CHAPTER FOUR

Coaching in Early Mathematics

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Abstract

Falling scores in math have prompted a renewed interest in math instruction at early ages. By their own admission, early childhood educators are generally underprepared and not always comfortable teaching math. Professional development (PD) in early

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mathematics is widely considered a main way to increase teachers' skills and efficacy (e.g., Guskey, 2000; Hyson & Woods, 2014; Munby, Russell, & Martin, 2001; Piasta, Logan, Pelatti, Capps, & Petrill, 2015; Richardson & Placier, 2001; Sarama, Clements, Wolfe, & Spitler, 2016; Sarama & DiBiase, 2004; Zaslow, 2014). However, it has been documented that stand-alone PD is not as effective in changing practice (e.g., Biancarosa & Bryk, 2011; Garet et al., 2008; Guskey, 2000; Hyson & Woods, 2014; Institute of Medicine and National Research Council, 2015; Joyce & Showers, 2002; Zaslow, 2014). Site-embedded ongoing support in the form of coaching or mentoring has been shown to be critical for successful implementation (Neuman & Cunningham, 2009; Powell, Diamond, Burchinal, & Koehler, 2010). In this chapter, we describe coaching models and abstract characteristics of effective coaching from the research. With this background, we provide an in-depth view of the coaching aspect of two large empirical studies in early mathematics. We introduce the theoretical framework from which the coaching models for these projects were developed and describe the research on which they were based. We then summarize how the planned models were instantiated and challenges to their implementation within each project. In the final section, we summarize what we have learned and described implications and challenges for the field.

1. OVERVIEW OF COACHING RESEARCH

The transforming the workforce report (Institute of Medicine and National Research Council, 2015) outlines several factors that impact the quality and development of the early childhood workforce. The report suggests that to develop and sustain professional competencies direct mechanisms including preparation programs, training, mentoring and coaching, and in-service professional development (PD) are all critical. For early childhood educators, PD can serve to equalize knowledge and skills across a workforce that has entered teaching without a common foundation of preservice preparation. Teaching is a dynamic profession, and ongoing PD is a necessary educational component if teachers are to continually refine practices for student growth (Darling-Hammond & Richardson, 2009). To continue their growth as educators, PD is a powerful resource to help augment the teachers' skills and knowledge so that they can best serve their students (Neuman & Cunningham, 2009).

Research on effective PD suggests that the development of effective teaching needs to occur in the context of teachers' own practices (Ball & Cohen, 1999; Pianta, Mashburn, Downer, Hamre, & Justice, 2008). Thus, a reasonable hypothesis is that coaching may be the most effective method of facilitating teacher's expansion of skills. However, the empirical evidence on coaching is limited and not conclusive. One review of studies conducted in a variety of settings including childcare centers, Head Start programs, family childcare programs, prekindergarten/preschool programs, and early elementary grades concluded that there was at least limited evidence that coaching contributed to improved quality and practices (Isner et al., 2011). However, the review could attribute the improvements that did occur to specific aspects of the coaching. The review also reported that coaching positively affected children's language and literacy when the coaching model focused on language and literacy teaching methods (Isner et al., 2011).

A metaanalysis on early childhood PD reported that the combination of training and coaching increased teachers' use of new skills (Sheridan, Edwards, Marvin, & Knoche, 2009). A separate review agreed with this conclusion, although again, could not attribute the improvement to any specific aspects of the coaching (Gupta & Daniels, 2012). However, coaching does seem to be a critical component of the combination of training with in-class support. For example, another metaanalysis found that when teachers were provided with training that consisted of only theory and discussion, a mere 10% demonstrated knowledge gained and none used the skills that were discussed within the classroom. However, when coaching was added to the training experience, 95% of the participants demonstrated knowledge gained, demonstrated the new skills, and used the new skills in the classroom, respectively (Joyce & Showers, 2002). Other studies support the hypothesis that coaching makes a unique contribution (Kretlow, Wood, & Cooke, 2011; Neuman & Cunningham, 2009). Other studies similarly found more improvements in literacy instruction when training is complemented by strong in-class coaching or mentoring (Biancarosa & Bryk, 2011; Garet et al., 2008; Gersten, Dimino, Jayanthi, Kim, & Santoro, 2010). In summary, PD that includes layered and combined training and on-site coaching can increase the effectiveness of instructional practices (Biancarosa & Bryk, 2011; Buysse, Castro, & Peisner-Feinberg, 2010; Carlisle, Kelcey, Rowan, & Phelps, 2011). Such coaching may not have to require in-person visits. Online coaching to be promising to improve practice in early childhood settings (Hemmeter, Snyder, Kinder, & Artman, 2011; Powell & Diamond, 2011).

1.1 Coaching on Math

Several studies have examined the effect of coaching to improve teacher practices and student achievement in language and literacy (Rudd, Lambert, Satterwhite, & Smith, 2009; Shidler, 2009), suggesting that coaching might be more successful when focused on one domain (Isner et al., 2011). Unfortunately, few studies have focused on coaching mathematics, especially in early childhood education (although there is recent interest, Bay-Williams & McGatha, 2014). Thus, there is a need to investigate if coaching in the domain of math will have the same efficacy as it does for other domains more typically coached in early childhood, such as language, literacy, and social–emotional development. There is some evidence conducted at the middle school level that found student achievement increased when teachers received math coaching (Obara & Sloan, 2009). Another study found math coaching for teachers of grades 3, 4, and 5 over a 3-year period resulted in greater student achievement—given expert coaches (Campbell & Malkus, 2011; Erchick et al., 2007). These results, though not in early childhood, still hold promise for the usefulness of math coaching.

However, any such effort will confront that the learning and teaching of mathematics present special challenges. The importance of mathematics is well known, especially in a global economy with the vast majority of jobs requiring more sophisticated skills than in the past (Doig, McCrae, & Rowe, 2003). However (Sarama & Clements, 2013), US students do not perform well compared to students from many other nations, as early as kindergarten (Stigler, Lee, & Stevenson, 1990) and even the preschool years (Yuzawa, Bart, Kinne, Sukemune, & Kataoka, 1999). Such achievement gaps are most pronounced in US children from low-resource communities (Siegler, 1993). This is especially worrisome because early knowledge strongly affects later success in mathematics (National Mathematics Advisory Panel, 2008).

Thus, we need to improve the basic academic mathematical concepts, skills, and motivation of low-achieving children early in their school career (Claessens, Duncan, & Engel, 2007). Although this can be achieved by providing high-quality experiences in early mathematics (Doig et al., 2003; Thomson, Rowe, Underwood, & Peck, 2005), few early childhood programs or settings do so (National Research Council, 2009), and few teachers of early childhood are prepared to do so (Sarama, 2002; Sarama & DiBiase, 2004).

In summary, improving mathematics education within early childhood settings holds challenges that range from the logistical (e.g., all-day PD may take teachers away from emotionally dependent children) to the philosophical and motivational (why "push down" math onto young children?)

to the practical (many teachers lack knowledge of the content of mathematics, as well as its learning and teaching). Any effort to support a high-quality early math education must meet these challenges (Sarama & Clements, 2013).

Research on effective math PD has also shown intensive coaching and mentoring to be a critical component (Clements & Sarama, 2008, 2012). Teachers participating in one project with the goal of implementing a preschool math curriculum received offsite intensive training that was focused on and connected to classroom practice and was complemented by classroom-based coaching. The training components were intensive involving 2 years of work with teachers, including 12 full-day PD sessions and twice-per month visits from coaches (Clements & Sarama, 2009). In general, successful models for professional learning in math seem to require intensive PD sessions, are conducted school-wide, and are followed by some form of ongoing on-site coaching support (Bobis et al., 2005; Bright, Bowman, & Vacc, 1997; Clements & Sarama, 2008, 2012; Clements, Sarama, Spitler, Lange, & Wolfe, 2011; Sarama, Clements, Starkey, Klein, & Wakely, 2008; Wright, Martland, Stafford, & Stanger, 2002).

1.2 Coaching in Education

Coaching typically involves a collaboration in which the coach uses various strategies to transfer or impart knowledge and skills to a teacher. Coaching is often employed to help teachers improve their practice generally or provide targeted assistance in supporting the implementation of instruction for a content area (Isner et al., 2011; Whitebook & Bellm, 2013). There are many forms and practices of coaching; however, the consistent theme among most is that coaching is a form of PD that involves ongoing classroom modeling, observations, reflection, and evaluation (Sheridan et al., 2009; Whitebook & Bellm, 2013). The coaching relationship may last from as little as a few months to 1 year or more (Isner et al., 2011; Whitebook & Bellm, 2013). The terms mentoring and coaching have often been used interchangeably, and we will do so in this chapter. Some make distinctions between the two, assigning mentors as more of an expert paired with a novice and coaching more about the relationship between the coach and the teacher who may have been in the classroom for years. Typically, coaches/mentors of early childhood educators are selected based on their education credentials and work experience in an early childhood care and education setting.

