The Value-Added Benefit of Distance-Based Instructional Coaching on Science Teachers’ Inquiry Instruction and Student Achievement

One of the major implications of the Next Generation Science Standards is the necessity to pull together inquiry and practice and recognize the role of engineering in science education (National Research Council, 2013). As studies in teacher education have reported, it is very difficult to achieve sustainable shifts in teaching practices due to a number of issues, including teachers’ unfamiliarity with how to practice change, their inadequate preparation, or lack of understanding of what the required change entails (Asay & Orgill, 2010; Capps, Crawford, & Constas, 2012; Kazempour, 2009). Embedded professional development (PD) supported by an instructional “coach” is a promising strategy for addressing the need for teacher changes in science education (Bransfield, Holt, & Nastasi, 2007; Habegger & Hodanbosi, 2011; Lotter, Yow, & Peters, 2013). However, little research has been conducted to (1) describe how instructional coaching works and (2) explain how an individual teacher changes his/her beliefs and practices in teaching science.

As technology has progressed, so have the platforms for technology-based mentoring, which have evolved from telecommunication to electronic mail/online discussion forums to web-based conferencing (Allen, Pianta, Gregory, Mikami, & Lun, 2011; Gentry, Denton, & Kurz, 2008; Kunz, Nugent, DeChenne, Houston, & Pedersen, 2013; Rock, Gregg, Gable, & Zigmond, 2009). The rise of web-based video conferencing technology enabled distance-based instructional coaching (DBIC) to facilitate almost all of the features of school-based coaching, including classroom observation, synchronous video-conference coaching, and sharing necessary materials. Research has suggested that teachers who received technology-delivered instructional coaching reported positive experiences and shifts in changes in their instructional practices, as much as teachers who received school-based instructional coaching (Gentry et al., 2008); however, few studies have substantiated teacher self-reported improvement in knowledge and practice through direct observation. However, very little of the teacher-reported data from the studies have been validated through direct observation, suggesting the need for more rigorous qualitative and quantitative research (Gentry et al., 2008).

The present study draws on empirical data from a specific case of teacher Kara who participated in two larger studies for two consecutive years. This present study aims to determine the value-added benefit of distance-based instructional coaching over what can be learned from a summer institute alone. With an in-depth analysis of a single case, this paper describes how the teacher implemented what she learned from PD without instructional coaching, with coaching, and after coaching as well as its impact on student learning. We apply the Vygotsky Space model to analyze an empirical case that we describe in detail, using data from interviews as well as observational and archival data (Gallucci, DeVoogt Van Lare, Yoon, & Boatright, 2010; Harré, 1984).

Background and Context

This presentation is about changes in teacher Kara’s instructional practice and the impact on her students’ science learning during or after her participation in two professional development studies, Coaching Science Inquiry (CSI) in Rural Schools in the 2012-13 school year and Coaching for Sustainability (CFS): Peer-Coaching Science Inquiry in the 2013-14 school year. The CSI PD comprises a two-week summer institute and a follow-up of 8 to 16 distance-based instructional coaching sessions during the following school year, 2013-2014. The
CFS study is a follow-up PD project to support the CSI participant teachers’ sustaining guided-inquiry instruction for their science teaching. The CFS study includes a three-day summer institute and distance-based peer coaching during the following school year, 2013-14.

Kara was in a unique situation in two respects. First, she taught the same material to six different groups of 7th-grade students sequentially throughout the school year, 2012-13, after she attended the CSI summer institute in 2012. She taught the first two groups of six persons each for eight weeks before she received the distance-based coaching; next, she taught one group while she received coaching for eight weeks; and finally, she taught three groups for eight weeks each after the coaching, until the end of the school year. Second, in the 2013-14 school year, teacher Kara also participated in the study of CFS peer-coaching science inquiry. In addition, she taught 18 students from the previous year now in 8th grade for the whole school year. With the data collected for the two years from Kara and her students, Kara’s unique situation allowed us to use her as a case study of how the value-added changes that teachers make in their instructional practice affect students’ achievement, especially with distance-based instructional coaching.

