Co-Teaching Mathematics: A Shift in Paradigm to Promote Student Success

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Abstract
In this article we describe models of co-teaching that can be used to promote students success. We will highlight how mentor teachers and teacher candidates can collaborate during instruction to address diverse learning needs of students within the mathematics classroom setting.

Introduction
Mathematics teacher preparation programs are designed to develop teacher candidates’ mathematical knowledge for teaching, pedagogical content knowledge, and the ability to foster students’ learning (Ball, Thames and Phelps, 2008; Feiman-Nemser, 2001). Clinical experiences provide teacher candidates an opportunity to make connections between research-based practices emphasized in their university coursework and lessons taught in the classroom. Depending on each state’s requirements, teacher candidates may spend anywhere from six weeks to a year in a mentor teacher’s classroom.

Many mentor teachers perceive clinical experiences as a means for teacher candidates to gain teaching experience, develop their classroom management skills, and learn about current practices and norms (Leatham and Peterson, 2010). Nevertheless, mentor teachers are often concerned that turning instruction over to teacher candidates will negatively impact their students’ learning and their performance on high-stakes standardized test scores. Thus, efforts are needed to ensure students’ learning is positively impacted while the teacher candidates obtain instructional support (Bacharach, Heck, and Danlberg, 2010).

One strategy that has shown to further support K-12 students’ learning, and improve students’ assessment scores, while providing mentorship to teacher candidates, is the co-teaching strategy (Bacharach, Heck, and Dahlberg, 2010). Co-teaching is a pedagogical practice that fosters collaborative efforts and strengthens communication between teacher candidates and mentor teachers, who share a common space in the delivery of instruction, organization, and assessment of learning (Bacharach, Heck and Dahlberg, 2010).

Co-teaching is a shift in paradigm from the traditional student teacher strategy because it promotes the sharing of responsibility, emphasizes that both the mentor teachers and teacher candidates are facilitating students’ learning, it encourages mutual respect, and it acknowledges the teacher candidates as a co-teacher from the first day of the clinical experience (Jaede,
Brosnan, Leigh, and Loot, 2014). More particularly, co-teaching provides mentor teachers increased opportunities to learn from their teacher candidates and reduces the frequency of completely turning over their classes. Teacher candidates benefit from co-teaching because it provides real-time instructional and classroom management support, and opportunities for collaboration. During co-planning meetings, the teacher candidates and mentor teachers can plan the nature of the co-teaching, and identify various instructional strategies that can be used during enacted lessons to promote learning. Moreover, students benefit from co-teaching because it provides more one-on-one time with a teacher, and there are more opportunities for differentiated instruction and formative assessment. Therefore, co-teaching is a paradigm shift that can promote students’ success, and ensures that everyone (mentor teacher, teacher candidate, and students) succeeds!

**Co-Teaching Models in Action**

There are six co-teaching strategies commonly used in education: one teach one observe, one teach one assist, parallel teaching, team teaching, station teaching, and alternative teaching (Brosnan, Jaede, Brownstein, and Stroot, 2014; Friend, Cook, Hurley-Chamberlain and Shamberger, 2010; Murawski and Spencer, 2011). The co-teaching strategies utilized can vary based on the objectives of the lessons and students’ learning needs. We will discuss the six strategies and provide practical examples of how the various co-teaching models can be enacted within a mathematics lesson. During a teacher candidate’s field experience, it is anticipated that more than one co-teaching model will be employed.

**One Teach-One Observe**

In the one teach-one observe co-teaching strategy, one teacher provides instruction while the other observes students for evidence of learning (i.e., fluency of mathematical communications, representations used, misconceptions exhibited, etc). Hence, although one teacher provides the instruction, the other teacher circulates the classroom and gathers information. For example, one teacher may utilize algebra tiles to demonstrate how to solve equations with one variable, while the other teacher circulates and documents the extent to which the students engages with the activity and accurately transform the concrete representation to an abstract idea. Additionally, the teacher that walks around may notice challenges students experience when working with algebra tiles, and may listen to the nature of students’ mathematical communications. For example the teacher may listen to students’ discussion on constructing and solving the equations involving an unknown variable, and may notice whether students are using the manipulatives to actively engage with the lesson. At the end of the lesson, both teachers will reflect on the lesson to further enhance students’ learning based on the data garnered from the focused observation.

