Traditional methods of educational research can be impractically slow. A year or more might elapse before posttests show that the intervention has produce results or failed to. In other fields, such as medicine and engineering, waiting a year for results is indefensible because of the urgency of the considerations, such as whether a patient will survive surgery or whether a bridge might fall, and time is a critical factor in obtaining research results. Educators also need quicker results. Improvement science offers an attractive alternative, because it is designed to study practices rapidly, make appropriate changes immediately, and continue the cycle of improvement (Bryk et al. 2015). In this chapter, we describe our use of improvement science to transform internship experiences for secondary mathematics education student teachers with co-teaching strategies.

What Is Improvement Science?

Improvement science focuses on essential goals for practice and uses evidence to determine positive movement toward those goals. Improvement science employs process measures, to monitor whether the change idea is performing as intended, and balancing measures, to monitor adverse implications (Bryk et al. 2015). When evidence shows that the practice is generating undesirable outcomes, inquiry is conducted to determine the cause of these outcomes; appropriate changes are then made to achieve better outcomes for all. Improvement
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Science is guided by three practical questions: “1. What specifically are we trying to accomplish? 2. What change might we introduce and why? 3. How will we know that a change is actually an improvement?” (Bryk et al. 2015, p. 114).

Improvement science studies involve multiple sites, in order to enable an examination of how the suggested change works differently in different contexts. To inform a broad community, it is insufficient to identify ideas under controlled situations only; rather, it is vital to support the sustainability and viability of ideas across multiple, real life contexts.

Improvement science relies on teams dedicated to common improvements. These teams are referred to as network improvement communities (NIC). Members of a NIC share information, work in parallel, and connect to external factors and larger problems (Bryk et al. 2015). The educators in our NIC convened around a desire to improve the internship experience in our teacher education programs.

■ Plan-Do-Study-Act (PDSA) Cycle

The process of inquiry in improvement science, described by Bryk and colleagues (2015), is the plan-do-study-act (PDSA) cycle. Because it is cyclical, it can answer questions that arise as the inquiry develops. During the plan phase, the team identifies the change needed, hypothesizes potential strategies, and considers means to measure the nature and magnitude of the change. During the do phase, individuals enact the change strategy and collect data on how the strategy was executed. For the study phase, data are analyzed, the team compares what occurred to what was predicted, and ideas are extracted for the next cycle. Finally, in the act phase, decisions are made about how to proceed based on what was learned. Initial ideas may be abandoned, adjusted, or adopted.

■ Our Journey in Improvement Science

Our NIC, the authors of this paper, consisted of mathematics education faculty from eleven universities across the United States. We come from mathematics teacher programs of different sizes, with varying student populations, and different program structures. Despite the variety in our programs, we shared a common interest in improving internship experiences (otherwise known as student teaching, in which interns spend an extended, supervised period of time in classrooms and assume instructional responsibilities), because internship experiences are crucial to effective teacher preparation (National Council for Accreditation of Teacher Education [NCATE] 2010). According to Darling-Hammond (2006), the experiential component of teacher education has traditionally been somewhat haphazard and disconnected from theoretical teachings. Our NIC shared a number of problems with internship experiences across our programs. These included philosophical differences between school and university personnel regarding teaching and learning, a lack of professional learning opportunities to help mentor teachers to implement new standards and curriculum materials, and difficulties in recruiting and retaining mathematics teachers for high-needs schools. Also, mentor teachers are often unsure how to mentor (Anderson 2007), many interns feel unprepared to teach mathematics (Ingersoll 2012), and university faculty are sometimes ineffective change agents (Veal and Rikard 1998). Once these problems were identified, we discussed possible causes, namely insufficiencies in communication between school and university personnel (Zeichner 2010), goal setting, professional learning opportunities, and leadership for new ideas for internship experiences.
We subsequently reviewed the literature to learn how we might improve the quality of internship experiences. We identified co-teaching as a promising change mechanism based on its success in special education, where it has been shown to strengthen partnerships between university personnel and teachers, motivate ongoing professional development, and improve student learning (Friend et al. 2010). Because high quality co-teaching requires high quality co-planning, we decided to emphasize co-planning in our investigation as well. Aware that the structure of internship experiences varies widely across institutions, we looked to improvement science as a means to effectively implement and study co-teaching across our programs.

