EMC Project Research Brief †

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Summary of Findings

The EMC Project set out to understand how types of coaching knowledge influence coaching effectiveness. Our hypothesis was that improvements in certain kinds of knowledge and practices among coaches would translate into improvements in coaching effectiveness as defined by our measures of teachers' knowledge and practices.

No single study, including ours, can make definitive statements about coaching effectiveness. EMC will be an important part of a growing *body of research* on mathematics coaching. That being said, our results do support mathematics classroom coaching as a school-based strategy for influencing teacher practice, knowledge, and beliefs. The diverse nature of the school districts whose coaches participated in our study, combined with the way that our project studied mathematics coaches in the varied contexts in which coaching is being enacted in those school districts, provides evidence that the results from this study are useful in understanding coaching in varied settings.

We did find strong evidence that changes in some coaching characteristics are important in explaining teacher improvement. In short, we found evidence that:

- improvements in coaches' perceptions of their skills in coaching standards-based mathematics content and practices explained improvements in teachers' mathematics knowledge for teaching, teaching practice, and self-efficacy; and
- improvements in coaches' knowledge of and use of coaching practices recommended by leading coaching texts explained improvements in teachers' knowledge of the mathematics they teach.

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We looked for, but did *not* find, evidence that:

- changes in coaches' mathematics knowledge for teaching explained variation in any of our teacher measures;
- changes in coaches' knowledge of and use of coaching practices recommended by leading coaching texts were related to changes in teachers' classroom practices; and
- variations in the amount of time coaches spent in pre- and post-lesson conferences with teachers (or "coaching intensity") explained changes in any of the teacher variables.

What does it mean that we did not find evidence to support our predicted relationships? In the case of the first item above, there are a couple of scenarios that might explain the lack of evidence. One is that coaches' mathematics knowledge really does matter, but our study wasn't designed appropriately to find evidence of that. The other is that coaches' mathematics knowledge really doesn't influence our teacher measures. There is no way for us to know which of these is the cause, which is what happens sometimes with educational research. A similar caveat applies to the second item above relating specifically to changes in teachers' classroom practices.

All studies have limitations, and sometimes, despite the best design efforts, these limitations can prevent researchers from being able to make conclusions. For example, in our study, the amount of time our coaches spent coaching decreased dramatically as the years progressed. This was due to a variety of school factors, such as reduced budgets, that were beyond our control. The lack of evidence supporting the importance of coaches' mathematics knowledge and the intensity with which they coach does not mean that these coach characteristics are not important. It simply means we were not able to detect these relationships in our study.

Because we clearly acknowledge EMC's limitations in our findings, future studies will be able to improve and build upon what we have done in the continuing search for a better understanding of coaching effectiveness.

Further Discussion of Findings

One of the fundamental goals of the EMC Project was to establish types of coaching knowledge, skills, and activities that are important in improving teacher knowledge and practice in an era of standards-based teaching and more rigorous content standards. We used multi-learner models to explore how changes in coaches' knowledge and practices explain changes in teachers' knowledge and practices.

During the 5 years of the project, we collected an unprecedented amount of data about coaching and teaching mathematics using several instruments, including some designed specifically for EMC. Below is a list of the coaching measures and teaching measures—all very familiar to our project's participants—that proved to be important to our findings.

Coaching Measures:

- Coaching Skills Inventory (CSI): Measures how skillful a coach feels he or she is in coaching using standards-based mathematics practices. This is the survey our coaches completed that asked things like, "How effective do you feel coaching teachers on creating and using mathematical applications and connections in their mathematics classes?"
- Coaching Knowledge Survey (CKS): Measures the degree to which a coach's knowledge and practices align with the recommendations of leading coaching texts. This is the survey our coaches completed that asked them, among other things, to rate their level of agreement with statements such as, "An effective mathematics coach provides teachers with an understanding of how the mathematics they teach supports learning beyond the grade level they teach."
- Mathematics Knowledge for Teaching (MKT): Measures a coach's depth and sophistication of knowledge of elementary- or middle-school mathematics. This is the survey our coaches completed that contained multiple-choice questions relating to how students might approach classroom mathematics problems.
- Intensity: Measures the total amount of time a coach spends in a given year in both pre-lesson and post-lesson conferences with a given teacher. For this measure we used the figures that coaches reported on their year-end surveys about coaching activity.

Teaching Measures:

- Inside the Classroom Observation Protocol (ITCOP): Measures the degree to which a teacher's practice aligns with standards-based best practices and the likelihood that the practices improve students' abilities to "do" mathematics. This is the instrument that our classroom observers used when conducting their annual springtime visits to EMC teachers' classrooms.
- Mathematics Knowledge for Teaching (MKT): Measures a teacher's depth and sophistication of knowledge of elementary- or middle-school mathematics. This is the same survey that our coaches also completed, as described above.
- Teacher Survey (TS): Measures a teacher's beliefs about mathematics instruction, professional activity around mathematics instruction, and comfort with teaching mathematics. This is the survey our teachers completed that asked them, among other things, to rate statements such as, "What is your ability level to gauge student comprehension of a mathematics lesson you just taught?"

Our findings suggest that improvements over time in coaches' self-assessment of mathematics coaching skills (CSI) were positively related to all three of the teacher response variables. In other words, as coaches' assessment of their mathematics coaching skills increased, so did teachers' mathematics knowledge for teaching (MKT), teachers' self-efficacy (TS), and teachers' use of standards-based practices (ITCOP). This effect was also detected when we analyzed a subset of the data, covering just the first 3 and then the first 4 years. This indicates to us that the effects of coaches' knowledge and practice on teachers' knowledge and practice can be detected on a shorter term than 5 years. Improvements in coaches' alignment with the recommendations of predominant coaching texts (CKS) were related to increases in teachers' mathematics knowledge for teaching (MKT). We found no evidence that changes in coaches' MKT scores explained variation in any of our teacher measures.