1.3 Coaching Models

There are multiple models for coaching/mentoring that all share similar characteristics. We focus on four that have been identified as those used by math coaches (Barlow, Burroughs, Harmon, Sutton, & Yopp, 2014). For this chapter, we briefly describe cognitive coaching (Costa & Garmston, 2002), instructional coaching (Knight, 2007), content-focused coaching (West & Staub, 2003), and a guide to mathematics coaching (Hull, Balka, & Miles, 2009). Though these models differ somewhat in approach, they all address coaching roles, interactions with the teacher, reflection as a core component, and managing the teacher–coach relationship.

1.3.1 Cognitive Coaching

Cognitive coaching (Costa & Garmston, 2002) utilizes reflective questioning strategies to support teachers in honing their professional practices and knowledge. This approach aims for the teacher to arrive at self-directed growth with the coach as a mediator. The theory is that teachers' thoughts and perceptions drive their behavior. This model follows a three-phase process of prelesson conference, lesson observation, and a postlesson debrief. Coaches must meet with the teacher beforehand to know what to look for in an observation. During these conversations, coaches use reflective listening, questioning, and paraphrasing to mediate teacher growth. For example, to mediate a teacher in their reflective process, a coach might paraphrase what a teacher said to focus on a personal goal by prompting "Tell me more about that …" This action is designed to support the teacher in clarifying their thinking.

1.3.2 Content-Focused Coaching

Content-focused coaching (West & Staub, 2003) is more direct in focusing on the content of what is being coached. In this model, the coach is assumed to have a high level of content knowledge and more experience than the teacher. This assumption drives much of how the coaching process unfolds. Unlike cognitive coaching, the emphasis is more on student learning of a content area and teacher's practices within that content area. Coaching interactions may focus on designing lessons for that content area. Less likely to use teacher self-direction to arrive at goals, the content-focused coach will use direct evidence of student learning, student data, or work samples to guide a coaching conversation. However, similar to cognitive coaching, a three-phase process is generally employed with the pre- and post-conversation and observation.

1.3.3 Instructional Coaching

Instructional coaching (Knight, 2007) treats coaching as a partnership. The coach actively listens so as to understand the teacher's point of view, as in cognitive coaching. The theoretical foundations emphasize seven principles to ground the coaching relationship: equality, choice, voice, dialog, reflection, praxis, and reciprocity. This model is heavily based on relationship building, viewing personal connections between the coach and teacher as having a profound impact on the quality of the experience. The coach focuses on the positive, using direct observations of student behavior, content, instruction, and formative assessment. Again similar to cognitive coaching, a three-phase process is generally employed with the pre- and postconversation and observation.

1.3.4 Mathematics Coaching

Mathematics coaching (Hull et al., 2009) interweaves information about instructional strategies and content knowledge. This approach views the coach as having a solid background in mathematics content and pedagogy. In their role, coaches must also have knowledge of adult learning styles and strategies, group dynamics, and social norms. Developing trust and a positive relationship is central to the coach's role in this model. Mathematics coaches use data, analysis, interpretation, and application in their conversations with teachers. The focus of coaching is directly working with classroom teachers to improve student learning. Coaches similarly follow a pre- and post-observation and conversation process.

The four models briefly reviewed share similarities in process with a three-phase cycle. Additionally, all emphasize the importance of the professional relationship. The primary differences are more philosophical. Cognitive coaches mediate self-directed growth. Content and mathematics coaches focus on teacher knowledge and student evidence, while partnership and relationships are central to instructional coaches. Finally, a particular model may provide a framework for coaching, but often it is the case that characteristics unique to a school or district determine how that model is enacted.

1.4 Characteristics of Effective Coaches

Of course, coaching expertise is not equal across coaches using any model, and the effectiveness of the coach is sure to have an impact on the gains experienced by the teacher (Campbell & Malkus, 2011; Poglinco et al., 2003). The Institute of Medicine Transforming the Workforce report suggests that the knowledge and skill of coaches are critical to effective professional learning. They need to have the content, general pedagogical knowledge, and pedagogical content knowledge, as well as competence in effective coaching. Coaching is crucial, but simply having access to coaching does not ensure improvements (Garet et al., 2008; Hsieh, Hemmeter, McCollum, & Ostrosky, 2009). The coaching should also be ongoing and conducted by knowledgeable coaches (Biancarosa & Bryk, 2011; Carlisle & Berebitsky, 2010; Powell et al., 2010). Several concrete coaching practices that facilitate a positive experience for the teacher have been highlighted in the literature.

1. Coaches should have both content and pedagogical knowledge for the domain being coached as well as the ability to cultivate a positive and trusting relationship with teachers (e.g., Campbell & Malkus, 2011; Garet et al., 2008). Coaching is multifaceted in that coaches need to be able to gage both the complexity of what teachers are being instructed to implement, and the newness of the content in terms of previous knowledge and practice of the teachers (Joyce & Showers, 2002).
2. Coaches should assist teachers with lesson planning, providing resources, modeling, and coteaching. Technique modeling, coteaching, and acting as a resource provider are also essential (Fox, Hemmeter, Snyder, Binder, & Clarke, 2011; Neuman & Cunningham, 2009). These important, though often overlooked, aspects of the coach–teacher relationship are essential to effective coaching. For one, they help break the misconception that coaches are not (or should not be) an active part of the classroom. In fact, teachers and students see much more substantial gains when coaches move away from simple observation and feedback and move toward collaboration and active involvement (Neuman & Cunningham, 2009).
3. Coaches should also be continually working with teachers to set goals and adjust those goals to meet the teacher's current needs. For instance, as coaches and teachers enter into a professional relationship, curriculum and lesson planning, as well as goal setting, should be made priorities (Neuman & Cunningham, 2009; Skiffington, Washburn, & Elliott, 2011).

4. Coaches should facilitate reflection. Effective coaches provide descriptive, not evaluative feedback using concrete observations from the classroom. Engaging the teacher in collaborative problem solving to improve practice (Guiney, 2001; Harwell-Kee, 1999).

2. COACHING/MENTORING MODEL FOR TWO LARGE-SCALE PROJECTS IN EARLY MATH

In the remainder of this chapter, we describe two large-scale projects in early mathematics that were designed to rely heavily on coaching. First we introduce the theoretical framework from which the coaching models were developed, and the research on which they were based. We then summarize how the planned models were instantiated and challenges to their implementation.

Our mentoring/coaching model is dynamic. Initial questionnaire data are not sufficient for knowing who will need additional assistance from coaches and mentors. For example, some teachers present themselves well and even misrepresent how much of the curriculum they are teaching; only coaching/mentoring visits reveal and address such problems. Therefore, we created a dynamic model in which additional attention by both mentors and peer coaches is given until adequate fidelity of implementation is achieved. Several additional features of our training plus in-class coaching model also encourage sensitivity to individual needs of teachers, including (a) time to learn and work with cohort groups; (b) job-embeddedness—addressing concrete, immediate concern with practical problems of implementation; (c) opportunities for practice, receiving individual, nonthreatening feedback from mentors/coaches; and (d) software and web resources that facilitate individualization. In summary, our PD follows research-based guidelines and provides a combination of experiences (Guskey, 2000; Showers, Joyce, & Bennett, 1987; Hyson & Woods, 2014; Munby, Russell, & Martin, 2001; Piasta, Logan, Pelatti, Capps, & Petrill, 2015; Richardson & Placier, 2001; Sarama, Clements, Wolfe, & Spitler, 2016; Zaslow, 2014). Research indicates that when staff development includes ongoing coaching, classroom innovations continue at a 90% level after external funding ceases (Copley, 2004; Costa & Garmston, 1994; Nettles, 1993).

2.1 TRIAD (Technology-Enhanced, Research-Based, Instruction, Assessment, and PD)

We created a research-based model for scale-up called TRIAD (see Sarama et al., 2008; Sarama, Clements, Wolfe, & Spitler, 2012), with the intent to generalize to both other subject matter areas and other grade levels. We implemented in the early childhood years because long-range benefits to children are greatest for interventions in that period (Carneiro & Heckman, 2003; Clements & Sarama, 2009) and because there is conflicting evidence as to whether the effects of early interventions persist or fade.