**Co-Planning and Co-Teaching Strategies**

Co-planning and co-teaching increase interns’ and mentors’ opportunities to learn from each other, and they can alleviate mentor teachers’ and administrators’ concern about putting interns completely in charge of a class of students (Brosnan et al. 2014). Co-planning begins with building relationships and trust between mentors and interns. At first, the mentor takes the lead in planning and conducts “teach alouds” to reveal the many and varied decisions teachers must consider when planning for instruction. Over time, interns gain confidence in the process and make greater contributions to instructional planning (Brosnan et al. 2014).

Co-teaching is a pedagogical practice that fosters collaboration and communication between teachers, who share a common space in the delivery of instruction and assessing learning (Bacharach, Heck, and Dahlberg 2010). Co-teaching began in special education, where general and special education teachers shared instructional efforts (Friend et al. 2010). Subsequently, educators began to apply the same practices in general teacher-preparation programs (Bacharach et al. 2010). Co-teaching is a paradigm shift from the traditional internship experience to one in which mentor and intern share responsibility for planning and instruction. Mentor teachers encourage mutual respect for and acknowledgement of the interns as co-teachers from the first day of the internship (Brosnan et al. 2014). Introducing the intern as a co-teacher helps students see the intern as an advantage—an extra teacher in the room to help them learn.

Interns and mentor teachers can both benefit from co-teaching strategies, which provide real-time instructional support, classroom management support, and opportunities for collaboration. For our pilot, we employed six co-teaching strategies adapted from the special education literature: *one teach, one observe; one teach, one assist; parallel teaching; team teaching; station teaching; and alternative teaching* (Friend et al. 2010; Murawski and Spencer 2011). These are summarized in fig. 21.1.
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<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 A &amp; B</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 A</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>
</tr>
<tr>
<td>Station Teaching</td>
<td>Regrouping A &amp; B</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>Regrouping A &amp; B</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 A &amp; B</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 A</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>

Fig. 21.1. Various co-teaching models adapted from Murawski and Spencer (2011, p. 97)

How Our Team Used Improvement Science to Implement and Study Co-Teaching

Following the process of improvement science, our NIC identified the change to be tested (namely the adoption of co-teaching strategies during internship experiences), developed instrumentation, and determined the data collection protocol for our multiple sites. We collected detailed notes about the PDSA cycle activities, administered surveys, and analyzed the data (Bryk et al. 2015). After a few institutions piloted co-teaching, we reflected on patterns in the data and made recommendations for changes in the subsequent cycle. Here, we discuss this first PDSA cycle in greater detail.
Plan Phase

Faculty members from eleven institutions met during the summers of 2014 and 2015, and they engaged in online meetings throughout the academic year to discuss the benefits of co-teaching and its potential to transform internship experiences. We hypothesized that one teach, one observe would be the most widely used co-teaching strategy and that few interns and mentors would be aware of other co-teaching strategies. These faculty members worked in sub-groups to draft professional development modules and develop instrumentation to measure the extent and nature of co-teaching implementation and its impact. Descriptions of these instruments (Pre-Survey, Professional Development Survey, Just-in-Time Survey, and Exit Survey) are described below:

- **Pre-Survey** — On this survey, mentors and interns rate their knowledge about and ability to implement the Common Core Content Standards and Standards for Mathematical Practice (National Governors Association Center for Best Practices and Council of Chief State School Officers [NGA Center and CCSSO] 2010), as well as their knowledge of strategies to teach diverse learners, co-teaching, and various assessment practices. The survey is administered before the professional development and internship experiences.

- **Professional Development Survey** — This survey is administered at the end of the professional development experience. Mentors and interns are asked to describe the extent to which they found the professional development experience to be effective and to have enhanced their understanding of co-planning and co-teaching.

- **Just-in-Time Survey** — This survey, ideally administered at least twice during the internship, asks mentors and interns to describe their co-teaching experiences as the semester progresses. They are also asked to describe instructional norms and to rate the quality of communication, frequency of co-planning, and perceived benefits of co-teaching. A section for optional comments is included.

