An Exploratory Study of Science Teachers' Instructional Decision-Making in Relation to "Coherence"

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Abstract: Lesson coherence improves students' learning in science (Roth et al., 2011). This paper examines teachers' ability to distinguish coherent lessons from incoherent ones in relation to their academic and professional backgrounds. I report an exploratory study of 22 teachers. Results indicate that professional development does contribute to teachers' ability to distinguish coherent lessons and may support teachers' consistent understandings of coherence. However, the teachers were generally unable to explain reasons underlying the coherence of lessons.

Conceptual and theoretical background

Teachers' use of strategies to build coherent instructional sequences is essential in student learning. Coherence describes "how the science ideas in a science lesson or unit are sequenced and linked to one another and to lesson activities to help students construct a coherent 'story' that makes sense to them" (Roth et al., 2011, p. 120). Roth and colleagues (2011) found that the use of these strategies to build coherent instructional sequences predicted students' achievement in science. Throughout the literature about coherence, there are studies investigating the difficulties teachers faced when they were designing coherent instructional sequences (Ermeling & Graff-Ermeling, 2016; Hanuscin et al., 2016; Plummer & Tanis Ozcelik, 2015; Wiebke & Park Rogers, 2014). There are other studies examining teachers' abilities in distinguishing a coherent instructional sequence from an incoherent one (Hanuscin, Lee, Lipsitz, Arnone, & de Araujo, 2015). However, teachers' ability to distinguish coherent instructional sequences from incoherent ones in relation to their academic and teaching background needs to be studied further.

This is a critical issue, because as Bybee stated, "When translating those educational reform policies into teachers' practical science teaching, their individual pedagogical decisions are the most uncertain factor regarding the success of those reform efforts" (Lee & Lin, 2005, p. 453). Therefore, in an effort to move science instruction towards a more coherent structure, understanding the place of "coherence" in teachers' instructional decisions are essential. The following questions were investigated: (1) What are the differences between teachers who preferred coherent instructional sequences and those who preferred incoherent instructional sequences in terms of their academic and teaching background? and (2) Do teachers consider coherence as a criterion in their instructional decisions? Constructivism and social constructivism suggest learning should draw from students' existing knowledge. Learners try to make sense of their experiences; they ask questions and try to find answers to those questions by interaction and collaboration with others. The concept of coherence in storylines is grounded in constructivist and social constructivist theory since students build a deep understanding of ideas being learned in interaction with their peers.

Methods

This is a mixed-methods exploratory study. The research was conducted at the PrIMES (Practices Integrated across Mathematics Engineering and Science) Professional Development Workshop. PrIMES aimed to improve teachers' content knowledge of mathematics, science and engineering practices, and was designed to improve teaching aligned with disciplinary core ideas, science and engineering practices, and crosscutting concepts. Lastly, PrIMES leaders intended to create a lasting professional learning community (PLC) to improve student learning. Data used in this paper was collected during summer institute 2018, which was held between June 11th-23rd.

Twenty-two teachers participated in this study. The grade level that participants taught ranged from kindergarten to high school. The participants' bachelor's degree varied across elementary and early childhood education (N=10), middle school education (N=1), secondary education (N=1), and other disciplines (N=10). Finally, 14 participants held master's degrees, and twelve of those were master's degrees from education-related fields. In addition to surveys, I conducted follow-up interviews to allow me to have "control over the line of questioning" (Creswell, 2014, p. 241). The survey started with questions asking about participants' academic and teaching experiences. In the 13th and 15th questions (Hanuscin et al., 2016), the participants were given two lesson plans (one was coherent, and another one was incoherent, without labels) and asked which one they would prefer for their instruction. They were then asked to provide at least three detailed reasons for their choice. The interview was semi-structured and focused on participants' definitions of coherence and their responses to items 13 and 15.

Data analysis and findings

Regarding the first research question, based on survey responses, nine of the participants preferred the coherent instructional sequence in both questions, and nine of the participants preferred the coherent instructional sequences in one of two questions. The participants were divided into three groups: high coherence (the ones who preferred coherent instructions in both questions), medium coherence (the ones who preferred coherent instruction in one of the questions), and low coherence (the ones who preferred incoherent instructions in both questions). Then, these groups were characterized in terms of group members' academic and professional background: grades which teachers teach, and degree which participants hold. It was analyzed if there is any pattern, for example, if all or majority of "high coherence group" members teach at middle school while all or majority of "low coherence group" members taught at the elementary school. Also, these three groups were compared in terms of average years of teaching and average hours of professional development attended in the last twelve months. Findings showed the participants teaching K-2 grades were less likely to prefer coherent instructional sequences. Three of the participants preferred the incoherent version in all questions.

Based on the follow-up interview, three exemplary cases were selected to show consistent, moderately consistent, and inconsistent understanding of coherence were selected. Analysis of the exemplary cases revealed teachers' academic and teaching experiences might contribute to teachers having a consistent understanding of coherence. Notably, the case with the most consistent understanding of coherence had graduated from a teacher preparation program, had the most years of teaching experience, professional development, and involvement in the PLC. To answer the second question, I returned to their initial responses to items 14 and 16: "Please explain the reason for your preference. Give at least three reasons and try to give as much detail as possible." I then interviewed participants and encouraged them to elaborate on their answers. Only one of the participants mentioned connections between the steps of the instructional sequence as a criterion in his instructional decisions. However, the majority of the participants preferred coherent instructional sequences (12 participants for item 13; 15 participants for item 15). Therefore, teachers may implicitly consider coherence as a criterion in their instructional decisions.

Discussion and implications

This study explored (1) teachers' understanding of coherence in relation to their academic and teaching backgrounds, and (2) whether or not teachers use coherence as a criterion in their instructional decisions. Only one teacher could explain coherence in terms of the connectedness of one instructional activity to the next. While the first finding has implications for supporting teachers' academic and teaching background via extended professional development in learning communities, the second finding suggests that making the meaning of coherence explicit—and explicitly supporting coherence in teacher planning—may be necessary to support teachers to think about coherence from the student perspective.

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