The rationale for situating the intervention in mathematics is that children from low-resource communities and who are members of linguistic and ethnic minority groups demonstrate significantly lower levels of mathematics achievement than children from higher resource, nonminority communities (Denton & West, 2002; Duncan & Magnuson, 2013; National Mathematics Advisory Panel, 2008). Such differences are evident from the earliest years (National Research Council, 2001, 2009; Sarama & Clements, 2009). This is important because early mathematics competence predicts later achievement even into high school (National Mathematics Advisory Panel, 2008; National Research Council, 2009; Stevenson & Newman, 1986), with persistent difficulties with mathematics one of the strongest predictors of failure to graduate high school and enter college (Duncan & Magnuson, 2011). Interventions to address these early differences may benefit low-resource and minority children more because they have fewer educational opportunities in their homes and communities (Brooks-Gunn, 2003; Carneiro & Heckman, 2003; Natriello, McDill, & Pallas, 1990; Raudenbush, 2009). Such interventions have been shown to be effective; however, most have not been taken to scale and often used the individual child as the unit of analysis, despite their assignment to treatments by class or school, which can inflate findings (Case, Griffin, & Kelly, 1999; for a review, see Clements & Sarama, 2011; Griffin & Case, 1997; Griffin, Case, & Siegler, 1994; Klein, Starkey, Clements, Sarama, & Iyer, 2008; National Mathematics Advisory Panel, 2008; Starkey, Klein, & Wakeley, 2004). Thus, an important practical and theoretical challenge is scaling up successful mathematics interventions in the early and primary grades in the United States and especially ensuring the persistence of the effects of such interventions.

The TRIAD model was created to address this challenge. In this study, we evaluated the persistence of effects of a TRIAD implementation, with and without the follow-through component, in its third and final year. That is, two experimental groups received the TRIAD implementation in prekindergarten (pre-K), and one of these groups also received the follow-through intervention in their kindergarten and first-grade year. Here we report the effects at the end of the students' first-grade year and whether these effects were equivalent for various subpopulations, as well as possible indirect, or mediational, effects through particular pedagogical practices (Clements et al., 2011).

2.2 TRIAD Theoretical Framework

TRIAD's theoretical framework (Sarama et al., 2008) is an elaboration of the network of influences theory (Sarama, Clements, & Henry, 1998). Scale-up is considered to involve multiple coordinated efforts to maintain the integrity of the vision and practices of an innovation through increasingly numerous and complex socially mediated filters, through phases of introduction, initial adoption, implementation, and institutionalization.

The TRIAD model scales up the support of "interactions among teachers and children around educational material" (Ball & Cohen, 1999, p. 3). This strategy creates extensive opportunities for teachers to focus on mathematics, goals, and students' thinking and learning, which improves teachers' knowledge of subject matter, teaching, and learning and increases student achievement (Ball & Cohen, 1999; Cohen, 1996; Schoen, Cebulla, Finn, & Fi, 2003; Sowder, 2007). Research suggests that the most important feature of a high-quality educational environment is a knowledgeable and responsive adult and that PD can foster these characteristics (Darling-Hammond, 1997; National Research Council, 2001; Sarama & DiBiase, 2004; Schoen et al., 2003; Sowder, 2007). Use of demonstrations, practice, and feedback, especially from coaches, increases the positive effects of information-only training (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005; Pellegrino, 2007; Showers et al., 1987). The PD in TRIAD provides a promising path for developing teachers' understanding of learning, teaching, curriculum, and assessment by focusing on research-based models of students' thinking and learning (cf. Bredekamp, 2004; Carpenter & Franke, 2004; Hiebert, 1999; Klingner, Ahwee, Pilonieta, & Menendez, 2003). Research-based learning trajectories are TRIAD's core (Clements & Sarama, 2004a, 2004b; Clements, Sarama, & DiBiase, 2003). Learning trajectories have three components: a goal (that is, an aspect of a mathematical domain students should learn), a developmental progression of levels of thinking, and instruction that helps them move along that trajectory. Thus, they facilitate teachers' learning about mathematics, how students think about and learn this mathematics, and how such learning is supported by the curriculum and its teaching strategies.

They address domain-specific components of learning and teaching that have the strongest impact on cognitive outcomes (Lawless & Pellegrino, 2007). By illuminating potential developmental progressions, they bring coherence and consistency to goals, curricula, and assessments (Clements & Sarama, 2009; Sarama & Clements, 2009) and help teachers focus on the "conceptual storyline" of the curriculum, a critical element that is often missed (Heck, Weiss, Boyd, & Howard, 2002; Weiss, 2002).

2.3 Research-Based Guidelines for Scaling Up

The wider social context in which these groups are embedded, the American educational system, has a persistent "grammar of schooling" (Tyack & Tobin, 1992) composed of rigid cultural beliefs about proper teaching, learning, and knowledge. A historical analysis of innovations reveals that those challenging this grammar tend to be short lived (Tyack & Tobin, 1992). Especially because we were attempting change close to the "core" of educational practice (Elmore, 1996), based on our innovation on suggestions and cautions from the literature.

TRIAD follows the 10 guidelines we abstracted.

1. Involve, and promote communication among, key groups concerned with young children (Huberman, 1992; Kaser, Bourexis, Loucks-Horsley, & Raizen, 1999), emphasizing a shared understanding of, and connections between, the project's goals, national and state standards, and greater societal need (Elmore, 1996; Fullan, 2000; Sarama et al., 1998). Promote clarity of these goals, of leadership, and of all participants' responsibilities and accountability (Kaser et al., 1999). Begin creating (and eventually institutionalize) a support infrastructure (Kaser et al., 1999).
2. Promote equity through equitable recruitment and selection of participants, allocation of resources, and use of curriculum and instructional strategies that have demonstrated success with minorities and females (Kaser et al., 1999).
3. Plan for the long term, encouraging active participation with a "start small and build" strategy (Fullan, 1992).
4. Focus on instructional change that promotes depth and quality of children's thinking (Ball & Cohen, 1999; Fullan, 2000), placing

standards- and research-based learning trajectories at the core of the teacher/child/curriculum triad to ensure that curriculum, materials, instructional strategies, and assessments are aligned with (a) national and state standards and a vision of high-quality mathematics education, (b) each other, and (c) "best practice" as determined by research and the wisdom of expert practice (Bodilly, 1998; Clements, 2002b; Clements & Sarama, 2004a, 2004b, 2004c; Kaser et al., 1999).

5. Build expectation and camaraderie to support a consensus around adaptation. Reform strategies often perversely isolate teachers, either gathering them together in isolation or nurturing "special" teachers in a building (Elmore, 1996). Instead, (a) promote "buy-in" in multiple ways, such as dealing with all participants as equal partners, and distributing resources to support the project (Berends, Kirby, Naftel, & McKelvey, 2001); (b) establish and maintain cohort groups (Jacobson, Emihovich, Petrie, Helfrich, & Stevenson, 1998); (c) facilitate teachers visiting successful implementation sites and talking with other teachers there; and (d) build local leadership by involving principals and encouraging teachers to become teacher leaders (Fullan, 1992, 2000).
6. Provide PD that is multifaceted; extensive; ongoing; reflective; focused on common actions and problems of practice, and especially on children's thinking; grounded in particular curriculum material; and situated partially in the classroom. Encourage sharing, risk taking, and learning from and with peers (Bodilly, 1998; Cohen, 1996; Fullan, 1992; Kaser et al., 1999). Develop teachers' knowledge and beliefs that the curriculum is appropriate and its goals are valued and attainable (Elmore, 1996), keeping all PD activities targeted toward those goals (Fullan, 2000).
7. Give latitude for adaptation to teachers and schools, but maintain follow through and integrity (Fullan, 1992, 2000; Huberman, 1992). Emphasize the similarities of the curriculum with sound early childhood practice and what teachers already are doing. Do not allow dilution due to uncoordinated innovations (Fullan, 2000; Sarama et al., 1998).
8. Maintain frequent, repeated communication, and follow-through efforts emphasizing the purpose, expectations, and visions of the project (Fullan, 1992; Kaser et al., 1999). Conduct formative and summative

evaluations connected to specific benchmarks for expected outcomes and methods for improvement (Huberman, 1992; Kaser et al., 1999).

9. Give teachers continuous feedback from sources they trust that children are learning what they are taught and that these learnings are valued (Bodilly, 1998; Elmore, 1996; Sarama et al., 1998).
10. Provide incentives for all participants, including intrinsic and extrinsic motivators linked to project work (e.g., external expectations—from standards listed in the first guideline to pressures from administration; Berends et al., 2001; Cohen, 1996; Darling-Hammond, 1996; Elmore, 1996; Jacobson & Battaglia, 2001; Mohrman & Lawler, 1996).

