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# Meeting Rural Science Teachers' Needs: Professional Development with On-going Technology-Delivered Instructional Coaching[1]

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# Introduction

Teachers are key in successfully educating students. Access to high quality professional development is critical to insuring teachers are equipped with pedagogical knowledge and skills needed to deliver classroom instruction that leads to successful student outcomes, meets state standards for core academic content (e.g., science, mathematics, reading), and prepares students for their futures.

While science including inquiry is critical for success in many careers, U.S. students perform miserably compared to international counterparts (Science and Engineering Indicators, 2012). Of 46 countries, students in 10 countries are higher achievers in science than in the U.S. (Trends in International Science and Math Study, 2007). Nationally, 35% of eighth-graders have a "below basic" understanding and only 32% of eighth-graders have a "proficient" understanding of science (National Assessment of Educational Progress, 2011). Performance is much lower for minority students: 63% of African-American and 52% of Hispanic eighth graders score "below basic" in proficiency in science; only 10% of African-American and 16% of Hispanic students have a "proficient" understanding (NAEP, 2011). Further, results from NAEP 2011 show that students in the U.S. "… do much better identifying the correct answers to simple scientific tasks than using evidence from their experiments to explain those answers" (Parnass, 2012).

A recent national survey of K-5 teachers comparing professional development (PD) experiences for teachers in rural and non-rural schools revealed that PD experiences for all teachers were rare for science compared to other core areas (e.g., reading and math) (Glover & Nugent, 2011). For rural science teachers, geographic and professional isolation coupled with great distances from "local" opportunities make access to PD in science even more difficult. Further limiting for middle and high school rural science teachers is the fact that often there is only one science teacher in the building. As a result, (a) it is extremely difficult for these science teachers to be absent for a day or two and (b) there is no immediate "community of practice" available for those teachers who are required to be knowledgeable and proficient in all science areas in multiple grades (e.g., 7-12) (Lave & Wenger, 1991).

The *purpose of this study* is to investigate effects of professional development in an approach to science instruction including guided scientific inquiry and benefits of support to teachers through instructional coaching via distance technology. Approximately 162 middle and high school rural science teachers will work with researchers to learn ways to incorporate guided inquiry experiences in lessons to maximize students' learning of scientific concepts and methods. In this study, teachers will be randomly assigned to either a group receiving the professional development or a control group not receiving the training. Teachers assigned to the control group for the first year have first choice to participate in the professional development during the second year (2013-2014). We will present initial results from the first professional development Summer Institute on teachers' inquiry knowledge, skills, attitudes and beliefs, and confidence in teaching inquiry. We will also describe and present preliminary findings from on-going teacher supports delivered via distance technology from instructional science coaches.

## Theoretical Framework

Our research-based theoretical framework for a guided science inquiry professional development with instructional coaching experience includes elements listed in Figure 1. The elements of our professional development model can be found in Table 1. This professional development meets a pressing need for teachers to have supports necessary to meet requirements of state standards in science with inquiry as a content area for all students.

Successful performance for all students comes through equipping teachers with solid understanding of knowledge and skills needed to enhance students' education, especially in science. Once teachers gain these skills, they can apply them annually (Sanders & Horn, 1994). There is a strong need for professional development experiences that include opportunities for teachers to gain and practice the skills being addressed in the professional development. Garet et al. (2001) identified features for effective professional development, including deepening teachers' content knowledge (e.g., in science) and active teacher engagement in learning opportunities. Experiences should be highly accessible to encourage teacher collaboration, be of sufficient duration, and promote continuity to other in- and out-of-school experiences (Garet et al., 2001; Loucks-Horsley et al., 2003). Efforts must attend to processes that promote knowledge acquisition and skill transfer. Graduated experiences [e.g., instruction, modeling, practice, feedback, and opportunities to adapt newly acquired skills into natural classroom contexts (e.g., through mentoring)] are necessary to achieve desired experiential and learning outcomes. A prominent shift is from static, knowledge-based training to supported experiences that provide continuous, practice-focused support and guidance to teachers (Ingersoll & Kralik, 2004; Pianta, 2005). Such strategies reinforce teacher development of evidence-based instructional strategies and application of these desired skills in relevant instructional contexts (Akerson & Hanuscin, 2007; Fixsen et al., 2005).

## Method

### Participants

Forty-seven rural middle and high school science teachers from 45 schools in the Midwestern region participated in the treatment group for this guided science inquiry professional development summer program developed by university educators as part of a large-scale research study. In keeping with the typical profile of rural teachers, 83% of the teachers taught multiple grades and 92% taught multiple subjects. Professional development focused on instructional strategies in a guided science inquiry approach to support teachers' classroom instruction for inquiry as both content and a process.

