illustrates instruction involving Mathematical Bet Lines as Herrema implemented the strategy with her students for the following story problem, which focuses on the Common Core State Standards for Mathematics (CCSSM) grade 2 Measurement and Data content standard for relating addition and subtraction to length story problems (2.MD.D.5):

Continued...

Instruction involving Mathematical Bet Lines

Mathematical Bet Lines emphasize that students should make sense of a problem text; they de-emphasize getting straight to an answer. The classroom transcript below is from a story problem that focused on the CCSSM second-grade Measurement and Data content standard (2.MD.D.5) for relating addition and subtraction to lengthy story problems.

Herrema: So far we have this: "Rachael and Alberto each flew a paper airplane. Rachael's airplane flew 283 centimeters." What do you bet comes next?

Carol: I bet that Alberto flew 282 less than Rachael.

Herrema: OK, so you're saying that Rachael's airplane flew 283 centimeters and that Alberto's flew 282 centimeters less than Rachael's? OK, so what would that be? Carol just bet that Rachael's airplane flew 283 centimeters and that Alberto's airplane flew 282 centimeters less than Rachael's. What do you bet is going to come next?

Kevin: "How far did Alberto's paper airplane fly?"

Herrema: That would be a good question to follow up with: "How far did Alberto's paper airplane fly?" If that is our question, how would we solve that? What would be the equation we might use? What operation would we use?

Kevin: Subtraction.

Herrema: Subtraction; why?

Kevin: Because Alberto threw it 282 less than Rachael.

Herrema: So, it could say, "Rachael's airplane flew 283 centimeters, and Alberto's airplane flew 282 centimeters less than Rachael's. How far did Alberto's paper airplane fly?" Let's check what comes next: Alberto's airplane flew 59 centimeters farther than Rachael's. It now says, "Rachael and Alberto each flew a paper airplane. Rachael's airplane flew 283 centimeters. Alberto's airplane flew 59 centimeters farther than Rachael's." What do you bet is coming next? Amy?

Amy: "How many centimeters did Alberto throw his airplane?"

Herrema: OK, so you think it is going to ask, "How many centimeters did Alberto fly his airplane?" OK, does anyone have a different bet than that? Isaac?

Isaac: "How many did they fly together?"

Herrema: Oh, it could be. That would be a really tricky problem. Let's see why that would be tricky. Isaac bets that the question is, "How far did Rachael and Alberto throw their paper airplanes . . . ?"

Students: Altogether

Herrema: Altogether; so, that would be like Rachael threw hers, and then Alberto flew his airplane after that. What would we need to still solve for, if that was our bet? What do you think, Lin?

Lin: How far Alberto flew his airplane.

Herrema: Oh, we would still have to find out how far Alberto flew his airplane in order to find out how many they flew altogether. Let's see what the last part is: "How many centimeters did Alberto's airplane fly?" How would you go about solving this?

> Rachael and Alberto each flew a paper airplane. Rachael's airplane flew 283 centimeters. Alberto's airplane flew 59 centimeters farther than Rachael's. How many centimeters did Alberto's airplane fly?

The transcript picks up after Herrema had revealed the second sentence of the story problem. At this point, the whole story problem had been shared and students had solved the problem on their individual whiteboards. The transcript shows how Herrema was able to elicit thoughts from a number of different students in a brief conversation that illustrates one aspect of the first of the Common Core's eight Standards for Mathematical Practice (SMP 1): *Make sense of problems* (CCSSI 2010). Herrema constantly asked questions of the students to ensure that their bets made mathematical sense in relation to the story problem context. Her questioning verified that her students' ideas focused on making sense of the story problem through talking about the numbers and the operations that fit the different student predictions. Students engaged in not only making and analyzing their own bets but also listening to and making sense of other students' bets. Isaac's (an ELL) bet shows him working to make sense of the problem (see the sidebar). His bet, followed by Herrema's questioning, engages his classmates in thinking deeply about the problem situation.