TRIAD includes collaboration of key groups to establish and maintain (a) a pre-K mathematics curriculum, with all components of the curriculum—a teacher's manual, demonstration videotapes, manipulatives, software, teaching strategies, assessments, and PD—based on a common core of understanding the learning trajectories through which children develop mathematically; (b) PD for teachers; (c) on-site support for teacher by facilitators during the school year; and (d) supportive roles and materials for parents. TRIAD's collaboration with key groups is dedicated to developing organizational structures that intensify and focus, rather than dissipate and scatter, teachers' motivation to engage in and maintain this challenging practice (Elmore, 1996).

2.4 TRIAD Intervention

The TRIAD implementation occurred in 42 schools in two urban districts serving low-income communities, randomly assigned to three conditions. Following the research-based guidelines previously listed, the TRIAD model emphasizes PD and curriculum implementation.

The TRIAD model provides multiple forms of support for teachers. The main two supports were the sequence of PD sessions and in-class coaching. The initial PD sessions included a brief description of the study and an overview of the integrated curriculum and its goals. From that point forward, most sessions included a short introduction to the learning trajectory for a topic and hands-on experience and interactions with peers and staff around the curriculum's activities. We emphasized using materials as intended by the developers rather than on teachers adapting them, an approach supported by research (Weiss, 2002).

In a typical PD session, one of the coprinciple investigators presented upcoming mathematics content and research on the teaching and learning of that content, the group discussed questions and issues arising from the presentation, and teachers presented and discussed their own classroom experiences with the curriculum. This was followed by 2 h of hands-on experience with the curriculum for children, in which teachers rotated through practicing small group, computer, whole group, and "math throughout the year" activities. These experiences emphasized the understanding and use of learning trajectories, assessment with the small-group record sheets, and questions from teachers.

Part of each session was spent on teachers watching videos of the activities. Discussion of the videos centered on student learning and instructional strategies. The videos were designed to communicate the vision of the curriculum in action and to make the ideas and processes accessible, memorable, engaging, and therefore usable. This type of intense, focused work with video examples, interactions with peers around the curriculum's activities, and support throughout the year was designed to positively change teachers' perceptions, because "most teachers report that they believe their children are capable of fine work, but what they think they know from daily experience often hedges that belief with limited expectations" (Ball & Cohen, 1999, p. 8).

Coaching was the second main component. We collaborated with peer coaches (teachers in the study who served the role of "leaders" within their schools) and expert coaches, whom we called "mentors" to distinguish them from the peer coaches. Coaching by these mentors was conducted throughout the year. Mentors included coordinators/specialists from within the study schools as well as several project staffs. Mentors were responsible for supporting both teachers and the peer coaches. This type of real time, classroom-based observation, demonstration, coaching is viewed in the TRIAD model as indispensable. Section 2.5 describes the role of the mentors.

2.5 Mentor Role

This TRIAD coaching included shared decision making, one-to-one consultation, monitoring, and reinforcement. Coaches worked with teachers in their classrooms throughout the year, visiting teachers in their classrooms no less than once per month, discussing students' learning and teaching based on the LTs. Mentors' observations and reflection sessions were guided by the project's "I-Fidelity" tool, which was a teacher (thus the "I") version of the project's fidelity of implementation measure with the Likert ratings removed. That is, descriptions of high-fidelity practice were maintained, but no evaluative structures were included. After the observation, the teacher and mentor read and discussed the descriptions and reflected on the teacher's practice, making notes for improvement that stayed with the teacher. (Mentors also completed the fidelity of implementation evaluations several times per year, which informed their work with teachers, but were not shared with anyone outside of the researchers.) When visiting peer coaches, mentors also provided guidance on the peer coaches' role and relationships to ensure the coaching relationships were working at all levels.

Mentors reported to site coordinators after each visit with teachers to monitor the facilitation process. Any concerns were immediately communicated to the Implementation Director and Project Directors who then collaborated to increase support. Finally, mentors participated in, and supported professional learning, during all project PD activities for teachers (e.g., every training session).

2.6 Mentor Training

In addition to attending all PD sessions with teachers, mentors participated in a 5-day institute developed and piloted in a previous instantiation of the TRIAD project. The institute included, 1/2-day introduction, 3 days on learning the mathematics intervention, and one 1/2 day on mentoring per se, all conducted by project staff. All mentors met once per month via distance learning.

2.7 Implementation of Mentoring in TRIAD

Mentors supported teachers implementing the Building Blocks (BB) mathematics curriculum. On average, each mentor visited eight teachers. In general, most teachers had only one mentor. In a few instances, teachers may have had 2 or 3 mentors due to staff changes or the need for additional support (Fig. 1).

Mentor logs were coded for the second year of implementation to evaluate the extent to which mentoring occurred as intended. Mentor logs provide information on the date, teacher, duration, and type of visit, as well as qualitative notes about the visit. Two research assistants independently coded the qualitative notes from mentor logs. Researchers were trained on a coding rubric until 100% agreement was achieved across the coding rubric. Each researcher coded all the logs and any discrepancies in rating

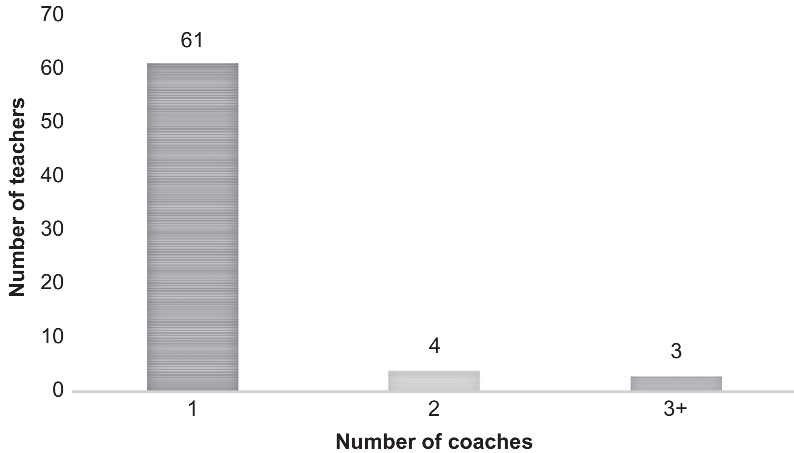


Fig. 1 Number of coaches by teacher.

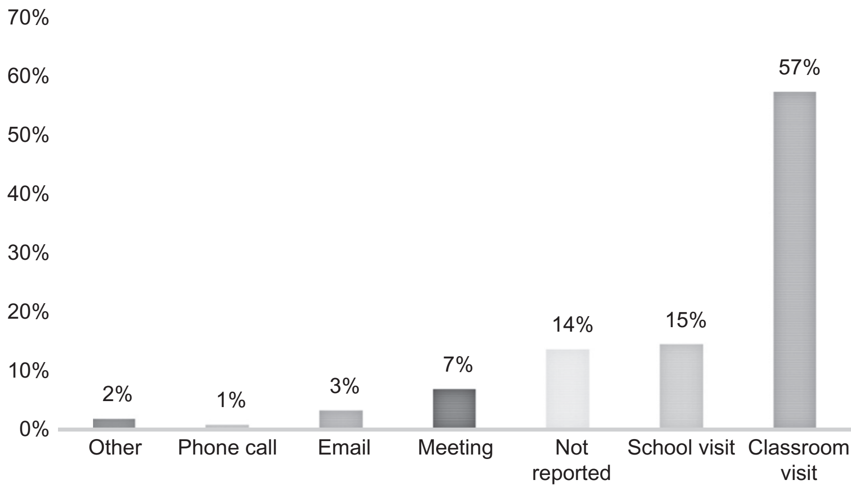


Fig. 2 Frequencies of method of contact by research group.

were resolved to reach consensus. Researcher codes were compared and collapsed to determine larger themes in the data.

Mentors recorded their method of contact on logs. Primarily mentors were visiting teachers' classrooms (Fig. 2). Meetings represent when a mentor conducted a small group or grade level meeting with teachers to provide training on a specific implementation topic. School visits may have been conducted to collected data from the school such as attendance or other school level information.