### Design

This study uses an experimental group design examining differences between a treatment group of rural science teachers in grades 6-12 receiving the intervention (professional development in guided scientific inquiry with instructional coaching) and a control group of 6th-12th grade rural science teachers who do not receive any professional development from the research team.

### Procedure

Teachers in the professional development with coaching treatment condition in the first cohort participated in an eight-day Summer Institute (June 2012) held over two consecutive weeks on-site near a university campus. Teachers were taught elements of guided inquiry instruction, adapted an inquiry lesson for their classroom, and presented their lesson and received feedback from a designated coach and teacher peers. They will implement this lesson in their classroom during a 6 - 8 week period during the following school year (NOTE: at submission, the 2012-2013 school year has not begun, but by the AERA conference, we will have preliminary findings, including case study data, from lesson implementation and coaching sessions for the first two quarters of the school year). Two lessons per week during this 6-8 week period will be video recorded for teacher self-reflection and coach review. Two distance-delivered (web-based technology WebEx) coaching sessions will be held per week where teachers and coaches jointly discuss successes and challenges and plan for future lesson implementation. Coaching sessions will also be video/audio recorded to provide data on coaching processes. In general, coaches will provide support and guidance to the teachers regarding effective classroom implementation of guided inquiry.

**Measures**

Quantitative data included teacher knowledge of inquiry (Nugent et al., 2011), science inquiry teaching self-efficacy (project-developed instrument), and beliefs about teaching science inquiry (Duran et al., 2009). Measures were given to teachers pre- and immediately post-professional development, and will be administered again after they implement their inquiry unit during the school year.

The inquiry knowledge measure (Nugent, et al., 2011) consists of three sub-scales. The science inquiry scale measures knowledge of inquiry in science and the nature of science. The classroom inquiry scale measures the five essential features of classroom inquiry (NRC, 2000) including scientific questioning, giving priority to evidence, and formulating explanations. The inquiry pedagogical content knowledge (PCK) scale measures a teacher's propensity towards types of instructional strategies (Schuster, Cobern, & Applegate, 2011). Each question presents a teaching scenario and asks the teacher to choose what they think is the best approach for teaching in that situation. There are four choices: one which describes a direct didactic model, such as lecture with a demonstration; one which describes a direct active model, such as lecture followed by a confirmatory laboratory experience, and two inquiry options. The first inquiry choice describes guided inquiry, where there is data collection directed toward developing a scientific concept for the students, and the second choice describes open inquiry, where the materials are provided but little or no instruction is given on what to do with them and the focus is on exploring the phenomenon.

The beliefs about inquiry teaching measure (Duran, et al., 2009) contains 30 items about teaching science inquiry. Prior research (unpublished) with those items suggested that there were factors related to beliefs about improvements to student engagement (8 items) and student learning (5 items), and barriers to implementation (4 items) of science inquiry within a classroom.

The self-efficacy instrument was a project-developed measure focusing on teacher behaviors necessary to elicit student abilities necessary to do scientific inquiry identified in the standards. Teachers responded on a scale of 0–100% on their confidence in achieving each of the behaviors.

## Results

Teachers' pedagogical content knowledge (PCK) of guided science inquiry significantly increased from 34% correct before the summer portion of the guided science professional development institute (i.e., Summer Institute) to 58% correct immediately after the Summer Institute (p=.000). Similarly, teachers' scientific inquiry knowledge (SI) significantly increased from 69% correct prior to the Summer Institute to 80% correct immediately after the Institute (p=.002). The growth of teachers' classroom inquiry knowledge (CI) was not statistically significant (from 68% to 72% correct, p=.125). But overall, teachers' inquiry knowledge increased significantly following the Summer Institute (from 60% to 70% correct, p=.000). In addition, teachers' self-rated confidence in inquiry teaching increased from 78% to 91% immediately after the Summer Institute (p=.000).

In addition, on a 20-item evaluation survey specifically developed for the Summer Institute, teachers reported an overwhelmingly positive evaluation. Specifically, on a 5-point rating scale with 5 being the best, the average of all scores was 4.4. Scores for individual items ranged from 3.7 (evaluation of one specific demonstration session) to 4.9 ("the Summer Institute introduced me to science inquiry teaching strategies that will be useful in my classroom instruction"). Scores from several items are of particular interest. Specifically, teachers stated that the Summer Institute "introduced me to valuable inquiry teaching resources that are applicable to my classroom instruction" (4.5); "provided adequate time for me to work on lesson plan development and refinement" (4.4); "provided adequate time to practice my inquiry lesson" (4.5); "having the opportunity to present my inquiry lesson to coaches, [professional development] staff and fellow teachers was valuable" (4.7) and "experiencing the lessons of other teachers gave me ideas for my own classroom" (4.8). The average score for the item that asked teachers to provide an overall rating of the Summer Institute was 4.7.