In terms of control variables, we found no evidence that coaches' professional development in coaching knowledge received outside of the EMC Project was positively related to changes in our teacher measures, even though many of our coaches reported having considerable amounts of such training. Teachers' professional development in mathematics received outside of the project was related to increases in teachers' self-efficacy (TS) and improvements in teachers' use of standards-based practices (ITCOP).

Coaching Variables That Explain Changes in Teachers' Perceptions of Preparedness, Anxiety, and Self-Efficacy For Teaching Mathematics

We saw improvements in teachers' TS scores (measuring teachers' preparedness, anxiety, and self-efficacy for teaching mathematics) over the course of the project. Our question is not whether the TS scores went up, nor simply whether TS scores correlate to coach measures; rather, we were concerned with whether or not changes in the coaches' measures *explain* these changes in teachers' measures.

In our statistical models for the TS total scores, we found strong evidence of a relationship between changes in coaches' CSI scores and teacher TS scores ($p = 0.0002$). In practical terms, as coaches became more comfortable and felt more proficient in coaching on standards-based mathematics, the coached teacher also became more comfortable and felt more proficient in teaching mathematics.

There was also strong evidence of an effect of outside mathematics training (i.e., not received as part of EMC) on the TS scores ($p = 0.0001$), with a teacher who had outside professional development in a given year having an estimated mean TS score that is higher than that for a teacher who didn't. In data sets up to Years 3 and 4, there was similar evidence that improvements in coaches' CSI scores and teacher outside professional development explain changes in TS scores, which provides additional confidence in the strength of the findings.

There also was weak but positive evidence of an effect of the mean coaching intensity ($p = 0.076$), with higher coaching intensity related to higher TS scores, on average. None of the other effects were suggested as being important in our statistical model.

Coaching Variables That Explain Changes in Classroom Practice

The EMC Project performed annual classroom observations for each teacher in the 5-year study. Lessons were scored using the ITCOP, which rated lessons from 1 to 7, with a 7 representing the highest adherence to standards-based practices that is highly likely to increase student mathematical knowledge and practice. Our observers took into account the diverse contexts of project teachers' classrooms and respectfully considered the choices teachers make in their day-to-day instruction. We saw distinct improvements in teachers' ITCOP scores over the course of the project, with the median score moving from a 3 to 5 on the 7-point scale. Again, our question is not whether the ITCOP scores went up or simply correlated to coach measures, but instead how changes in the coaches' measures explain those changes.

By Year 5, the evidence was quite strong in showing that as coaches' CSI scores increased, corresponding teacher practice scores (ITCOP) also increased ($p < 0.0001$). We also found that whether a teacher had outside mathematics professional development explained improvements in her or his ITCOP scores ($p = 0.014$). Both of these effects were detected as important in analyses using data up to Years 3 and 4. None of the other effects were suggested as being important in the model.

Coaching Variables That Explain Changes in Teachers' Mathematics Content Knowledge

The teachers in our study began the project with average MKT scores just slightly above the mean of a nationally normed sample (the mean of our participants was 0.096, with a standard deviation of 0.970), and we saw improvements in teachers' MKT scores over the course of the project, ending half a standard deviation above average. So how did changes in the coaches' measures explain these changes in teachers' MKT scores?

Improvements in coaches' knowledge of coaching (CKS) ($p = 0.0009$) and improvements in coaches' self-assessment of their coaching skills in mathematics (CSI) ($p = 0.021$) strongly explained improvements in teachers' MKT scores. These relationships were also detected in our Year 3 and Year 4 analyses (all p-values < 0.05), indicating that this effect of coaching can be seen in a 3-year time span. None of the other effects were suggested as being important in the model.

Intensity

We were surprised that our analysis did not detect a relationship between coaching intensity and teacher variables. Because our primary analysis defined intensity as the sum of total annual minutes in a pre- or post-lesson conference, we were worried that we may have missed an effect. From our qualitative approaches in the study, we did have evidence that some coaches were working with teachers in a variety of ways that did not align with our EMC definition of coaching. For example, some coaches were holding larger-audience professional development sessions and informal follow-ups, and some coaches were at times “coaching” the teacher during the lesson observation with neither a formal pre-lesson nor a post-lesson conference. These coaches would ask the teacher questions and offer suggestions as the students performed individual or group work.

As a post-hoc analysis, we replaced our measure of coaching intensity with a measure of the number of coaching sessions in mathematics reported and reran the analysis as described above. We then replaced this measure with the number of coaching sessions in mathematics that were reported as attending to number and operation. In both cases, the overall picture did not change. The relationships discussed above remained intact, and these alternative measures of intensity did not explain changes in teacher measures. We had no way of keeping track of the other types of professional development, such as larger group trainings, so these additional impacts were not considered.

Another problem is that intensity numbers went down dramatically as the project progressed. This was due to district restructuring and perhaps financial constraints brought about by the recession, which occurred in the middle of the project. Many of our EMC coaches found themselves teaching more and coaching less, and that was very apparent in our data. In a similar project in which intensity remains high throughout all 5 years of the project, researchers might find intensity to be very important in explaining teacher change. There are a handful of coaching studies in the content areas of reading and literacy that report an intensity effect.

For More Information

Please check the “Results” page of the EMC Project Web site in early 2015 for the complete manuscript of the project’s paper “Influences of Coaching Knowledge on Teacher Change,” which is currently under consideration by a peer-reviewed journal.

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