- **Exit Survey** — This survey, administered at the end of the internship, comprises open-ended questions about participants’ experiences with co-teaching, interactions with collaborators, and the impact of the professional development experience.

Do Phase

During the do phase of Cycle 1, team members from four institutions and their affiliated schools agreed to implement co-teaching with a subset of their mathematics interns and collect data. The faculty at these institutions sent emails to interns and mentor teachers asking them to complete the various surveys. These faculty members also observed and took field notes in classrooms where interns were co-teaching, and they interviewed mentors and interns about their co-teaching and the impact on classroom climate. Considering the variation in length and timing of internship experiences across institutions, we agreed to collect data throughout the academic year, allowing faculty members to identify the best time to collect the data at their institution. Our maximum sample for a single survey was five mentor teachers and ten interns.

Study Phase

We conducted thematic analysis of data from the surveys and classroom observations from the four institutions. We reflected on participants’ knowledge about co-teaching, the frequency and nature of co-teaching strategies used, and the challenges that hindered the extent to which co-teaching could
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be adopted during internship. Process measures were largely gleaned from the surveys and balancing measures mainly from team members’ observational and interview data. At face-to-face meetings in 2015 and 2016, our team identified emergent themes across institutions and issues that appeared unique to a particular institution. These themes and institution specific issues would shape our next PDSA cycle.

**Act Phase**

After observing that our data collection process could be cumbersome, we revised our surveys. The tenure-line faculty members on our team were not always able to supervise interns, so we recognized the need to educate non-tenure-line university field supervisors about co-teaching. Additionally, we considered how to disseminate the professional development modules to a practitioner audience to further support the implementation of co-teaching strategies. Finally, recognizing that it was highly unlikely that teachers would implement co-teaching strategies if they had not first engaged in high quality co-planning, we made plans to emphasize and to provide more training in both co-planning and co-teaching strategies. Based on these lessons, we revised our initial PDSA cycle for the second cycle, scheduled for 2016–2017.

**Lessons Learned from Cycle 1**

During our first PDSA cycle, we learned about the extent to which various co-teaching strategies were used on the four campuses, the implications of adopting co-teaching during internship experiences, the challenges of having too many surveys, the importance of carefully co-planning lessons, and the need for significant professional development. Here, we elaborate on the lessons we learned and on our modifications for future PDSA cycles.

Classroom observations by team members revealed that most of the co-taught lessons used the one teach, one assist, or one teach, one observe strategies; about half of the pairs (mentors and interns) also tried station teaching. Team teaching, parallel teaching, and alternative teaching were rarely observed. For the next cycle, we would like to see mentors and interns try these other co-teaching strategies. This would enable us to examine the effectiveness of the range of co-teaching strategies in different contexts. We also noticed some variation in co-planning and co-teaching across contexts. For instance, in one urban context, the mentor teachers used co-planning and co-teaching to assist only with formative assessment, while in other contexts they were used for all instructional activities.

Personal correspondence with mentor teachers and Just-In-Time surveys provided evidence that mentors saw co-teaching as having a positive impact on student learning. Mentor teachers perceived that co-teaching increased opportunities for personalized instruction and improved instructional quality. For instance, one mentor teacher noted via email correspondence, “I think it’s great thing to have two adults in the room. It allows me a lot more flexibility when I work with kids” (teacher A, email 2015). Similarly, another teacher wrote, “But with two . . . you have so much more capabilities of getting to each student. So there is hardly a day that goes by that every student hasn’t had contact with at least one of the teachers.” (teacher B, email 2015).

On the Just-in-Time Survey, the mentor teachers (n = 5) generally agreed that co-teaching was beneficial and that it fostered student-centered instruction. Similarly, the interns’ survey responses (n = 10) indicated that the co-teaching experience supported their learning to teach. The faculty's observations and interviews provided a triangulated view of the merit of implementing co-teaching during internship experiences. Faculty members noted that students in co-teaching classrooms...
appeared to receive more individual attention and more consistent instruction, and they were less
distracted by classroom management issues than in classrooms where interns had not co-taught
with their mentors.