Preliminary findings from post-coaching evaluation for 25 teachers who have implemented their Units and completed the coaching sessions are promising. Responses indicate an overwhelmingly positive evaluation of the coaching experience. The complete evaluation survey has 17 items with a 5-point Likert-type rating scale with 5 being the best score. Average responses ranged from 4.0 – 4.87. Some of the items include "Coaching helped me understand the inquiry approach and its implementation" (4.48); "Coaching changed my instruction in ways that benefit student learning" (4.61); "Coaching improved my teaching skills" (4.7); "Coaching encouraged self-reflection" (4.7); "Coaching identified student outcomes and teaching strategies to support outcomes" (4.61); "Coaching provided valuable feedback" (4.78); "Overall, how would you rate the coaching you received as part of the CSI project?" (4.87).

## Discussion

Preliminary results provide evidence regarding effective methods for teaching students in rural settings scientific inquiry concepts and processes, including the use of instructional coaching (via distance technology) in promoting teachers' knowledge, skills, and practice. Individual teachers in the treatment group will immediately benefit by receiving instruction and support for developing inquiry instructional strategies that foster student understanding of the inquiry process in addition to receiving direct, ongoing coaching to more successfully implement the inquiry model of instruction in their classrooms. Lesson plans are developed that are consistent with district curriculum, the State Standards, and are classroom ready.

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Table 1.

*Elements of Guided Science Inquiry Professional Development with Instructional Coaching*

| Process Phase | Components | Application to Guided Science Inquiry Instructional Strategies |
|---|---|---|
| Needs Assessment | | Teachers identify needs of students and self needs, taking into consideration unique contextual factors (e.g., rural) |
| Skill Acquisition | Content Instruction | Subject-specific (guided science inquiry) educators deliver instruction to teachers according to teachers' self-identified needs and needs of their students |
| | Pedagogical Instruction | Subject-specific educators present pedagogical instruction, including strategies for educating diverse learners, methods for inquiry-based instruction, designing and using high quality student experiences, assessment and progress monitoring, and how to engage families in support of out-of-class student learning |
| | Teacher Collaboration | Teachers work together within the science discipline and within a grade range (e.g., middle or high school) to develop implementation strategies for lesson plan guides and learning activities for students regarding science inquiry as content and as process skills |
| | Mentoring/Coaching | Teachers are mentored by science coaches teachers (experienced science teachers with experience in implementing guided science inquiry strategies), including conceptualization, development and delivery of lesson plans (topics, activities, method of delivery) |
| | Modeling | University science instructors and coaches model effective instructional strategies and delivery |
| | Practice | Teachers deliver their lessons to a community of practice sub-group during the summer and to their students in their classrooms during the school year |
| | Evaluation and Feedback (Self-monitoring / self-reflecting) | Coaches provide verbal evaluations of lesson implementation and practice lesson implementation; fellow teachers provide verbal feedback of the practice lesson; |

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| | | teachers video-record their lesson implementation and engage in guided self-reflection/self-monitoring |
| | Communities of Practice | Teacher collaboratives are extended with university personnel (educators, content experts), ESU personnel, fellow science teachers, and instructional coaches |
| Skill Transfer | Coaching | Supported by technology, instructional coaches with science expertise and grade 6-12 science teaching experience coordinate and oversee the teacher development process from training through successful implementation through an iterative process of on-going coaching sessions in a 6-8 week period during the school year via distance technology |
| | Classroom Implementation | Teachers implement lessons in their classroom; lessons are videotaped [to be evaluated for integrity of characteristics identified in "Modeling" (above) by coach, self-reflection, data collectors (for research purposes only), and possible posting on the web as an instructional aide];<br>collaborative team teacher and coaches observe the classroom implementation and provides evaluation and feedback |
| On-going Teacher Supports | Access to Supports | University faculty and coaches provide examples of science inquiry unit lessons; teachers have access to the community of practice members |
| | Communities of Practice | Teacher collaboratives are extended with university personnel (educators, content experts), ESU personnel, fellow science teachers, and instructional coaches |
| Characteristics | Components | Application to Science in Rural Settings |
| Methods of Delivery | Combination of On-Site (Summer Institute) and Technology-based (for coaching sessions during school year) | Brief on-site 8-day professional development summer institute using components of effective professional development identified in the literature; use of distance education methods of on-going instructional support through coaching sessions (~ 2/week for 6-8 weeks); time-delayed feedback to videotaped implementation sessions; computer-based collaboration tools (e.g., electronically available forms) |
| Duration | Multi-Phase Process over Time | Training occurs in empirically supported multiple steps; |

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|---|---|---|
| | | not a “one-shot” training (e.g., stand-alone workshop or web-based presentation); 8 full days in summer and ~ 2 hours per week for 6-8 weeks during the school year |

**Figure 1.** *Theoretical Framework of Professional Development*