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Discursive strategies that foster an epistemic community for argument in a biology classroom

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ABSTRACT

Although the study of classroom discourse has a long history, there has been a recent change in theoretical perspective towards viewing learning as becoming a member of a disciplinary community. In science classrooms, teachers are attempting to create epistemic communities that include some of the characteristics of scientific communities. Using this theoretical lens, we describe how an experienced classroom teacher used discursive moves to scaffold her students' appropriation of scientific argumentation over several weeks. As her prompting of their critiques changed, we noticed that the participation structures shifted from her position as a mentor to as a partner. We argue that this new classroom community differed from the community of school science in several ways: authority was shared, epistemic goals were valued, and authentic problems were investigated. These new instructional objectives are consistent with the standards movement in the United States and the teacher's own experiences and goals.

1. Introduction

Connections between classroom discourse and student learning have been a focus of research for almost a century, but recently theoretical perspectives on student learning have expanded from Piaget's (1926/1952) domain-general theory of cognitive development to theories that are situated in particular domain-specific or disciplinary contexts (Ford & Forman, 2006). At the same time, theories of discourse have also grown to include approaches to language variation that reflect the linguistic choices that competent speakers employ in classroom contexts (Wagner & Herbel-Eisenmann, 2014).

This shift in perspective has also occurred in mathematics and science education from a focus on individual concept development to an emphasis on learning by becoming a member of a community of practice (e.g., van Oers, 2001). Mirroring changes in how scientific practice is characterized by historians and philosophers of science, education researchers are beginning to examine how epistemic communities can be fostered in science classrooms (Passmore, Gouvea, & Giere, 2014). School science (the traditional instructional model) has been found to misrepresent the nature of science and to fail to engage students in the creative endeavors of scientific modeling and argumentation (Passmore & Svoboda, 2012).

In the United States, the science standards (NRC., 2012) recommend that practices such as engaging in argument and developing and using models should be at the core of science instruction. Given the gap between the rhetoric of the standards and the reality of most science classrooms, it is important to describe learning environments where teachers incorporate scientific practices in their curriculum. Also we need to understand how these learning environments are created by tracing the changes in teacher-student interactions over time (Mercer, 2008).

Our research context was the MUSE (Modeling for Understanding in Science Education) curriculum (Passmore & Stewart, 2002). This context has been previously identified as a setting that was found to successfully teach science for understanding (Gamoran, Anderson, Quiroz, Secada, & Ashmann, 2003). In the Gamoran et al. study, this successful implementation of earlier U.S. science education standards (NRC., 1996) was partially attributed to

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the efforts of the classroom teacher who is the focus of the present study. An investigation of changes in discourse throughout the 9-week evolutionary biology course had not previously been the focus of research. Our goal is to illustrate how an epistemic community for argumentation in this classroom may have been created through scaffolding.

2. Literature review

Our review of the literature begins with socio-cultural theory and connects it to more recent developments in classroom discourse that investigate the creation of a classroom community. We also discuss how scaffolding may change over time in a classroom as students assume greater intellectual authority. Finally, we will discuss research on the development of an epistemic community for argumentation as a framework for our examination of scaffolding and discourse moves in this classroom context.

2.1. Socio-cultural theory and scaffolding in the classroom

The beginnings of the "practice turn" in learning theory can be found in Vygotsky's writings in the early twentieth century (Ford & Forman, 2006). Important themes in Vygotsky's theory include: the social origins of logical reasoning, the importance of semiotic mediation in thinking, and the necessity of studying learning historically (Moll, 2014). One example of the convergence of these themes is in Vygotsky's familiar notion of the zone of proximal development (zpd) (1978), the difference between assisted and unassisted performance. An application of the zpd to instruction can be found in the concept of "scaffolding" (Wood, Bruner, & Ross, 1976).

In their tutoring study, Wood and his colleagues identified six common functions of scaffolding: recruitment; reduction in degrees of freedom; direction maintenance; marking critical features; frustration control; and demonstration. Although their tutoring context differs in many ways from classroom contexts, similar functions of scaffolding have often been identified in later studies (e.g., marking critical features and reduction in degrees of freedom) (Reiser & Tabak, 2014). One key feature of scaffolding across these studies is that adult support is temporary and fades in response to children's task mastery (Stone, 1998).

