Talking Science: It's Not Elementary!

Improving Elementary Pre-service Teacher Discourse Skills through a Scaffolded "Science Talks" Assignment

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Abstract: *Learning science requires communication between participants, however creating effective discourse for elementary classrooms has shown to be a difficult task. In this article, we highlight an assignment given to undergraduate elementary pre-service teachers concentrating in elementary science. Transcripts of elementary pre-service teachers' (EPST) "Science Talks" have been reviewed and, over the course of three semesters of implementation, scaffolds have been put in place to provide EPSTs with strategies and tools necessary to better plan, implement, and evaluate science discourse. Initial findings, which point to the effectiveness of this assignment and the additional scaffolding, will be discussed. These findings have potential applications for teacher education programs as well as for in-service teacher professional development.*

Keywords: Science Discourse; Talk Moves

Rationale for "Science Talks" Assignment

Science education researchers acknowledge the importance of socially constructed knowledge when learning science (Alexopoulou & Driver, 1996; Bianchini, 1997; Kelly & Crawford, 1997; Kelly & Green, 1998; Linn & Burbules, 1993; Richmond & Striley, 1996). Therefore, science teachers should engage students in knowledge-building processes using discourse as an essential component (Duschl, 2008). A majority of classroom discourse is structured in a way that does not provide opportunities for students to engage in the construction of ideas (Alexander, 2008; Lyle, 2008). Kovalaninen and Kumpulainen (2005) observed that teacher-initiated talks during science investigations in elementary classrooms were described as information-driven with teachers providing knowledge as opposed to fostering evidence-based discussions among all participants. This common method of class discussion results in students' contributions being brief responses that require no student reasoning or critical explanations.

At our southeastern university, we have a subset of elementary education majors who have chosen to concentrate in elementary science. This Elementary Science Concentration (ESC) involves taking specific science content and methods courses focusing on teaching K-6 science. Five of the courses (Life, Earth, Physical, Elementary Science Methods, and Informal Science) are taught within the science education program in the college of education. As professors of elementary science education courses, we recognize the challenge elementary pre-service teachers (EPSTs) face when planning and teaching effective science lessons. Through our experiences with pre-service teachers, both in our class discussions and in video-recorded lessons, we observed the complexity of orchestrating discourse skills and the need to support the development of such skills. As stated, research has provided widespread agreement that academically productive talk is critical for learning science (NRC Consensus Report Taking Science to School, 2007). To better prepare EPSTs for the challenge of creating "academically productive talk" we developed our "Science Talks" assignment that focused on planning and implementing effective discourse on a core idea in science.

CLASSROOM DISCOURSE

Students' abilities to construct explanations of scientific phenomena that incorporate current understandings of science are a major

component of the *Next Generation of Science Standards* (Achieve, 2013). Classroom discussion addresses essential academic content, exposes alternative ideas, and clarifies understanding; therefore, it is a critical component of every lesson. Sandoval and Morrison (2003) argue that, in order to understand the actual practices of science, students need explicit discourse experiences, which require them to construct their own evidence-supported explanations. Language should be viewed as alive, not as a static phenomenon (van Eijck & Roth, 2011; Roth, 2008); therefore, it should be constantly moving between participants. During an active "talk," teachers and students explore ideas and use evidence to build and critique academic arguments. When a talk becomes static, classroom instruction tends to focus on vocabulary, which can deter the development of science language (Richardson-Bruna, K., Vann, R., & Escudero, M.P., 2007) and conceptual knowledge.

The construction of scientific knowledge is a social process through an engagement of negotiation and consensus building (Tobin & Tippins, 1993). The skill necessary for facilitating these types of discussions among students is recognized nationally as essential (Mercer, 2008) and complex. The difficulty lies with helping EPSTs learn how to conceptualize classroom discourse, which involves two important aspects — understanding the sequencing of the talk while managing the engagement of students (Lehesvouri, Viiri, & Rasku-Puttonen, 2011). One of the essential components of a successful talk is the extent to which students are treated as active agents in classroom discourse (Alexandra, 2006). Elementary pre-service teachers need help in planning and implementing effective classroom discourse. Therefore, they should have experience planning and implementing questions within a real talk. To make sure the talk is active, planned questions are evaluated and the interactions involving the questions are explored. Knowing how and when to ask questions and how to navigate student responses is essential and multifaceted (Molinari & Mameli, 2010).

