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CSI: Coaching Science Inquiry in Rural Schools¹

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Introduction

- CSI is a Research Study conducted by the National Center for Research on Rural Education (R²Ed) at the University of Nebraska-Lincoln
 - Research study funded for 2 years by the U.S. Department of Education
 - Involves 120 teachers over two years
 - Consists of both experimental and control groups
 - Year 1 control group had first option for year 2 experimental group
- Research question:
 - What is the impact of professional development on guided scientific inquiry with follow-up coaching (treatment) versus no professional development (control) on (a) teacher inquiry knowledge, skills, self-efficacy, and beliefs and (b) student inquiry knowledge, skills, engagement and science attitudes?
- CSI Professional Development targets
 - Nebraska State Standards for science inquiry
 - Science inquiry instructional strategies
 - Supports for classroom implementation
 - Student engagement in science inquiry
- CSI: Rural Schools is specifically designed for
 - Middle and high school science teachers in rural schools (grades 6-12)
 - Teachers that are looking to expand their instructional tool box
 - Teachers that are looking for Professional Development readily transferrable to classroom practice

Participants

- Teachers
 - 57 Control Teachers
 - 44 Schools
 - 82 Treatment Teachers
 - 74 schools
 - Over 60,000 miles traveled by teachers for Summer Institutes
 - 120 Teachers
 - 70% Female / 30% Male
 - Years of teaching experience
 - 0-2 years 15.6%
 3-5 years 11.5%
 - 6-10 years 13.5%
 - 11-15 years 26.0%
 - 16-20 years 11.5%
 - 20+ years 21.9%
 - Grades taught by teachers (4 teachers did not respond)

- 29% Middle School Only $(6^{th} 8^{th})$
- 33% High School Only $(9^{th} 12^{th})$
- 33% Both Middle and High School
- Courses taught

•	Physical Science	53%
	Chemistry	39%
	Physics	38%
•	Life Science	48%
	 Biology 	48%
	 Anatomy/Physiology 	37%
•	Earth Science	43%
	General Science	34%
	Environmental Science	19%

- Students
 - Approximately 3,700 Students from Nebraska and Iowa schools
 - ~1,850 High School Students (9-12)
 - ~1,850 Middle School Students (6-8)
- CSI Instructional Coaches
 - Four experienced science teachers trained as instructional coaches
 - Nearly 100 years of classroom experience in both the middle and high school classrooms
- CSI Coach: Peg Coover
 - "I have a unique opportunity to work with rural science teachers to improve student learning. Beginning with the Summer Professional Development, teachers were immersed in the process of science inquiry and their excitement about the prospect of ongoing PD and support during the school year was encouraging! During the school year, the teachercoach partnership focuses on desired student outcomes to plan inquiry lessons and teaching strategies to achieve those goals. I look forward to working with all of the teachers this year!"
- CSI Coach: Melissa Hall
 - "At many times during my teaching career, I wished I'd had the luxury of a confidant who knew what it was like to be in a science classroom. Simply having someone to bounce ideas off of would have improved my outlook and impacted student achievement positively. I believe this program provides that rare opportunity to Science teachers the opportunity to connect with someone that understands your position and is there to provide meaningful feedback."
- CSI Coach: Bruce Hayden, Jr.

- "As a CSI coach, I have the opportunity to interact with many wonderful science teachers.... Supporting them in their effort to increase student achievement in the area of inquiry, is a highlight of my professional career. I hope to provide for them what I wish had been available to me."
- CSI Coach: Sandy Kendall
 - "After 30 years of teaching using 'Hands On' activities, I thought I knew all about inquiry....I have learned that inquiry has different meanings. During the past few months I have learned what works best with kids! I am excited to share some of these new ideas with teachers in and around Nebraska."
- Quotes from Treatment Teachers during coaching sessions
 - "...it has forced me to be very purposeful and...I am growing as a teacher: How do you NOT use it in other classes?"
 - "I get a little tense about how much time it's taking, but we are taking a deep drink and it's been good."
 - "I watched myself on video and I look...and sound...like a *real* teacher."
 - "I find that I'm using this method more and more in my other classes. The kids ask me a question and I think, don't give them an answer...I ask them a question."
 - "I had the desks set up differently (for an activity). Kids started coming in and said, 'Oh, this is different.' People walking by in the hall stopped in and said, 'Oh, this is different.' A principal stepped in just to observe because the kids were up moving around wow, isn't this novel."
 - "The kids actually had a chance to show me that they saw relationships instead of necessarily proving it by answering a question."
 - "The kids did a good job of inferring and coming up with new ideas. They were also good at analyzing the questions."
 - "...They (the students) are getting good at this process so it's hard to find areas to improve...it's the way we do things now...it's what we do!"

