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NATURE AND UTILITY OF TEACHER QUESTIONING: A CASE OF CONSTRUCTIVIST-ORIENTED INTERVENTION

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This study examined question types utilized by a researcher-teacher to facilitate children's knowledge of unit fractions through a constructivist-oriented mathematics intervention. Data were derived from six tutoring sessions; analysis examined the nature and utility of employed questions. Preliminary analysis shows the teacher employed four main types and nine sub-types of questions. Future analysis will delineate the how questioning shifted to correspond with the evolution and solidification in children's conceptions.

Keywords: Rational Numbers; Learning Theory; Instructional Activities and Practices

This case study examined question types utilized by a researcher-teacher in a constructivist-oriented intervention as a means to foster conceptual understanding of students with learning disabilities (SLD). Development of conceptual understanding for SLD is critically important and presents an enduring challenge for researchers and practitioners. Current questioning methods used throughout much of the special education literature are rooted in Reductionist models (Poplin, 1988). Not surprisingly, interventions created for SLD use questioning based on student responses to teacher demonstration (e.g., Fuchs et al., 2014), as opposed to teacher's responses to student thinking. The issue we take with such interventions types is that although they are considered to yield procedural efficiency, they disallow SLD to cognitively reorganize and extend their informal thinking into abstracted, transferable conceptions (Hiebert & Grouws, 2007). Nonetheless, there is little research with respect to the nature of alternative questioning teachers might employ in interventions that have as their aim SLD's construction of conceptions. Initial depictions of questioning might support later studies that reveal how varying questions may be used to support thinking and, ultimately, how teachers may employ responsive interventions in the classroom. The research question was, What types of conceptually-driven questions were utilized by the researcher-teacher during a constructivist- oriented mathematics intervention used to promote unit fraction knowledge in one fifth grade SLD?

Conceptual Framework

One constructivist-oriented notion of knowing and learning that can guide teacher questioning is the Reflection on Activity-Effect Relationships (Ref*AER) framework (Simon, 2004). This framework defines the beginning of a mathematical conception as the assimilation of a situation into a child's existing conceptions. The perceived experience sets a goal for the child's learning that regulates his or her goal-directed, mental activity in a problem situation. In such activity, the child's mind makes two types of reflections. The first, within problem situation reflection (i.e., Type-I reflection), occurs when the child notices and reflects upon what they anticipated would occur as a result of their activity versus what actually occurred. The second, across problem situation reflection (i.e., Type-II reflection), occurs when the child reflects on and compares their effects of their activity across similar problems and begins to notice commonalities in the relationship between the mental activity and its effects. The child begins to anticipate that similar activity will result in similar effects as it did in past situations, and can thus use this anticipation to figure out effects in novel situations. Activity-based conceptions are participatory or anticipatory (Author, 2004). A learner who has participatory conceptions may know what activity leads toward an intended result, but he or she is relying on prompts in order to call upon the anticipation. Conversely, a learner who has anticipatory understanding of a concept has abstracted the anticipation resulting from their mental activity – learners can then apply abstracted conceptions to new situations.

The Ref*AER framework entails an adaptive, constructivist-oriented instructional approach comprised of facilitative activities (Author; Simon, 1995) that (a) identifies the child's goal- directed activities, mathematical objects they may operate on, contexts familiar to children, and effects they may notice and (b) focuses children's activity and reflection based on conjectures about how the child's activities and reflections may bring forth the intended learning. An essential part of focusing children's activity and indirectly influencing the child's advance or development from participatory to anticipatory conceptions involves "orienting students' noticing of differences between their anticipated and actual effects and interjecting prompts [questions] that orient reflection across the learners' mental record of activity-effect dyads" (p. 2). More explication is needed in the literature with respect to the types of questions teachers employ within constructivist-oriented interventions that utilize an Adaptive model.

Methods

Participants and Data Sources

Lia (11-year old, grade-5) attended elementary school in the Northwestern United States. She was purposively chosen to participate in the teaching experiment and subsequent tutoring sessions because she was identified by her school system as having a learning disability specific to mathematics performance. According to her Individualized Education Plan (IEP), Lia was 1.5 grade years behind her peers in terms of her mathematics performance, and had failed the district's state mandated testing in mathematics. Data collection was facilitated through a constructivist teaching experiment (Steffe & Thompson, 2000). We worked closely with Lia once a week for 60 minutes (fixed-time period) over six, non-consecutive weeks between February and April. Data collected for each teaching episode consisted of transcribed video-recordings and observation field notes taken independently by two observers during the episode.