"SCIENCE TALKS"

To address this need, we developed an assignment called, "Science Talks." Students in each of the ESC content courses prepare, facilitate and reflect on one "Science Talk." They also participate in three additional talks led by their peers each semester. Facilitators are provided with an assigned Page Keeley assessment probe (Keeley, P., Eberle, F., & Farrin, L., 2005). Probes include a scenario focused on elementary science content, related student misconceptions, and preconceptions. The associated "Teacher Notes" by Keeley are provided, which include background information and suggestions for implementation.

Prior to leading a talk, EPSTs complete a "Planning My Science Talk" assignment. This assignment, in initial implementation, required EPSTs to research science content related to the prompt, demonstrate understanding of the assigned prompt, and develop a potential "discussion map" of questions with which to engage students. EPSTs used instructor feedback on the "Planning My Science Talk" assignment to make required revisions and conducted a 10-minute video-recorded round table discussion with their peers. Facilitators viewed their videos and reflected on their individual talks.

"SCIENCE TALKS" INITIAL ATTEMPT

Thirty-four EPSTs in the Physical Science course were the first students to experience the "Science Talks" assignment. Transcripts were reviewed and some factors affording discussion were noted; however, factors constraining discussion predominated with recurring themes. For example, often EPSTs posed a question but rarely did they ask a follow-up question to make student thinking visible. In some cases, EPSTs ignored incorrect responses by their peers or responded affirmatively to responses that were inaccurate. In other cases, they provided feedback or explained content incorrectly (e.g. "air is a good conductor of heat," "the starburst is melting in your mouth," "the change from liquid to gas is dissolving"). In several cases, EPSTs introduced common misconceptions rather than engaging their peers with questions to "unearth" these misconceptions. Rarely did EPSTs demonstrate active listening in which

they probed deeper and required students to explain their thinking.

EPSTs also struggled with novice teacher issues including not having thought through how they would introduce the talk to students. Many mentioned that nerves took over and they could not remember what they wanted to say and do. They also had problems keeping the talk "active" and moving between participants. In many instances, the lack of participation among participants led the leaders of the talk to begin reading the planning sheet to their groups.

SCAFFOLDS IMPLEMENTED

In an effort to support the growth of these EPSTs' discourse skills, several scaffolds were added to the existing assignment.

Modeling

It was decided we should model a "Science Talk" for our classes. Using a Page Keeley probe, we led the group in a discussion, drawing attention to how students were encouraged to explicate their reasoning, how student thinking was made visible, and how peer-peer interaction was encouraged.

Talk Moves

We also introduced EPSTs to "talk moves" which are pedagogical tools to foster productive discussions. We assigned readings and viewed two short Teaching Channel videos in which teachers used talk moves such as restating, re-voicing, and having students apply their own reasoning to their peers' responses.

Restructuring the Assignment

The assignment was restructured to include a discrepant event, model, or task students would use to gather data or make observations during the talk. We also posted a sample "Planning My Science Talk" assignment to demonstrate the breadth and depth we were expecting for this assignment.

Pre-conference

On the class date prior to the talk, we instituted a pre-conference with all facilitators. We provided some advice for leading successful talks, like having a bulleted list of talk moves and key questions rather than referring to their entire "Planning My Science Talk" document. We suggested EPSTs use whiteboards to write down student responses, draw representations, and emphasize key words and big ideas during the talk implementation. We also encouraged EPSTs to think of ways to make their peers' thinking visible including making models, requiring students to explain their reasoning, and using real-life examples to which students could relate.

Talk

One additional way we changed the format of the talk was to instruct students in each group to think and respond as elementary students. Our goal was to eliminate students' fears of being wrong in front of their peers and to encourage them to think as elementary students might approach the prompt.

