Comprehension SEEDING: Providing Real-Time Formative Assessment to Enhance Classroom Discussion

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Abstract: The Comprehension SEEDING intervention aims to improve classroom discussion by providing real-time formative feedback to teachers based on student answers to open-ended questions. Teachers pose questions using the SEEDING system, students type responses, and the system automatically groups the responses according to semantic similarity. We describe the three features of the Comprehension SEEDING intervention: Self-Explanation, Enhanced Discussion, and Inquiry Generation and how teachers can use the system to identify misconceptions and facilitate a class discussion.

Comprehension SEEDING

Classroom response technologies, like clickers, can improve student learning and engagement by allowing all students, rather than only the few a teacher calls on, to answer and by giving teachers real-time formative feedback. Previous research on clickers has shown that they can be beneficial for enhancing student learning and engagement (Duncan, 2006; Fies & Marshall, 2006). However, there are limitations that may explain why small-scale efficacy tests for the use of the technology have seen mixed results (Bunce et al., 2006; Carnaghan & Webb, 2007; Duggan et al., 2007). Typically, in order to take advantage of the automatic scoring provided by clickers, teachers are restricted to asking multiple-choice questions. In our intervention, Comprehension SEEDING, we aim to replicate the engagement advantages attained through clickers while removing the limitations of the multiple-choice format through the development of a new classroom engagement technology that provides real-time formative feedback to teachers based on student replies. In our system, teachers pose a free-response question, students generate and type their answers using tablet computers, and the system automatically groups the student replies into clusters. While the teacher can also view student replies individually in real-time, providing individual feedback to students may be time consuming, so the clusters allow teachers to quickly determine the current overall status of the students' understanding.

The Comprehension SEEDING intervention consists of three distinct but related features that combine to create an enhanced learning environment for students and teachers. Each component is strongly grounded in cognitive science and learning sciences research. The three components are: self-explanation (SE), enhanced discussion (ED), and inquiry generation (InG). We review each component and highlight the theoretical learning advantages of using the Comprehension SEEDING intervention.

Self-Explanation

In a Comprehension SEEDING classroom, a teacher poses a question and all students generate a response. Through the process of generating a reply and reflecting upon their answers, students are engaging in a form of self-explanation. In a traditional class discussion, only a handful of students are called upon to share; however, in a SEEDING class, all students must generate and input an answer to the question. We expect this feature to increase learning gains because all students are responding to the material and the process of generating an answer is more cognitively engaging than some students passively listening to other students' answers (Chi, 2009). Additionally, there is a large body of research that has demonstrated that learning increases when students engage in rationalizing or elaborating difficult concepts and relationships (*cf.* Wylie & Chi, 2014).

Enhanced Discussion

After students respond, their answers are automatically clustered into semantically similar groups. The system then displays what it believes is the most representative answer from each cluster and the percent of student answers that fall within that cluster (see Figure 1). The teacher can choose to share these representative answers with the class as a basis for further discussion which could be a typical classroom discussion (without further using the system) or it could be guided by posing another question through the system. Teachers might ask students to rethink their answers in light of the discussion and to edit their original answer via the system or they might ask students to compare and contrast a pair of responses with a partner or in small groups.

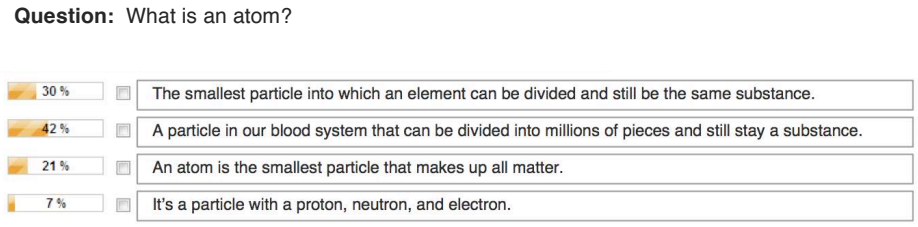

Figure 1. The Enhanced Discussion component clusters student responses and displays representative answers from each of the four clusters as well as the percent of students whose answer falls within each cluster.

Inquiry Generation

The final component of the Comprehension SEEDING intervention is the inquiry generation feature. This feature aims to support teachers in asking good follow-up questions, by automatically suggesting appropriate questions based on student replies. Previous research indicates that teaching good question asking skills encourages the listener to consider such questions while reading or contemplating subject matter and results in robust comprehension improvements (Singer & Donlan, 1982; Palincsar & Brown, 1984; King, 1990). We aim to support teachers and students by modeling deep reasoning questions within the system. For example, if a teacher asks, "What is matter?" as an initiating question, the system might suggest follow-up questions such as: "What is the difference between a solid, a liquid, and a gas?" or "What is the difference between *properties* of matter and *states* of matter?" The goal of this feature is to encourage teachers to facilitate deep discussions on the central topics in order to support learning.

Discussion

In this paper, we present Comprehension SEEDING, an intervention designed to improve classroom discussion by increasing student engagement and providing immediate formative feedback to teachers. We discuss the three components (self-explanation, enhanced discussion, and inquiry generation), and the theories underlying them. Future plans include the effects of student learning and classroom discussion quality in a yearlong classroom pilot study.

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