Analysis

Constant comparison analysis (Glaser & Strauss, 1967) was used to delineate codes and themes from the data as to the main types of questions the researcher-teacher utilized in the tutoring sessions. The unit of analysis in this study was a speaking turn, that is, a tri-part interchange consisting of a) the child's utterance or action, b) the researcher-teacher's question in response to the child's utterance or action, and c) the child's responding utterance or action. Emergent coding was utilized within the constant comparison method across two dimensions: a) the overall type of each question asked by the researcher-teacher (e.g., to assess the child's understanding; to foster Type I reflection) and b) any varying utility or subtype (e.g., asking for more explanation; requesting clarification). To categorize the utility of varying questions found within each overall question type and the level of cognitive complexity the question was meant to elicit, a coding theme adapted from Webb's (1997) Depth of Knowledge (DOK) was used as a deductive framework (Leech & Onwuegbuzie, 2007). Additionally, researchers performed classical content analysis to obtain percentages of overall question types and subtypes across the six tutoring sessions. Additional analysis is currently underway to delineate how the utility of questioning changed across sessions to align with how the child's conceptions evolved.

Results

Preliminary analyses show the teacher employed four main types of questioning and nine utilities (or subtypes) of questions within and across overall question types (Table 1 illuminates themes and codes). Preliminary analysis shows that Assess the Child's Understanding questions were most used by the researcher-teacher across the tutoring sessions, followed in frequency by Focus Type-II Reflection, Focus Type-I Reflection, and Invite Application of Concept questions. In terms of question subtypes, Make a Prediction/Formulate a Plan (DOK Level 3), Explain and Defend (DOK Level 3), Explain (DOK Level 2), and Evaluate Cause and Effect (DOK Level 3) were the most often noted utilities across the tutoring sessions.

Table 1. Researcher-teacher's questions in constructivist mathematics intervention

Types of questions and their codes	Examples
1. Assess understanding	
Define/Recall	OK. I'm going to take one of your pieces and pull it out of there. Let's label that. What would we call that piece?
Clarify	Do you mean that it takes three of these, if I wanted to make the whole back up, that I would have to have three of these?
Explain	One of the whole? Say more.
Explain and Defend	One-third. Why do we call it one-third?
Defend reasoning	So we can call this one 11 elevenths, and we can call this one nine ninths, even though the numbers are different, it's still the same thing? How can that be?
Critique	Couldn't you just put that entire amount of the [shortage/overage] on your next estimate? Why would that not work?
2. Invite Type-I Reflection	
Cl: Clarify	Was your estimate too long or too short? Too long? The piece should have been shorter?
Ex: Explain	What happened with your second estimate?
CE: Cause/Effect	When you repeated your estimate, is that about where you thought it would stop?
DrC: Defend reasoning/conclusions	You said it wasn't big enough. Why wasn't that one [estimate] big enough?
3. Invite Type-II Reflection	
Cl: Clarify	What do mean when you say make the piece a little bit bigger?
Ex/DrC: Explain and Defend	How did you know how much longer to make it?
DrC: Defend reasoning/conclusions	Smaller than the one-fourth you made. Can you say how you knew it was going to be that much smaller?
FP: Make a Prediction/Formulate a plan	How much less will you have to put onto each to cover it all? Convince me of the amount before you do it.
4. Invite Application of Concept	
Ex: Explain	The more you're giving away, the smaller the size gets? Talk about that more. What's that mean?
Crt: Critique	There's an eleventh. And there's a ninth. You're right. But when I count, 11 is a bigger number than nine.
Ana: Analyze	Which one's bigger, a ninth or an eleventh? Say why.

Although analyses are preliminary, two discussion points can be offered. First, Assess the Child's Understanding questions seemed predominant, and consistent with a two-fold constructivist teacher's purpose—inferring the child's current conceptions and inviting the child to voice their reasoning (elaborate on and make public her ideas). This is an important departure from Reductionist models of teaching and learning often provided for SLD. Assess questions facilitate the teacher's inferences about an SLD's mental activity and subsequent instruction builds on these inferences to foster the child's conceptualization of the intended mathematics. Such an assessment is based on the teacher's response to the child and her present conceptions to guide subsequent questioning to support learning. In contrast, Reductionist-framed mathematics interventions focus on measuring the child's responsiveness to the teacher's thinking as a finite gauge of learning or knowledge (Author, 2004; Poplin, 1988).

Second, an associated utility of Assess questions involve an effort to reorient the child's disposition in her own mathematical learning toward taking ownership of and justifying her own mathematical reasoning. Utilizing questioning in this manner originates from teaching approaches consistent with constructivism (von Glasersfeld, 1995), and help situating the child's notion of "doing" mathematics. This valuing of children's reasoning stands in contrast with Reductionist questioning utilities that seem to render the child a passive, compliant participant in mathematics learning (Poplin, 1988), and submit SLDs to scripted instruction of rather minute skills through a series of targeted, teacher-directed questions and rapid child responses (Fuchs et al., 2014). We contend that, if the goal of mathematics intervention is the SLD's conceptual reorganization and growth, then questioning needs to shift so a teacher responds to the child's available and/or forming notions of mathematics, situating questioning as a formative, dynamic mechanism within and a basis for instruction.

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