The Distance-Based coaching model used in the two studies is not a traditional face-to-face coaching after in class observation. Rather, it is delivered via WebEx (Cisco) – a web-based video-conferencing software. It allows for the teacher and coach to view the classroom video with specific time-stamped video clips showing teacher strategies and student classroom behaviors, to share their desktops or electronic files, and to record the coaching sessions. In addition to WebEx, GoPro camcorders were used for recording the classroom instruction that takes 170-degree-wide pictures capturing almost all of the students in the classroom with a microphone that records the teacher’s voice on an SD memory card. To share and deliver the recorded video, DropBox was used that allows each teacher to share 5G online spaces with their coaches.

Research Questions

The following research questions were addressed in the study:

1. What is the value-added benefit of distance-based instructional coaching on teacher instructional changes over a summer institute only?
2. What is the value-added benefit of distance-based instructional coaching on a teacher’s self-efficacy in inquiry instruction over a summer institute only?
3. What is the value-added benefit of coaching science inquiry to student outcomes?

The Vygotsky Space model was applied to interpret the qualitative data analysis results as the teacher’s learning occurred through the social and private spaces in the model. With this interpretation, the answers to the questions addressed not only what the changes were, but also how the changes took place.

Methods

Participants

Teacher Kara had 12 years of teaching experience and held a master’s degree in science education. She is one of the 47 middle- and high school science teachers who participated in the study (first year), Coaching Science Inquiry in Rural Schools, and one of the 16 teachers who participated in the study (second year), Coaching for Sustainability: Peer Coaching Science Inquiry (CFS). She completed all of the research requirements including two summer institutes, all of the measures for her and her students, and videotaping classroom instructions in the two studies. She taught six different groups of 7th-grade students (N = 15-19) the same inquiry unit
during the 2012-13 school year. In addition, she taught some of the same students in the 8th grade during the 2013-14 academic year and 18 students took the second-year post measures after she implemented the lessons she developed during the previous summer institute.

**Data**

The data from teacher Kara include 15 classroom observational video analyses by coding with the Teacher Inquiry Rubric (TIR) and EQUIP from five different timeframes and five semi-structured interviews during the five different time frames (see details below). From her students, inquiry knowledge and Nebraska Science Standard (NeSA) test scores were collected from six different groups of students during the 2012-13 school year and from the 18 students she taught in the 2013-2014 school year (see Figure 3).

**Results**

**Changes in Instructional Practice and Beliefs in Inquiry Instruction**

The target level of inquiry instruction during the summer institute was proficient inquiry (Level 3) in TIR and EQUIP with which teachers can use guiding questions, scaffolds, experiences, and/or feedback to help students comprehend the skills. In the first year, the summer institute is considered to be a learning event that took place in the public-social quadrant in the Vygotsky Space. During or after this event that introduces new knowledge or a skill, learning occurs as *Appropriation*, in which learners evaluate, negotiate, and accept the learning as valuable (Gallucci et al., 2010; Vygotsky, 1978). The learning as *Appropriation* was demonstrated in her interview following the summer institute. As she mentioned, “I’ve done a lot of [PD], but I still think that is far different from the way we went through this summer...I think that was much more guided and so much hands-on, I got the impression this summer the way we went through, the PD provided was truly how inquiry works.”

In teacher Kara’s classroom videos taken in the previous school year of the CSI study, the evaluations of her inquiry instruction were assessed between Levels 2 and 3 by TIR. Level 2 is “Developing Inquiry” in which teachers mostly provide didactic inquiry (lecture or demonstration) instruction. The major portion of the lessons in the baseline videos was hands-on activities, and Kara began the classes by distributing a worksheet with the detailed instruction of an experiment about different types of materials. When teacher Kara taught the first group of students in the beginning of the 2012-13 school year, her level of inquiry instruction moved up to near Level 3, *Inquiry Proficient*. She allowed the students to develop their own investigation methods that aligned with their hypotheses, which was evaluated as a proficient level of inquiry instruction in investigation area in TIR. However, she still was not at a proficient enough level to engage her students in defending their results and in verifying their hypotheses based on evidence. While Kara taught the same unit to the third group of students, she received eight distance-based instructional coaching sessions for about eight weeks. During the coaching sessions, the coach pointed out her lack of guiding her students to defend their results and provided suggestions, as she mentioned in the third interview.