**One Teach-One Assist**

During the one teach-one assist co-teaching strategy, one of the teachers will take a lead role in facilitating the whole-class discussion, while the other teacher provides assistance to individual students or small groups of students. Additionally, the assistant can address individual students’ concerns, which may be overlooked during the whole-class discussion.

The one teach-one assist strategy can be used in a statistics lesson. For instance, the lead teacher may facilitate a whole-class discussion on constructing the line of best fit for real world data, using the graphing calculator. The lead teacher will facilitate the class discussion, which
focuses on interpreting the slope of the line, the intercepts, and making inferences on the data presented. Concurrently, the assistant teacher may assist individual students with entering the data in the calculator and interpreting data trends, as well as providing additional assistance with constructing the line of best fit. The assistant teacher may also review vocabulary words (such as slope, and y intercept) at the same time. It is important that both teachers interchange roles when adopting the one teach-one assist co-teaching strategy, such that one teacher is not perceived primarily as an assistant for the class.

**Station Teaching**

When station teaching is utilized, the classroom has a minimum of three stations, or learning centers, through which the students rotate and engage in various mathematical activities. This approach can increase opportunities for hands-on activities, and can provide multiple opportunities to formatively assess students’ understanding of concepts. When station teaching is implemented, both teachers may agree to work with particular stations, or they may agree to circulate freely. The teachers will need to plan how students will be grouped, and what activity may occur at each station. For instance, in reviewing proofs in geometry class the teacher may have four stations. The first station can have sets of cards with given statements and supporting reasoning. The students will have to organize each set of cards to generate a correct proof, which logically progresses from the given to the concluding statements. For the second station, students may be asked to identify the error in hypothetical students’ proofs (which is printed) and rewrite the proof such that it is correct. For the third station, students can be asked to construct a written proof based on pictorial representations (a proof without words) of the proof of the Pythagorean Theorem, the area of a parallelogram, the sum of odd numbers, or circle theorems. Dynamic Geometry software, such as Geometer’s Sketchpad, can be utilized to provide a visual demonstration for the proof without words (Jackiw, 2002). Finally, for the fourth station, students can be asked to construct proofs with only the given and concluding statements provided, and a word bank with relevant definitions. When employing station teaching it is critical that sufficient time be allocated for students to rotate to the various stations and engage in the tasks. Therefore, a timer can be used to assist with controlling the time students spend at each station.

**Parallel Teaching**

Parallel teaching reduces the student-teacher ratio because the class is divided into two smaller groups, and each teacher provides instruction at the same time to the students within their group. When planning a parallel-teaching lesson, the teachers may identify common objectives and utilize different or similar instructional approaches. Or the teachers may have different objectives and may implement different or similar instructional strategies. For parallel teaching to work effectively, the noise level of the students and the volume of the teachers need to be attended to, such that one group is not distracted by the other group. Therefore, classroom management and allocation of instructional space needs to be carefully planned.

Parallel teaching can be used to provide instruction relative to functions. For instance, both teachers may use the same objectives of having students “construct and compare linear, quadratic, and exponential models to solve problems” (Common Core Mathematics – High School Functions Standard), however, their instructional approaches may differ. One teacher may pose a STEM focused model-eliciting activity that is published on http://www.cpalms.org, in which students are given data for multiple variables, and are asked to make recommendations
based on observed patterns in the data. The model eliciting activity will draw upon students’ knowledge of functions as well as require students to make sense of the situation presented, determine appropriate means to represent the variables mathematically, utilize appropriate mathematical procedures, reason mathematically, and clearly communicate their thinking in an effort to convince their peers. Whereas, the other teacher may have students generate graphs using Microsoft Excel or a graphing calculator, and interpret the information presented. Additionally, the teacher may provide real-world examples of how linear, quadratic, and exponential models are used.