Tips for implementing Mathematical Bet Lines

The use of the Mathematical Bet Lines strategy in Project AIM has helped us understand what it takes to successfully implement it in the classroom. On the basis of feedback from participating elementary school teachers, we developed the following tips.

1. Have the problem, with given stopping points, written out. Then you can use an interactive whiteboard, document camera, or overhead projector to display the appropriate pieces of the problem as you reveal them and pause for students to make and discuss their bets.
2. Good places to pause are immediately before information that suggests either the operations that will be used or a number that will be used in solving the problem.
3. Mathematical Bet Lines have no right or wrong predictions, although some predictions certainly are not helpful for making mathematical sense. Students should be encouraged to present bets that make sense and could be mathematically productive, given what has been revealed in the problem up to the point at which you pause.

Possible follow-up questions to ask after a bet include the following:

- What new math information do we know about the problem? Do we know what we might do with that information?
- Why do you think we might (add or subtract)? What about that new information makes you think we might do that?
- If that "bet" is right, what do you think the question in the story problem is going to be?

Monitor the time spent on Mathematical Bet Lines and limit the number of "bets" made to two or three students. Other students can then be included in the conversation around the "bets" during the follow-up questions.

Teachers' experiences with implementation

In reflecting on their implementation of Mathematical Bet Lines, other teachers who participated in the professional development reported that the strategy successfully engaged their students in thinking about and discussing story problems in depth. One teacher explained,

> Students began thinking more mathematically about possibilities for what could happen in the "story.". . . Students offered mostly bets about possible addition or subtraction scenarios and unknowns related to those operations. I was impressed by a few students who evolved their bets into multiple-step possibilities; they really demonstrated the sense they were making.

Highlighting how Mathematical Bet Lines emphasize making sense of the problem text and de-emphasize getting straight to an answer, another teacher indicated that ELLs—

> as well as students struggling with comprehending math word problems, benefited immensely. The class environment was less stressful, and wrong answers [predictions] were encouraged because it gave the students opportunities to explain and understand. It enhanced their confidence level and empowered them to think prior to solving a problem.

Despite the noted success of Mathematical Bet Lines, teachers also identified some challenges with implementing the strategy. Unlike many teachers who identified the strategy as being engaging, some teachers encountered difficulties with getting all students involved. Teachers offered such reflections as these:

- "At times the bets got off track and did not relate to the problem,"
- "Some students just wanted to focus on their 'bet' and weren't willing to listen or respond to other students' bets."

In hindsight, another teacher realized that she "totally took too many bets." These challenges contributed to concerns about limited instructional time that some teachers faced when implementing Mathematical Bet Lines.

To address these challenges, teachers shared successful modifications they made to the strategy. To assist students who tended to hastily provide guesses instead of mathematically sensible bets, some teachers found it beneficial to have their students turn and talk with a partner to come up with an agreed-on bet before sharing in the whole-group setting. To increase student engagement, some teachers had their students individually write down a bet; other teachers incorporated an agree or disagree part to the discussion of the bets to keep students involved with one another's predictions. To better scaffold their students' understanding of what makes a useful mathematical bet, other teachers created multiple-choice bets using, for example, the free iPad® app Student Clicker-Socrative (Socrative 2014).

Facilitate, monitor, and question

Recall that the purpose of the Mathematical Bet Lines strategy is to help students make sense of story problems by focusing on the given problem's story context and then making predictions. Similar to its use in ELL literacy, the mathematical application of the strategy requires teachers to facilitate a classroom discussion and monitor students' sense making through questions surrounding the implications of students' predictions. ELLs and other students struggling with comprehending story context can benefit from learning how to predict and think inferentially about mathematics story problems. Mathematical Bet Lines create a safe, fun environment that is also engaging and substantive in an atmosphere that supports students as they develop their mathematical sense making of story problems.

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Authors' note: We believe that the Mathematical Bet Lines strategy can be used throughout grades 3–12 whenever the need is present for making sense of a story problem.

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