Often coaches/mentors are pulled in multiple directions unable to focus on their role. The mentor notes revealed six prominent roles of TRIAD mentors (Fig. 3). TRIAD mentors primarily spent their time conducting classroom observations and provide interventions, central duties for their role. As stated previously, fidelity of implementation checks were an important component of the mentor role. The fidelity checks provided real-time information to the project directors regarding implementation. During the second year of implementation which is the period of analysis for the mentor logs, a total of 96 fidelity check visits were reported on the coach logs. On average, each teacher received at least two fidelity checks during the school year. Descriptions of each mentor role observed are further described below.

- *Observations*: Mentor takes a passive role in the classroom. Comments describe what was seen.
  - *Teacher observation*: Mentor describes teacher, and only teacher, actions.
  - *Student observation*: Mentor describes student(s), and only student(s), actions.
  - *Classroom observation*: Mentor describes general classroom environment possibly in conjunction with student(s) and/or teacher.
- *Interventions*: Mentor takes an active role assisting with curriculum access.
  - *Teacher-initiated intervention*: Mentor intervenes/provides support at teacher's behest.

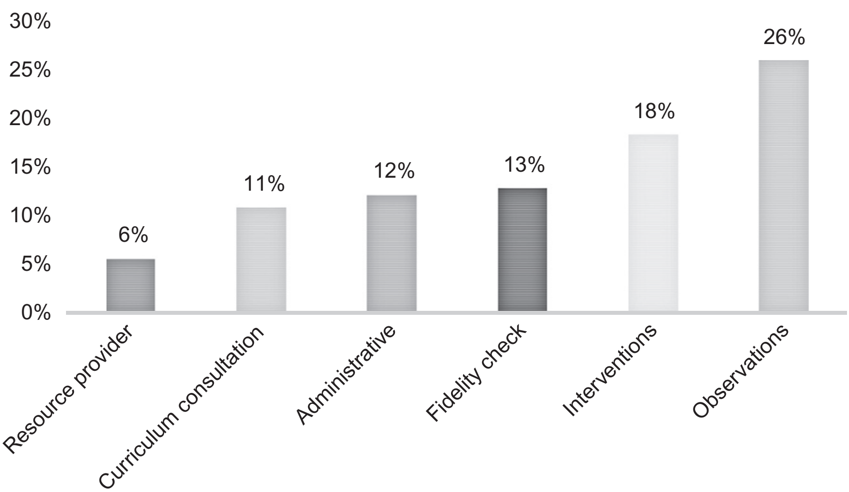


Fig. 3 Frequencies of coaching roles by research group.

  - *Mentor works directly with students*: Mentor provides direct instruction/ interaction to students in classroom.
  - *Mentor models*: Mentor demonstrates appropriate curriculum implementation.
  - *Mentor corrects or prompts*: Mentor provides immediate teacher feedback on incorrect implementation.
  - *Mentor-initiated intervention*: Mentor intervenes/provides support of own volition.
  - *Mentor works directly with students*: Mentor provides direct instruction/ interaction to students in classroom.
- *Fidelity check*: Complete fidelity checklist during observation report any concerns to the Implementation Director and Principal Investigators.
- *Administrative*: Any necessary tasks related to the mentoring role but not directly involving students or teachers such as making copies, picking up consent forms, etc.
- *Curriculum consultation*: Informal discussion between teacher(s) and mentor regarding aspects of curriculum.
- *Resource provider*: Bring curriculum-related materials into classroom.

2.8 Effectiveness of TRIAD as a PD Model

In summary, the mentor logs demonstrate that the TRIAD mentors performed their duties in alignment with the overall TRIAD PD model. Moreover, the mentor logs from the second implementation year also provide a glimpse at a mentoring model that meets effectiveness criteria from the greater literature on coaching. The coaching component is but one piece of the overall PD model, and although we hypothesize it to be a critical piece, we are not making causal claims about the specific contribution of coaching to the effectiveness of the intervention. Instead we posit that when coaching/mentoring are delivered in a manner that meets research-based criteria coupled with the other components critical to the TRIAD model, then we will see positive results. This is what we found. Children in the TRIAD group learned more mathematics than the children in the control group, with an effect size of 0.72 (Clements & Sarama, 2007). This effect size decreased over the kindergarten and first-grade years, but did not disappear. When examining only those students who experienced the assigned treatments (treatment-on-the-treated, TOT) from pre-K through first-grade analyses that included at the end of pre-K, the TRIAD groups (TRIAD-FT and TRIAD-NFT, whose treatments were identical in pre-K) were statistically significantly higher in mathematics achievement than the control group (Clements et al., 2011). By the end of kindergarten, both groups similarly outperformed the control group. At the end of first-grade results continue to support the benefits of high-quality, research-based mathematics instruction during pre-K as both groups continue to outperform the control conditions in TOT analyses (Clements, Sarama, Wolfe, & Spitler, 2013).

We conducted several analyses to measure the specific contribution of coaching to these positive effects. Unfortunately, these yielded no useful data. Using coaching hours as a positive mediator failed due to our dynamic model. That is, because coaches were asked to spend more hours with teachers who were having more difficulties, one could not hypothesize that more hours would lead to better results for children. This leads to the possibility that coaching hours could be a "negative mediator"—the higher the coaching hours, the lower the effects. This did not work either because coaches spent at least the minimum amount with all teachers, and, despite the request to spend more hours teacher scoring lower fidelity, a common pattern was that coaches also spent more time than average with their favorite teachers those who were doing well. Therefore, future research projects may wish to investigate alternative models to design the coaching and data collection to allow the use of proper mediational models. It may have been better, at least for our research purposes, to have a fixed schedules for coaching. Or, perhaps we should have earlier recognized and minimized the natural human tendency to spend more time those teachers whose classrooms were pleasant and easy to work within. Future research should consider these issues to better contribute to the research literature on coaching.

2.9 EMERGE (Early Math, Early Regulation: Good for Everyone)

The EMERGE project was designed to investigate whether adding a self-regulation component to an early mathematics curriculum provides enhanced child outcomes in multiple domains, above and beyond those yielded by the mathematics curriculum alone. The main rationale for such a study was that early childhood schools and centers are searching for solutions to the dilemma of child-centered or content-centered strategies. Child-centered programs have a long history. However, concerns about children's achievement and the pressure of content-specific standards have set up a perceived conflict, in which teachers often believe they are being asked to abandon child-centered approaches, or, at least, to compromise and squeeze in, as one teachers put it, "Literacy on Monday–Wednesday–Friday, math on Tuesday–Thursday, and social–emotional during our shortened play periods." The PD approach developed under EMERGE was designed to view both approaches in a positive light, in which teaching and learning content was an appropriate, important, joyful, and equitable component of early childhood education within a child-centered context. If empirically supported, the EMERGE approach could serve as a model that others could use to successfully and *synergistically* combine these strategies so the whole was *more* than the sum of its integrated, not conflicting, parts.

2.10 EMERGE Theoretical Framework

EMERGE was designed to follow the same research-based guidelines as those in TRIAD to provide a combination of PD experiences (Guskey, 2000; Showers et al., 1987). The two interventions synthesized were both theoretically and empirically grounded. The BB curriculum was previously discussed. The second intervention was the use of scaffolding designed to promote self-regulation (SSR) through make-believe play from the Tools of the Mind curriculum (TotM, Bodrova & Leong, 2007), an approach at the core of the child-centered approach. Self-regulation is important in facilitating learning and retention, especially for children at risk for later school failure. When explicit content-oriented instruction is mistakenly implemented as (only) teacher-led activities at the expense of engaging children in activities of their choice, children practice being "teacher-regulated" and are not given an opportunity to develop self-regulated behaviors which affects their ability to later engage in learning behaviors of their own accord.

Our hypothesis was that the dichotomy between explicit instruction and child-centered approach is a false one and that it is possible to design a program that would combine an explicit focus on content with equally explicit focus on promoting self-regulatory behaviors. The use of specific pedagogical strategies that optimize make-believe play has been proven successful in improving young children's self-regulation competencies and academic achievement (e.g., Bodrova & Leong, 2005). Used as a part of a comprehensive preschool curriculum as well as a part of an early literacy intervention, these strategies had been proven successful in improving young children's self-regulation and academic achievement (Barnett, Yarosz, Thomas, & Hornbeck, 2006; Bodrova, 2003; Bodrova & Leong, 2001; Diamond, Barnett, Thomas, & Munro, 2007).

2.11 EMERGE Intervention

Classes were randomly assigned to three conditions. A control group used standard district practices, while the other two groups used either the *Building Blocks* curriculum (BB), or a synthesis of BB and scaffolding designed to promote executive function (SEF), especially through make-believe play. Similar to TRIAD, the two-main PD supports implemented in EMERGE were the sequence of training sessions and in-class coaching.