Parallel teaching can also be used as a way to increase student participation in classroom discourse and can promote productive mathematical discourse (Stein, Smith and Hughes, 2008). For instance, different student groups could solve the same problem using different strategies. For example, after a topic has been introduced, students can be divided into two groups to explore the concept at different pace, as well as use different strategies depending on the group they are assigned.

**Team Teaching**

During team teaching both teachers lead the whole-class discussion and activities, hence, their actions must be in sync to ensure the fluency and clarity of ideas presented. For example, one teacher may pose questions that facilitate reasoning, while the other seeks to support the students during productive mathematical struggles. Alternatively the teachers may share different perspectives of how to solve the same problem. Thus, both teachers must be comfortable with sharing the same stage for instruction. For example, if team teaching was used for a lesson devoted to solving systems of equations, one teacher may demonstrate how it can be solved graphically using a graphing calculator, while the other may demonstrate the concept using a matrix on the graphing calculator. Subsequently, both teachers will connect their demonstrations to the elimination and substitution methods. Thus, students will be exposed to four different means to solve systems of equations.

**Alternative Teaching**

In alternative teaching the class is divided into two groups: a large group and a small group. The teacher of the larger group delivers the lesson, while the teacher in the small group may support students who need a greater challenge, or assist students who may need additional scaffolding. Alternative teaching can be used with students who have missed previous lessons on which the current lesson builds. The alternate teacher can provide clarity on ideas presented by reviewing content that was identified as prior knowledge to the lesson, and/or provide additional examples, if needed. Alternative teaching can also provide an opportunity to challenge high-achieving students by exploring advanced concepts. During alternative teaching, both teachers should seek to minimize the learning gap within their respective groups. Furthermore, teachers should be mindful of potential stigmatism students can receive if they are frequently assigned to small groups.

Alternative teaching can also be used in a lesson that seeks to “extend the properties of exponents to rational exponents” (Common Core State Standards – High School – number and quantity -content standards). In the lesson, the teacher facilitating the large-group discussion may use a worksheet to have students engage with using properties of exponents to rewrite expressions that have rational exponents and radicals, and solve equations containing radicals. Whereas, the teacher working with the smaller group of students may use note cards to review
the product rule, quotient rule, and power rules for exponents. Additionally, the teacher that is working with the smaller group may utilize an online game for students to demonstrate proficiency with the foundational ideas. Once mastery is observed on prerequisite knowledge for the lesson’s objective, the teacher of the small group can pose similar tasks to those on the worksheet given to the larger group, and provide additional guidance and support as students attempt each task.

Figure 1 is used to summarize the various co-teaching models and highlight key constructs relative to each strategy.

Figure 1: Various co-teaching models adapted from Murawski and Spencer (2011, p.97)