Year 1 Findings: Overall Teacher Results

- 47 treatment teachers; 43 control teachers
- Pre-Summer Institute to Post-Summer Institute for treatment teachers produced significant gains in:
 - knowledge of scientific inquiry,
 - beliefs about scientific inquiry, and
 - self-efficacy in teaching scientific inquiry
- Teachers in the treatment condition had significant gains in **inquiry knowledge** compared to the control condition (Figure 1). Teacher inquiry knowledge analyses

focused on changes in slope between pre-PD and post-unit assessments. The analysis showed a significant time (pre/post-unit) by group (treatment/control) interaction (Knowledge: F (1, 128) = 24.12, p < .0001). The slope for the treatment group was significantly greater than that of the control, resulting in a higher mean knowledge score for the treatment group at the post-unit measurement period

- Teachers in the treatment condition had significant gains in **inquiry beliefs** compared to the control condition (Figure 2). Teacher inquiry beliefs analysis focused on changes in slope between pre-PD and end-of-year assessments. Both analyses showed a significant time (pre/end of year) by group (treatment/control) interaction (Beliefs: F (1,128) = 8.26, p < .005). The slope for the treatment group was significantly greater than that of the control
- Teachers in the treatment condition also had significant gains in **self-efficacy in teaching scientific inquiry** compared to the control condition (Figure 3). Because there were four separate measurement time points (pre-PD, post-PD, post-unit, and end-of-year), a piecewise linear growth model was used to model the observed curvilinear trajectories as separate linear components: (a) from pre-PD to post-PD (designated as P1) and (b) from post-PD to end of year (designated as P2). There was a significant interaction effect for the P1 analysis, with the control group slope being significantly less than the treatment group slope (F (1,180) = 29.94, p < .0001). In contrast, there was no significant interaction for the P2 analysis, meaning there was no significant difference in slopes between the treatment and control groups (F (1,180) = .58, p = .45). This P2 result shows that significant gains were observed for the treatment group compared to the control group as a result of the summer institute, and that gains were maintained after the teachers implemented their science inquiry unit while receiving coaching in the school year after the summer institute
- Observations of Teacher practice: Teacher Inquiry Rubric (TIR) & EQUIP (Figure 4)
 - 21 treatment teachers and 23 control teachers
 - Average ratings on a 4-point scale:
 - for treatment teachers: 2.57 & 2.80 = between the "developing" and "proficient" levels
 - For control teachers: 1.74 & 1.95 = between the "pre-inquiry" and "developing inquiry" levels
 - Complete observational data coded from a limited number of teachers (treatment n=21; control n=23) show **no significant differences between treatment and control at baseline** of video-recordings of teachers' classroom inquiry instructional practice. Over the course of four video-recordings of classroom implementation during the intervention year, ratings from two observation instruments (*Teacher Inquiry Rubric* [TIR] and EQUIP) showed **significantly**

higher overall rating scores for teachers in the treatment group compared to control: TIR: t(42) = 3.85, p < .0001; EQUIP: t(40) = 6.98, p < .0001.

- Observations of teacher practice: Partial Interval Classroom Observation-Teacher (PICI-T, Figure 5)
 - 15 treatment teachers and 15 control teachers
 - Showed the percent of classroom time spent teaching with the guided inquiry approach
 - Treatment Pre Post = 20% 79% (59% increase)
 - Control Pre Post = 15% 28% (13% increase)
 - Results with 30 teachers (15 treatment and 15 control) whose classroom implementation videos have been coded using a 15-second partial interval classroom observation instrument for teachers (PICI-T), showed a negligible difference in the amount of inquiry instruction teachers delivered in the classroom during baseline (pre-SumInst) (20% treatment and 15% control). However, during classroom implementation following the summer institute and with coaching, teachers in the treatment condition delivered significantly higher amounts of inquiry (79%) compared to the control (28%).
- Student Findings: Inquiry Skills (Student Inquiry Rubric)
 - Higher performance for the treatment group compared to control group in the key inquiry skills:
 - questioning
 - collecting data
 - conducting an investigation
 - developing an explanation from evidence
 - communicating results
 - Middle school showed significantly higher performance for the treatment group in the key inquiry skills: *questioning* (F (1,573) = 4.11, p < .05), *collecting data* (F (1,572) = 7.24, p < .01), *conducting an investigation* (F (1,573) = 6.46, p < .05), *developing an explanation from evidence* (F (1,573) = 8.85, p < .01), and *communicating results* (F (1,573) = 4.98, p < .05).
- Student Inquiry Knowledge, Self-Efficacy, and Attitudes
 - No significant effects, although middle school results favored the treatment group.

- These results suggest, as indicated by previous research, that student impacts may not be realized until the second year of teacher experience and practice in delivering science instruction using a guided scientific inquiry approach.
- Observation of Student Practice: Partial Interval Classroom Observation-Student (PICI-S, Figure 6)
 - 15 treatment classrooms and 15 control classrooms
 - Showed the percent of student inquiry engagement
 - Treatment (post-only) = 80%
 - Control (post-only) = 29%

Figure 1. Change in teacher inquiry knowledge



Figure 2. Change in teacher inquiry beliefs





Figure 3. Change in teachers' self-efficacy in teaching scientific inquiry.

Figure 4: Observations of teacher practice: TIR & EQUIP

	Pre-Inquiry	Developing	Proficient	Exemplary
Treatment				
Control				



Figure 5. Observations of teacher practice: PICI-T

Figure 6. Observations of student practice: PICI-S