Teachers in the both groups were provided training in each of the 2 years of their involvement. Both groups received the same training on math education with BB, 2 days of during the first month of school in year 1, 2 days during the school day in the Fall and 2 days during the Spring (with the project paying for substitutes). Although this research-based plan is comprehensive, it was designed to be commensurate with support the program would receive under normal but adequate conditions of adoption. The course content included the following topics: learning trajectories for each math topic; using learning trajectories for observation and other authentic assessment strategies; supporting mathematical development in the classroom; recognizing and supporting math throughout the day; setting up math learning centers; teaching with computers (including use of the management system and research-based teaching strategies); small-group activities; and supporting mathematical development in the home. The main technological tool was the Building Blocks Learning Trajectory (BBLT) web application. BBLT provides scalable access to the learning trajectories via descriptions, videos, and commentaries. Each aspect of the learning trajectories—developmental progressions of children's thinking and connected instruction—are linked to the other (Clements, 2007; Clements & Sarama, 2008; Sarama & Clements, 2013).

The BBSEF group also included additional PD on the SEF component (i.e., they received twice as much PD). The SEF training, delivered by authors of TotM (Bodrova & Leong, 2007) and their colleagues, included an additional 6 days of training each of the 2 years of the teachers' involvement. The SEF training followed the general organizational structure as the BB training and included the topics of development of EF in early childhood, how dramatic play supports EF, and how teachers can scaffold mature and intentional dramatic play. Like BB PD, SEF PD combined building teachers' knowledge of young children's learning and development with helping teachers master effective instructional strategies designed to support this learning and development. The idea of mature dramatic play as a critical component in promoting EF is a new one to most teachers, and so is the idea that mature play may not emerge spontaneously but requires teacher scaffolding; therefore, SEF staff paid special attention to teachers' understanding of these new concepts. Videotapes illustrating various stages in play development as well as best practices of scaffolding play were discussed during training. In addition to SEF-specific training, the BBSEF teachers received training on modified BB instructional strategies redesigned to maximally promote EF. Further, the EF strategies added to the math curriculum combined focal activities implemented outside of the "math block" with instructional strategies embedded in existing math activities.

Coaching was similarly conducted throughout the 2 years. Coaching occurred within each teacher's classroom. Again, coaching was designed to be similar to that used in TRIAD (Clements, 2007, 2011; Clements & Sarama, 2008) except that coaches in EMERGE were from the district, not provided by the project. Coaches worked with teachers throughout the project, visiting teachers in their classrooms, with the initial expectation that they would visit each teacher no less than once per month. Coaches reported to a lead coach as well as mentors (in the second year) after each visit, who report to site coordinators to monitor the facilitation process. This type of real time, classroom-based observation, demonstration, coaching, and mentoring was again viewed as indispensable, and included shared decision making, one-to-one consultation, monitoring, and reinforcement.

2.12 EMERGE Coaches

Like that in TRIAD, this coaching model was intended to be dynamic in which additional attention by both mentors and coaches is given immediately until adequate fidelity of implementation is achieved. Coaching was provided to teachers in all three conditions. The coaches were hired to observe and give feedback on the implementation of BB and the self-regulation curriculum, as well as assist with materials acquisition and technical troubleshooting. Coaches agreed to participate in on-site coaching support for hour long, biweekly sessions, and provide study teachers with feedback using the structure of the classroom needs assessment (CNA). The CNAs were intended to be filled out during the observation period, and sent to the lead coach at the conclusion of each visit. Coaches were also tasked with providing off-site coaching support, or being available to teachers and research coordinators via email, phone, or fax. All three districts employed instructional coaches for mathematics, and the same coaches within each district worked with teachers in up to three of the study conditions.

There was one lead coach who was hired to supervise the coaches and accompany them on classroom visits to check for fidelity throughout the observation and feedback process. The lead coach completed CNAs documenting these visits with the coaches. There were two mentors who were hired to provide study teachers specific feedback on implementation of the BB curriculum. The mentors were active in working with teachers primarily during Spring 2011.

Coaching roles and responsibilities distributed during the first PD session listed the following:

- Sharing teaching strategies or information about early childhood teaching and learning mathematics in early childhood.
- Sharing information with the teacher about program procedures, guidelines, and expectations.
- Sharing information about children's thinking, including learning trajectories for mathematical topics.
- Sharing information about the curriculum components.
- Sharing information about effective use of computers.
- Linking the teacher to appropriate resources.
- Offering support by listening and by sharing your own experiences.
- Giving guidance and ideas about management, scheduling, planning organizing the day, and other topics.
- Assisting the teacher in arranging, organizing, and/or analyzing the physical setting.
- Counseling the teacher when difficulties arise.
- Allowing the teacher to observe you or other colleagues.
- Promoting self-observation and analysis.

While on-site with the teachers, coaches were expected to observe, offer suggestions, receive feedback from the teacher, and help the teachers with any issues they may be having or resources they may need.

As previously stated the coaching model for EMERGE was based on TRIAD (Clements, 2007, 2011; Clements & Sarama, 2008); however, coaches in EMERGE were from the district, not provided by the project. Coaches in EMERGE were primarily former administrators or teachers, and they continued to serve in these rolls part-time while also acting as coaches. Of the 21 coaches, 9 were employed as center administrators; 9 were resource teachers/lead teachers and/or pre-K teachers; 3 of the coaches hired were working as coaches for other entities (Preschool for All or a local School District).

2.13 Coach Training

Coaches in the EMERGE project were required to attend PD sessions throughout the study period as well as a ½ day Coaching Institute before the study. Coaches from each district participated in the same math and SEF PD as the teachers.

2.14 Implementation of Coaching in EMERGE

CNAs were coded over 2 years of EMERGE implementation to evaluate the extent to which coaching occurred as intended. CNAs provide information on the (1) duration and frequency of visits, (2) implementation fidelity, and (3) qualitative notes about the visit (Fig. 4).

2.15 Frequency and Duration

We first examine the frequency and duration of visits by coaches, the lead coach, and mentors as the quality of the teacher–coach relationship has been suggested to be dependent on consistent meetings and timely consultations. EMERGE teachers received varying amounts of coaching. Visits were recorded each time a CNAs was provided. Some teachers had as many as 15 visits from their coach, others as few as 1 visit, with the average being 4. However, it is uncertain if additional visits occurred in the absence of a completed CNA as they were not recorded elsewhere. The majority of the recorded visits was between 31 and 60 min. The lead coach and mentor CNA visits were generally longer than 60 min. Table 1 outlines the duration of visits by rater type.

Further, less than half (47%) of teachers had the same coach during the entire study (Fig. 5). The research on best practices would suggest that the coaching frequency and consistency in the current study may have posed challenges to building effective teacher–coach relationships and the effectiveness of coaches in facilitating changes in the classroom.

2.16 Fidelity Ratings

CNAs recorded ratings for the BB and SEF components based on the fidelity of teacher implementation of the intervention components. Table 2 explains the rating scale used by raters to complete the CNA. Figs. 6–8 display coach, lead coach, and mentor implementation ratings across intervention components. CNAs where raters listed a "0" or left blank are not included in these comparisons as interpretations to their meanings cannot be made; therefore, these figures will not add to 100%. First examining identification of

EMERGE Project Coaches

Classroom Needs Assessment Report

Coach: First Name _______________ Last Name _________________ District (choose one): ☐ SDUSD ☐ PUSD ☐ SBUSD

Teacher: First Name ______________ Last Name _________________ School/Site: _________________________

Date of Visit: ______/______/______ (Month / Day / Year) **Time of visit:** Start _____________ End _____________

Teacher is on week _____ of *Building Blocks* curriculum **Classroom has _______ computers working for children's use**

Area		Rating	Comments
Building Blocks Implementation	Large Group		
	Small Group		
	Computer Center		
	Hands On Math Center		
	Reflection Time		
	Assessment / Small Group Record Sheet		
Self-Regulation Implementation			
Questions / Concerns			

*****Rating Key: 3-Good implementation/understanding 2-Work needed 1-Lead Coach/coach intervention**

Instructions: Please fill out the form completely for ***each*** teacher for ***each*** visit. Visits should occur for 1 hour every two weeks. All forms for each month should be mailed (1366 Chisholm Trail, San Marcos, CA 92069), faxed (760-294-6627), or emailed (cindyleso@cox.net) to Cindy Leso by the last day of each month in which the visits occur.

Fig. 4 Classroom needs assessment report.