<table>
<thead>
<tr>
<th>Approach</th>
<th>Class Set-up</th>
<th>Quick Definition</th>
<th>Benefits</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Teach, One Observe</td>
<td>Whole Class</td>
<td>One of the teachers is in the front of the class leading instruction. The other is gathering specific information.</td>
<td>It provides an extra set of eyes in the classroom; provides data about instruction or student learning; easy to implement.</td>
<td>It can easily develop into a habit; generally effective if the lead teacher and observer agree in advance what is to be observed.</td>
</tr>
<tr>
<td>One Teach, One Assist</td>
<td>Whole Class</td>
<td>One teacher works with the whole class, while the other teacher assists individual students or groups of students. Assistant may also provide assistance with classroom management and a “voice” to articulate student concerns.</td>
<td>Provides assistance to individuals throughout the lesson; easy to implement – does not require a lot of planning.</td>
<td>It can easily become a habit, and may cause one teacher to always feel like assistant. Hence changing roles is essential.</td>
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<tr>
<td>Station Teaching</td>
<td>Grouping</td>
<td>Students are divided into three or more small groups to go to stations or centers. Students rotate through multiple stations. Teachers can facilitate individual stations or circulate among all stations.</td>
<td>Smaller groups are better for instruction, assessment, and classroom management; allows for differentiation, movement, and hands-on activity.</td>
<td>Teachers need to be willing to use their space differently. Both teachers need to plan for their group. Classroom management and transition needs to be structured, and independent station needs to be well planned and self-sufficient.</td>
</tr>
<tr>
<td>Parallel Teaching</td>
<td>Grouping</td>
<td>Both take half the class in order to reduce student-teacher ratio. Groups may be doing the same or different content in the same or different ways.</td>
<td>Smaller groups are better for instruction, assessment, and classroom management. It allows teachers to have their own groups.</td>
<td>Teachers need to be willing to use their space differently. Both teachers need to co-plan for their group. Classroom management and organization needs to be negotiated. Do not switch the groups during a lesson.</td>
</tr>
<tr>
<td>Team Teaching</td>
<td>Whole Class</td>
<td>Both teachers are in front of the class, working together to provide instruction. This may take the form of debates, modeling information, compare/contrast, or role-playing.</td>
<td>Demonstrates parity and collaboration between teachers; good for modeling; fun for role-playing.</td>
<td>Takes planning and willingness to “share the stage”. Both teachers need to feel comfortable in front of the class, which means no one is walking around or individualizing at that time.</td>
</tr>
<tr>
<td>Alternative Teaching</td>
<td>Whole Class</td>
<td>One teacher works with a large group of students, while the other teacher works with a smaller group providing re-teaching, pre-teaching, or enrichment as needed.</td>
<td>Good for smaller and more specific group work; good for addressing IEP/504 goals.</td>
<td>Need to be sure NOT to always pull the same kids or it becomes a “class inside a class” and can create stigmatizing, especially if small group is “strugglers”. Be sure to consider space, noise levels learning gaps, and means to re-assimilate the small group members back into the larger group.</td>
</tr>
</tbody>
</table>
Tips for Implementing Co-Teaching Effectively

1. **Carefully co-plan each lesson.** During the co-planning meetings, both teachers should engage in discussions regarding time management, task design and the nature of questions that will be posed. Additionally both teachers need to determine appropriate assessments and identify suitable instructional strategies that will be utilized. The co-planning should also attend to national standard documents (NCTM, 2014; CCSSM, 2010) and the five practices that promote effective discourse (Stein, Smith and Hughes, 2008). The decision-making process needs to be explicit, and the individual roles to be enacted should be clear.

2. **Be respectful.** Be mindful that individual differences exist. It is imperative that both teachers exhibit mutual respect for the ideas shared by their teaching counterparts and by students, as well as a willingness to adapt their perspectives based on the feedback provided.

3. **Be prepared.** Be sure to have all resources needed to implement the instruction as planned. Furthermore, organize the material in a fashion that is easily accessible to students.

4. **Utilize space effectively.** Considering that various co-teaching models require changes in the instructional space, arrange the room prior to the start of class, in order to accommodate the respective instructional model.

5. **Be willing to switch roles.** Both teachers should take active roles in the lessons, and should be knowledgeable of the skills needed to fulfill the assigned roles.

**Conclusion**

In closing, co-teaching as a model for clinical experiences can provide learning opportunities that cannot be accomplished with one teacher alone. Having two teachers focusing on student learning concurrently, without the mentor teacher relinquishing total control of her/his classroom, maximizes learning for all. It is a paradigm shift that can promote students’ success. By collaborating, both teachers can reflect on and implement best practices that can enhance students’ understanding, as well as afford students an opportunity to engage in the doing of mathematics. Hence, co-teaching can be used to enhance the overall quality of clinical experiences, and positively influence the delivery of mathematical content to support student learning (Murawski and Spencer, 2011).

**References**