Next, Kara tried to have her students speak more about their idea regarding their questions, investigation process, and data as evidence associated with their first hypotheses. This change was observed by the coders, and her levels of inquiry instruction of explanation moved up above Level 3. This observational evaluation is consistent with the evaluation by EQUIP. In EQUIP, *Discourse Factors* include questioning, complexity of questions, questioning ecology, communication pattern, and classroom interactions. Among these indicators, the complexity of questions and questioning ecology are about engaging students in discussions of reasoning.
justifying, or explaining with data as evidence that is consistent with the explanation level in TIR. Teacher Kara’s Discourse level in EQUIP evaluation did not reach a proficient level until she participated in a couple of coaching sessions in November, 2012. However, during and after the coaching sessions, her inquiry instruction level in EQUIP went up above Level 3, which she maintained throughout the 2012-13 and 2013-14 school years. Learning for the teacher that occurred in this period can be considered Transformation in the Vygotsky Space in which Kara transformed new concepts in the context of her teaching in the classroom.

**Student Outcomes: The Inquiry Knowledge and Nebraska Standardized Achievement (NeSA) Test**

An ANOVA test was conducted to compare the group mean scores of inquiry knowledge tests, but there were no significant differences in pre- and post-tests in the school year 2012-13. To compare each group’s pre- and post-test’s mean differences, a paired sample t-test was conducted for each group of students. However, none of the groups showed significant differences between pre- and post-test mean scores in the school year 2012-13. In addition, when an ANCOVA ran with the post-test scores adjusting the pre-test scores, there was no significant difference between groups \((F = 22.86, p = 0.107)\). Although teacher Kara showed noticeable improvement in teaching practice and confidence, the significant impact on student inquiry knowledge did not seem to appear in the first year. However, of the students Kara taught in the 2012-13 school year, 18 students whom she taught again in the 2013-14 school year took the same test in January, 2014. Consequently, the students were exposed by the same teacher’s guided inquiry instruction from the beginning of the 2013-14 school year for about five months. When an ANCOVA test was conducted to adjust the pre-scores, it showed a significant difference between the post-test mean scores.

To analyze NeSA test scores, the paired sample t-tests to compare the pre- and post-test mean scores all showed significant improvement. However, without a control group like whom Kara taught without the intervention, we cannot assume that the impact on the students’ test scores is associated with Kara’s improved teaching practice and confidence resulting from the summer institute and the coaching. An ANOVA and an ANCOVA test were conducted to compare the post-test scores of each group; but there were no significant differences in the school year 2012-13 \((F = 0.700, p = 0.499)\). The impact of teacher Kara’s new teaching strategy on students’ achievement did not seem to be clear in the first school year. However, the test scores of the 18 students who taught by teacher Kara continually in the second school year showed significant improvement when compared with other groups’ post scores in the first year \((F = 6.088, p = 0.001)\).

**Contribution to Science Teacher Education**

With the idea of sustainable changes of science teachers for improving science inquiry knowledge and skills after a summer institute by using distance-based instructional coaching model, this present study would be most interesting to science teachers, faculty members in teacher education, developers of teacher PD programs, or curriculum developers. The results in this study show how teachers’ changes initiated from a PD program can be effectively sustained by the distance-based instructional coaching that was effective as much as school-based instructional coaching. As shown in the results, the teacher’s changes as learning did not seem to move beyond Appropriation effectively until she received the instructional coaching. However, Transformation seemed to occur during the coaching that provided her with various reflective
opportunities. This transformation has appeared to have the impact on her students’ test scores in the second year of implementation that is consistent with several previous science teacher PD studies.

Although this study focused on the case of only one teacher, some implications for a broader audience can be offered. This case study will provide ASTE members with insight into the specific aspects of teachers’ learning for changes in their beliefs and practice in teaching with distance-based instructional coaching. The case of teacher Kara cannot describe all aspects of being coached by distance-based technology and inquiry teaching practice; however, in-depth analyses in this study can provide an illustration of how coaching makes the things that need to take place for the Transformation as learning. By implementing a distance-based (peer) instructional coaching model, science coaching experiences can continue without the ongoing need for a school-based coach.

References


The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant # R305C090022 to the University of Nebraska-Lincoln. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.