Table 1 Duration of rater visit

Duration of Visit (min)	Coach CNA (#)	Lead Coach CNA (#)	Mentor CNA (#)
0–30	9	1	7
31–60	71	24	21
61–90	47	14	8
>90	40	14	20

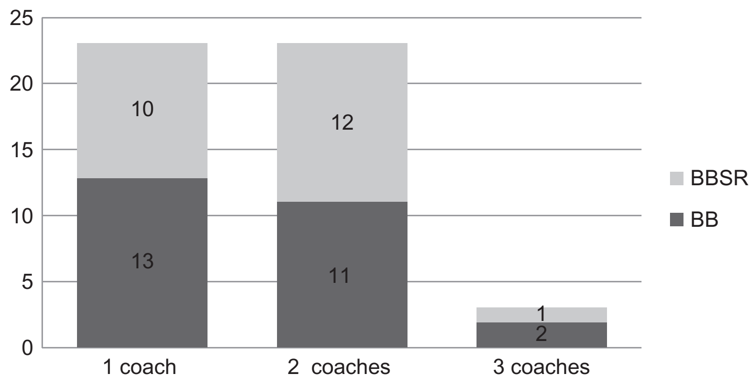


Fig. 5 Number of coaches a teacher had by research group.

Table 2 Classroom Needs Assessment Rating Scale

Rating	Explanation
1	"Lead coach/coach follow-up" was needed to assist the teacher struggling with implementation
2	"Work needed" to assist with implementation
3	"Good implementation/understanding" of the curriculum/a

struggling teachers, Fig. 6 shows that compared to coaches (12%) and the lead coach (7%), mentors most frequently (58%) rated the SEF implementation as needing "Lead Coach/Coach Follow-Up" to assist the teacher struggling with implementation. Recall that the CNAs are a primary source to provide real-time feedback to the lead coach and project directors on implementation issues. Additionally, recall that mentors were not conducting visits until the second year of implementation.

In the second year as mentors were included in observations, these raters were more likely to rate implementation across all intervention elements as

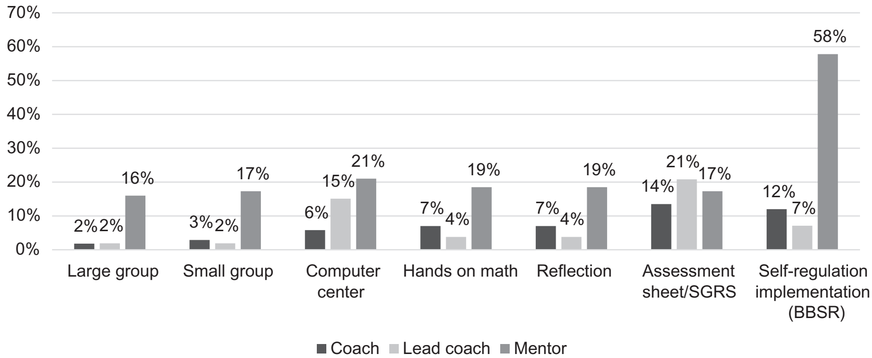


Fig. 6 "Lead coach/coach follow-up" to assist the teacher struggling with implementation.

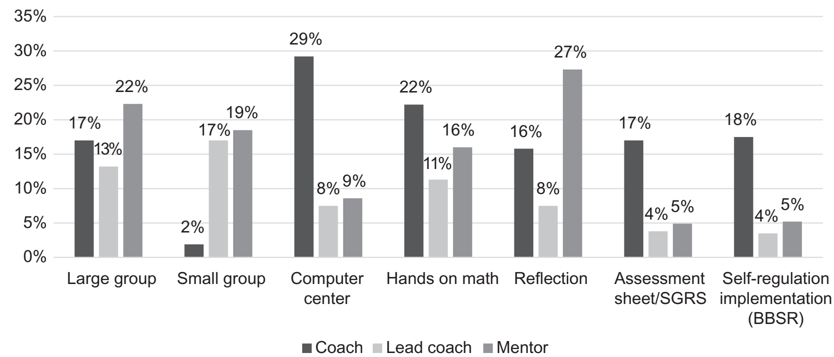


Fig. 7 "Work needed" to assist with implementation.

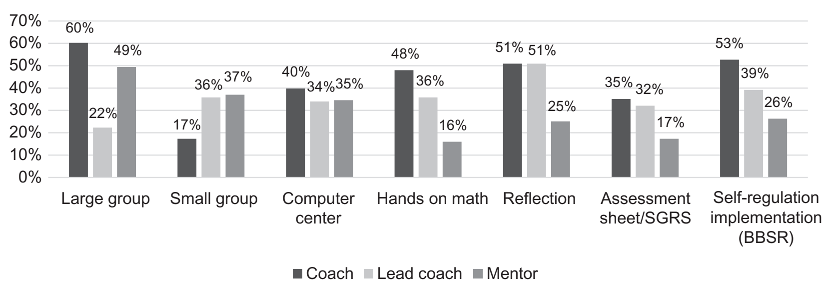


Fig. 8 "Good implementation/understanding" of the curriculum/a.

needing support. Finally, any teacher receiving a rating of 1 should have had a follow-up visit by the lead coach. However, it was found based on the CNA reports that the lead coach followed up with teachers only 20% of the time that a rating of 1 was provided on any component.

There was similar variability for rating 2 which indicated that a teacher needed assistance with implementation (Fig. 7). Coaches were most likely to rate computer centers (29%) as needing "work to assist with implementation." While the lead coach most frequently (17%) rated small group and mentors rated reflection (27%) as needing some assistance.

It is interesting when examining ratings for "good implementation" that coaches are nearly reverse in the SEF component (Fig. 8). On 53% of the CNAs coaches rated the SEF component as good, while the 58% of the mentor CNAs rated those teachers as struggling with implementation.

2.17 Qualitative Observation Notes

The coaches' qualitative notes about the visits were coded based on best practices in coaching.

1. Coaches should have both content and pedagogical knowledge for the domain being coached as well as the ability to cultivate a positive and trusting relationship with teachers (e.g., Campbell & Malkus, 2011; Garet et al., 2008). Coaching is multifaceted in that coaches need to be able to gauge both the complexity of what teachers are being instructed to implement, and the newness of the content in terms of previous knowledge and practice of the teachers (Joyce & Showers, 2002).
2. Coaches should assist teachers with lesson planning, providing resources, modeling, and coteaching. Technique modeling, coteaching, and acting as a resource provider are also essential (Fox et al., 2011; Neuman & Cunningham, 2009). These important, though often overlooked, aspects of the coach–teacher relationship are essential to effective coaching. For one, they help break the misconception that coaches are not (or should not be) an active part of the classroom. In fact, teachers and students see much more substantial gains when coaches move away from simple observation and feedback and move toward collaboration and active involvement (Neuman & Cunningham, 2009).
3. Coaches should also be continually working with teachers to set goals and adjust those goals to meet the teacher's current needs. For instance, as coaches and teachers enter into a professional relationship, curriculum and lesson planning, as well as goal setting, should be made priorities (Neuman & Cunningham, 2009; Skiffington et al., 2011).

4. Coaches should facilitate reflection. Effective coaches provide descriptive, not evaluative feedback using concrete observations from the classroom. Engaging the teacher in collaborative problem solving to improve practice (Guiney, 2001; Harwell-Kee, 1999).

   The method was revised three times before the research assistants began coding. The assistants used the first 15 CNAs to test initial reliability. The remaining 290 CNAs were divided into four batches and assigned an assistant to code them and were then double coded. GRA's discussed codes of each batch to obtain 100% reliability. GRA's had to maintain 100% reliability before moving on to the subsequent batches of CNAs. This process was repeated for four batches until all 305 CNAs were coded and double coded with 100% reliability. The four variables on the CNA that were coded are defined below.

- *Number of direct coach interventions*—Rater engaged in a direct intervention during the observation period, including, but not limited to: coteaching, modeling, providing resources, suggesting related to implementation, using reflective questioning with the teacher, assisting the teacher in creating plans, debriefing on classroom activities, or other interactions related to curriculum implementation.
- *Presence of a need identified*—Rater describes that the teacher or classroom needs assistance with something in order to implement the curriculum properly.
- *Type of need identified*—Needs identified by rater were categorized by type of need: computer issues, materials needed, software/website issues information, schedule for computers, help curriculum implementation, classroom management help, assistance with students, planning, and training.
- *Identifying questions/concerns*—Indicates whether the rater used the questions/concerns section on the CNA form.