While *process measures* (derived from our small sample’s responses to the Just-in-Time Survey)
showed participants’ appreciation for co-teaching, the *balancing measures* (derived from observation
and interview data) revealed that our surveys were overly burdensome for participants. In fact,
none of the interns or mentor teachers completed the Professional Development Survey, and no
mentor teacher completed the Exit Survey. We learned that, given the many responsibilities of
mentors and interns, completing multiple surveys is too time-consuming, especially if there is no
monetary reward.

Additionally, the data we did collect from the interns’ Just-in-Time and Exit Surveys made
clear that careful planning is critical to successful implementation of co-teaching. One intern
described the value of co-planning with her mentor:

> Overall, I would say that it [co-planning] was a very beneficial experience. I appreciated
> having the support of my CT [mentor] for classroom management and for figuring out
> how to scaffold my lessons. She is great at developing scaffolded notes for them and has
> many of her own resources to use. Also, she was very generous in letting me use all of
> the materials she has developed over the years, including notes for students, assignments,
> quizzes, and tests. [intern A, exit survey 2015]

Other interns described the importance of talking through the lesson with their mentors and
the value of the feedback that they received on lesson plans. Mentor teachers also described benefits
that they derived from co-planning and co-teaching with the interns. In one instance, two interns
and their mentor teachers co-planned and subsequently co-taught a *station teaching*
activity. One of
the mentor teachers reported that she had never really seen great value in *station teaching* until she
experienced the planning and implementation of this activity with the interns. Overall, we found
that an environment that was supportive, respectful, and well planned provided benefits for interns
and mentors alike.

Despite the recognized value of co-planning and co-teaching, both mentors and interns
expressed concerns about finding time to co-plan, which limited the number of co-taught lessons.
In addition, faculty members’ classroom observations and their personal communications with
mentors and interns indicated that sometimes the communication process during co-planning was
perceived as cumbersome and problematic. Due to limited time for lesson planning, interns and
mentors found it difficult to plan multiple lessons together that incorporated co-teaching.

Finally, we noticed a need to improve the nature and frequency of co-teaching and co-planning
professional development experiences. Sites varied widely in the kinds and duration of professional
development experiences they provided for participants. Across the campuses, the total time
allocated to training varied from thirty minutes to a full day. We concluded that careful thought
needs to be given to professional development if co-teaching is to be implemented effectively.

### Plans for Cycle 2

Due to our findings from our *study* and our *act* phases, we revised our surveys, enhanced the
professional development experiences, and acknowledged the need to meet more frequently to
analyze data across institutions in order to take full advantage of the improvement science model.
For our next PDSA cycle, we seek to have seven institutions engage in the data collection process
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to expand our data sources. To reduce the data collection burden on mentors and interns, we have abandoned the Pre-Survey and reduced the number of questions on the Just-In-Time Survey. Additionally, we sought to improve professional development in both co-planning and co-teaching by using a voiced-over PowerPoint presentation and creating online video clips of various co-planning and co-teaching strategies in action. These modules can now be used during initial training or as refresher guides during the academic semester. In our next PDSA cycle, we plan to send monthly newsletters to all NIC members that will encourage greater use of co-planning and all six co-teaching strategies. We surmise that calling frequent attention to co-planning and co-teaching strategies in formal and informal communications with mentors and interns will increase the prevalence of these strategies being used during internships.

■ Conclusion

We chose to use improvement science to transform internships via co-planning and co-teaching strategies because improvement science uses content knowledge as well as organization knowledge to adapt an idea to fit various contexts. Based on our process measures, we concluded that mentor teachers and interns generally viewed co-planning and co-teaching strategies favorably. However, our balancing measures showed that we needed to reduce the data collection burden on participants and provide more consistent and ongoing professional development for both co-planning and co-teaching. As we continue to engage in the iterative process of PDSA cycles, we will continuously seek to identify factors that increase the sustainability and effectiveness of co-planning and co-teaching in various settings. Improvement science afforded us an opportunity to acknowledge variation among the internship experiences at multiple institutions while seeking to achieve a common goal.

References


Using Improvement Science to Transform Internship Experiences  