DISCUSSION OF STUDENT REFLECTIONS

In our first round of science talks using the revised assignment and scaffolds, we noted several factors that promoted productive talk. We used student reflections as evidence of EPSTs' increased knowledge of effective implementation of science discourse, as well as areas that need improvement. Recurring themes in these reflections are noted below.

As evidenced by their reflections, there continues to be room for growth and improvement. Some EPSTs mentioned suggestions for facilitators, as did Jordan, stating many of the questions her facilitator asked were "yes or no questions that lead to dead-end answers." One facilitator commented after watching her video on asking leading questions, "I noticed I gave away the answers before asking the question, which limited responses." Some struggled with their ideas about the teacher's role in the talk, saying, "I asked the students questions and instead of promoting talk and letting them answer, I answered. For some reason, I felt like if I wasn't talking, I wasn't doing it right." These comments demonstrate that EPSTs are novices and recognize they need practice to develop their discourse skills.

Despite these struggles, student reflections cite tremendous growth in certain

areas. Facilitators spoke of the importance of preparation, as did this EPST who said, "One thing I learned from the teaching aspect of this talk was you really need to understand background knowledge before teaching a subject … If I thought I knew what melting was and didn't read up on the subject, I wouldn't have been able to explain the difference between melting and dissolving." The ideas of constructivist teaching were made real as when one students stated, "Especially for science, I feel it is important to have an experiment available so one can physically see the difference between two common activities. If we would have just argued back and forth on why one feels they are the same, and another feels they are different, I might still be confused about what melting really is." Their comments pointed to the effectiveness of the scaffolds we provided, especially the incorporation of a task within the talk in which students gathered evidence to support their claims.

Another recurring theme in the reflections was EPSTs' perception of having learned from their peers. They mentioned learning science content, as evidenced by comments like, "Before this talk, I can honestly say I had no idea what the difference was between melting and dissolving." They also learned about leading discourse, "Before this, I would have had no idea how to lead a successful talk that kept students engaged in conversation. I am very thankful Sara did such a wonderful job with her science talk to give me an idea of how to lead one of my own."

Overwhelmingly, EPSTs commented in their reflections that they recognized specific talk moves their facilitators used. For example, one student commented, "Nicole used a lot of talk moves. For example, she made us restate what other students had previously said but in our own words." A fellow student noted, "The leader of my talk asked us why we agreed or disagreed and created a friendly debate between the group to engage us in the learning." And another stated, "Not only did she ask us for our answers, but she also asked why we came up with the answer we did." As evidenced by their comments, EPSTs now recognized "talk moves" and how they were used to promote discourse, and they felt better prepared to lead their own future discussions.

CONCLUSION

Through modeling and practicing science discourse, EPSTs have the opportunity to significantly develop this pedagogical skill while improving their content knowledge. We found EPSTs used and can identify such talk moves as restating, re-voicing, and peer-to-peer talk. From our experience, we discovered that EPSTs had similar struggles in facilitating discourse in such areas as asking thought-provoking questions, managing silence, and revealing too much information before asking questions, which limited participants' active engagement (Alexandra, 2006). When the talk became static, EPSTs stated that they felt that to be a successful teacher you should continue talking and at times this type of talk turned to defining vocabulary (Richardson-Bruna, et al., 2007). We found that EPSTs discovered the complexity and the multifaceted aspects of planning and leading science discourse. Through this experience, EPSTs stated the value and significance of this pedagogical tool. Based on the data collected in three semesters, this assignment with added scaffolds has shown promise in growing pre-service teachers' science content knowledge and the essential skill of leading classroom science discourse.

As of this fall semester (2016), the impact of the assignment and scaffolds has been extended beyond the science concentration students to include students in our elementary science methods courses. Many students successfully incorporated the assessment probes and "talk moves" within lessons they planned and taught. We plan to strengthen our research in the future to include an evaluation of content and discourse skills of elementary students based on the science talks assignment implementation in methods courses.

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