A review of the literature by van de Pol, Volman, and Beishuizen (2010) found that most of the empirical studies were descriptive, providing a rich picture of scaffolding in different tutoring settings. In their conclusions they questioned if the few experimental studies of tutoring that they examined would generalize to disciplinary learning in classrooms. Theoretical and empirical reviews by Stone (1993, 1998, 2002) may do a better job than van de Pol et al. of expanding the notion of scaffolding to classroom discourse because of their firmer grounding in concepts from Vygotsky's theory. For example, one of Stone's recommendations is that we enrich the scaffolding metaphor by carefully investigating the cycles "of communicational challenge and inference" (1978, p. 353) that occur during adult guidance of children's activity.

Stone (2002) proposed that the key scaffolding features are context, contingency, and challenge. By context, he meant the attentional and affective functions of scaffolding (e.g., frustration control). Contingency meant that the support of the learner must be dependent upon the adult's understanding of the child's changing needs. Unfortunately, he found that challenge is often downplayed in the literature. Challenge requires that the adult hand over authority to the learners as their understanding of the situation begins to approximate that of the teacher.

Challenge is often communicated through subtle means such as violations of Gricean conversational maxims (such as quantity and quality) (Stone, 2002). When conversational maxims are violated (as they often are in humor), learners are required to construct a new meaning for the teacher's comment: they cannot merely follow well-practiced routines. According to Stone, it is this active process of interpretation that is capable of helping the learners not only *do* the activity competently but come closer to *understanding* it like the teacher. He refers to this discursive move as "prolepsis" where listeners are forced to construct the presuppositions implied in the speaker's utterance: "Thus the listener is led to create for himself the speaker's perspective on the topic at issue" (Stone, 1993, p. 171).

2.2. Teacher-student authority

Tabak and Baumgartner (2004) identified how scaffolding relates to changes in authority. They discussed three participation structures: monitor, mentor, and partner. The first structure is connected to class management; the second two are directly connected to scaffolding scientific argumentation, which is the focus of this article. If the teacher is the primary intellectual authority in the classroom then the participation pattern is asymmetrical. This is the *mentor* participation structure. If student talk predominates, then a more symmetrical pattern may be created: the teacher shares authority with her students as if she were a *partner*.

A complementary approach to classroom authority can be found in the research of Wagner and Herbel-Eisenmann (2014). They identified four different types of authority configurations in discourse: personal authority; discourse as authority; discursive inevitability; and personal latitude. They found these discursive moves by examining lexical bundles: "three or more words that frequently recur together, in a single group" (Herbel-Eisenmann, Wagner, & Cortes, 2010, p. 24). A bundle such as "I want you to" indicates a personal request (e.g., personal authority). Wagner and Herbel-Eisenmann claim that modal verbs such as "we need to" allude to the authority of the discipline that is embodied in its discourse. Discursive inevitability may occur when the teacher uses directives that seem to come from an impersonal source: "You are going to." The final category, personal latitude, may be found in a variety of lexical choices, including open-ended questions that invite dialogue: "Are we going to do X?" Thus, by examining the recurrent patterns of lexical choices made by teachers and students, we can see how different authority structures are employed to establish a mentor relationship or change it to a partner relationship, which create different kinds of classroom communities.

2.3. How scaffolding can be used to create a disciplinary community

Beginning with research by Palincsar and Brown (1984) on reciprocal teaching, a new generation of ethnographic research studies has emerged (e.g., Forman, Larreamendy-Joerns, Stein, & Brown, 1998). The focus on ethnographic research in classrooms was accompanied by the emergence of new theories that view learning as a process of participation in communities of practice (Sfard, 1998). In her review of the literature, Manz (2015) showed how to apply this theory of learning as participation to science classrooms. First, she clarified the differences between scientific communities and classroom communities. Then, she proposed how to adapt features of scientific practice to the classroom context. This activity system, which she calls an epistemic culture, has some of the following components: new goals; new classroom community norms; teacher scaffolding of shared authority; and incorporation of argumentation in most classroom activities. Similarly, Chinn and Malhotra (2002) found that most science classrooms seem to "foster a nonscientific epistemology" (p. 190). They also argued that

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