2.17.1 Direct Coaching Interventions

Effective coaches should be assisting teachers with lesson planning, providing resources, modeling, and coteaching. Coaches should also be continually working with teachers to set goals and adjust those goals to meet the teacher's current needs. The CNAs were coded for these types of direct coach interventions (DCI). DCIs were coded anytime qualitative notes on the CNAs suggested that coaches engaged in a direct intervention during the observation period, including, but not limited to: coteaching, modeling, providing resources, making a suggestion related to implementation, using reflective questioning with the teacher, assisting the teacher in creating plans, debriefing on classroom activities, or other interactions related to curriculum implementation. The number of DCIs reported on an individual CNA ranged from 0 to 14. Overall, data reflect few DCIs were provided to teachers in the current study with 81% of coach CNAs, 83% of lead coach CNAs, and 92% of mentor CNAs indicating 0–2 DCI were provided.

2.17.2 Identified Needs

CNAs were also coded for *Identified needs*. Identified needs were coded anytime qualitative notes on the CNAs noted implementation support was needed, including, but not limited to: computer issues, help with specific curricular components, and classroom management. The majority of needs identified on CNAs were related to issues with technology and computer software, a critical component of the synthesized curriculum teachers were implementing. Coded data indicated 41% of coach CNAs, 28% of lead coach, and 25% of mentor CNAs included identified needs. Of coach CNAs that were coded as having identified needs, 45% had an identified need that was continually identified. Of the lead coach CNAs that were coded as having identified needs, 38% had an identified need that was continually identified. Mentor CNAs did not appear to have identified needs that were continually reported. Nearly 50% of the time the same need was repeatedly identified on a CNA, which may reflect that while coaches and lead coaches were able to identify what teachers needed for successful implementation, they were not as successful at following-up on those needs and ensuring that they were addressed.

Identification of teacher needs was also captured on CNAs in the "Questions/Concerns" section. Lead coaches and mentors used the questions and concerns section of the CNA more frequently than coaches. Specifically, the lead coach included a question or concern 81% of the time, while coaches only included it 41% of the time.

Lastly, we examine the extent to which coaches participated in PD. Recall the only training coaches received on the intervention content was at the same time teachers received it. Fig. 9 displays that coach attendance at PD sessions was poor at best, with only 9% of coaches attending all eight PD sessions. Finally, examining the relation of frequency of rater visits as reported on the CNAs to the date of PD activities, we find that visits peak at or just after these sessions (Fig. 10). This speaks to the critical importance of having coaches involved in the PD sessions to increase engagement and connection with the intervention content and classrooms.

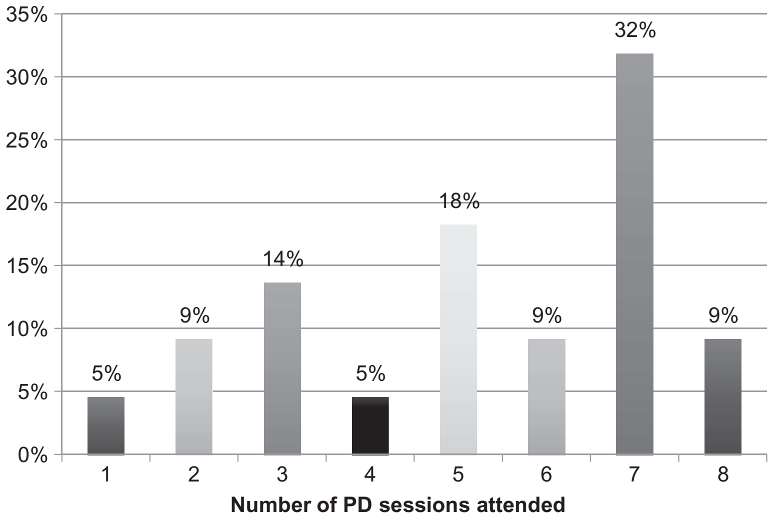
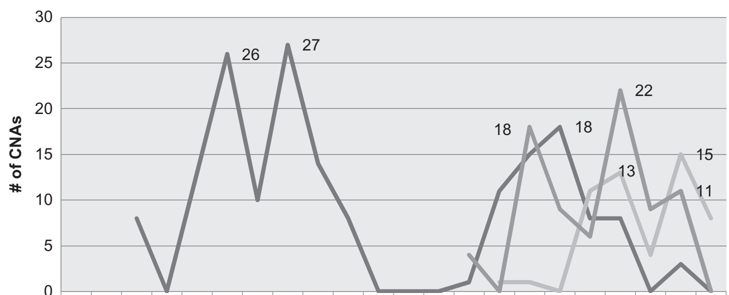


Fig. 9 Number of PD sessions attended by coaches.



	1	2 (PD)	3	4 (PD)	5 (PD)	6	7 (PD)	8	9	10	11	12	13	14 (PD)	15	16 (PD)	17 (PD)	18	19 (PD)	20	21	22
Coach CNAs			8	0	13	26	10	27	14	8	0	0	0	1	11	15	18	8	8	0	3	0
Lead coach CNAs															1	1	0	11	13	4	15	8
Mentor CNAs														4	0	18	9	6	22	9	11	0

Project month
PD = professional development

Fig. 10 Rater visits and PD.

2.18 Effectiveness of EMERGE as a PD Model

In summary, the CNA data demonstrate that implementation of coaching in EMERGE was less aligned with the overall TRIAD PD model than was the previously described TRIAD implementation. Moreover, the CNA data provide a glimpse at a coaching instantiation that did not meet all the effectiveness criteria from the greater literature on coaching. Certainly, the coaching component is but one piece of the overall PD model. However, if coaching is not delivered in a manner that meets research-based criteria then we may expect to see less positive results. In fact, Clements et al. (under review) found while the majority of the impact estimates for BB were positive, fewer were statistically significant. At the end of pre-K, only one of the four measures of executive function was significantly higher. At the end of kindergarten, with no additional treatment in kindergarten, two of the four executive function measures were significantly higher for the BB group and one of the two tasks of mathematics confidence was significantly higher for the BB group compared to either the BBSEF group or the control group. For BBSEF, the impact estimates were mixed in sign, small in magnitude and, all statistically insignificant. We conclude that while the effects on student-level measures do not make a strong case for students being positively affected by either intervention condition, they support two hypotheses: First, implementing multiple innovations simultaneously may limit desired outcomes. Second, early gains in both mathematics and EF competence can be mutually supportive and thus resist fade out.

Importantly for this paper, even though teachers achieved adequate fidelity and those measures differed in practically and significantly between groups in hypothesized directions (e.g., the BBSEF group outscored the other two groups on a measure of mature play), their fidelity scores were lower than in previous studies. We are conducting further analyses and suggest that future studies do so, to determine if the less satisfactory coaching can explain both the less adequate fidelity and the lower impact on child outcomes.

3. CONCLUDING THOUGHTS

This coaching implemented as part of the TRIAD and EMERGE projects highlights coaching that both adheres and strays from an intended model, and may serve as microcosm of the state of the practice—promising, but without sufficiently consistent and intense oversight to ensure teacher benefit. To simply say we have coaches or that there is coaching is not enough. Coaching still needs to be implemented with fidelity to a model that has been proven effective. We saw here the importance for coaches to be trained in both the content and process of coaching. Only 9% of EMERGE coaches attended all of the PD sessions, missing valuable content.

In comparison, TRIAD mentors received more training prior to the start of the study and participated in almost all the PD sessions. Neuman and Cunningham (2009) similarly found the importance for literacy coaches to be well versed in the PD content. The math coaches in the EMERGE study may have had less content expertise than the coaches in TRIAD. Perhaps this is somewhat related to the difference in how coaches were acquired for the studies. EMERGE coaches were part-time district employees who continued their role as administrator or teacher while trying to maintain coaching duties. In comparison, TRIAD mentors were not district employees and were identified by the TRIAD project staff. Perhaps this selection aspect as well as the TRIAD mentors not being doubly employed by districts in which they were coaching translated to better fidelity to the coaching model.

Overall, the data presented here suggest the importance of providing training and support for coaches on not just the content of coaching but also processes to achieve effective teacher–coach relationships. The data point to the need for more formal or standardized training for coaches to guarantee that enlisted coaches will follow best practices.

Despite these outlined "ideals" in coaching, the practice parallels teacher preparation in its high variance in training. Coaching, in itself, is often (though not always) implemented by experienced teachers. Regardless of any practical experience gained, little formal or standardized training for coaches exists. In fact, coaches often receive no more than a handful of multiple-day training sessions spread throughout the year *during* the time they are enlisted as coaches (Frost & Bean, 2006). The result has been coaches with a wide range of training, professional experiences, and qualifications. In spite of the strong support effective coaching has garnered, it is difficult to guarantee that enlisted coaches will follow a research-based model.

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