Planning for the elicitation of students’ ideas: A lesson study approach with preservice science teachers

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ABSTRACT: In an effort to better prepare science teachers to engage in high-leverage practices, this study investigates the choices and rationales of preservice science teachers in planning elicitation strategies and describes how their understandings about the elicitation of students’ ideas changed over time. Four cohorts of preservice science teachers engaged in a cycle of modified lesson study focused on the elicitation of student ideas. Findings suggest that the participants focused on revising the elicitation task to achieve greater task clarity and student participation and to provide more opportunities for individual thinking. One notable outcome of the study is the need for a greater conceptual distinction in science teacher education between elicitation practices in which resources for student thinking are identified, and assessment practices that seek students’ progress toward learning goals.

This paper begins with the premise that the main instructional responsibility of a science teacher is to “work on and with students’ ideas,” (Stroupe & Windschitl, 2015), and that the ability to effectively elicit students’ ideas about scientific phenomena is a learned skill that can be taught as a component of preservice teacher preparation. Eliciting students’ ideas is considered a core, high-leverage practice in science teacher education because students’ ideas serve as a source of information to help teachers design instruction that is responsive to the learning needs of students, and also provide a starting point for model-based inquiry (Windschitl & Calabrese Barton, 2016; Windschitl, Thompson, Braaten, & Stroupe, 2012).

The purpose of this study is to better understand how preservice teachers approach the act of planning to elicit students’ ideas by having them engage in a condensed but authentic cycle of
collective lesson study (Stigler & Hiebert, 1999), with the goal of better supporting these teachers as they take up more advanced elicitation practices throughout their preparation and beyond. Of interest here are the processes by which novice science teachers learn this practice, with particular attention to changes in participants’ thinking about the nature and purposes of eliciting students’ ideas. The specific research questions addressed here are:

1.) What choices do preservice teachers make when revising elicitation strategies in lesson study groups, and what rationales do they invoke?
2.) How do preservice teachers’ views on the elicitation of students’ ideas change as an outcome of a “lesson study” pedagogy in a science teaching methods class?

Background

Importance of eliciting student ideas

The importance of ascertaining the existing ideas of students and using them for the basis for instruction has been a central pillar of constructivist approaches to teaching for decades (Ausubel, 1968; Bransford, Brown, & Cocking, 1999). In science teaching, the role that learners’ ideas play in learning scientific concepts has been widely recognized by science educators, and there has been a particularly robust attempt to identify student conceptions around a wide variety of phenomena and topics (Anderson, 2007), driven largely by the recognition of the role that student ideas play in teaching for conceptual change (Hewson, Beeth, & Thorley, 1998; Posner, Strike, Hewson, & Gertzog, 1982).

The perspective that student ideas may serve as resources for the student or the teacher draws upon a theoretical framework that broadens the definition of resources beyond conventional material resources to include the personal, environmental, social, and cultural resources that are accessed during instruction (Cohen, Raudenbush, & Ball, 2003; Windschitl &
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Calabrese Barton, 2016). The relationship between student learning and resources is mediated by the way these various resources are activated by both teachers and students, and these resources, especially when focused on student thinking (Levin, Hammer, & Coffey, 2009), serve as assets to be used to foster more meaningful learning.

From this perspective, student ideas at odds with scientific concepts—often termed “misconceptions”—are seen as valuable in their own right as a resource for teaching because of the way they represent existing structures of knowledge in the mind of the learner (Campbell, Schwarz, & Windschitl, 2016; Donovan & Bransford, 2005; Smith, diSessa, & Roschelle, 1993). Numerous efforts across the field of science teacher education and teacher development are dedicated to fostering a deeper understanding of the role of student ideas in science learning, and there now exists a firm consensus on the value of eliciting student thinking about scientific concepts at all stages of instruction (American Association for the Advancement of Science, 2011; Keeley, Eberle, & Farrin, 2005; Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013; M. Schneps, 1997; M. H. Schneps, Sadler, & Harvard-Smithsonian Center for Astrophysics, 1987).

In this paper, the overall theoretical framing of Ambitious Science Teaching (Windschitl et al., 2012) is used because of its well-established research base in preservice science teacher education. The Ambitious Science Teaching approach is governed by teachers’ mastery of a number of high-leverage practices and the use of specific planning and instructional tools. Stroupe and Windschitl (2015) describe elicitation of students’ ideas as part of a set of core

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1 The term “misconceptions” carries a certain amount of historical baggage in science education research because of its more colloquial use to indicate an “incorrect” idea, and even a certain ignorance on the part of the holder (Author, 2012). Nonetheless, the idea of a misconception still has currency among preservice science teachers as a shorthand for a wide range of terms including: alternative frameworks, preconceptions, prior knowledge, student ideas, conceptions, or other cognitive labels among which it might be important to distinguish in a different context. From the perspective of model-based inquiry, it is simply more accurate to discuss ideas—even so-called “misconceptions”—as models to be tested and revised. In this article, I ask forbearance on the part of the reader, and recognize the potential criticisms I invite from the use of such a problematic term.
practices used to activate students’ prior knowledge, foster student engagement and inform instructional planning.

Another aspect of the elicitation of students’ ideas notable in this study is the fact that student ideas also represent a potential connection for teachers to engage in culturally responsive pedagogy (Gay, 2002; Villegas & Lucas, 2002) or for teachers to understand their students’ cultural representations of scientific content (Brown, 2006; Ladson-Billings, 2003; Upadhyay, 2009). In all of these ways, student ideas about phenomena represent resources for teaching.

Though preservice science teachers may recognize the importance of eliciting student ideas, many likely underestimate the level of difficulty in both planning the prompts for doing so and in using these ideas in subsequent instruction (Author, 2012; Davis, Petish, & Smithey, 2006). In the teacher education program described here, the practice of lesson study is used to scaffold this task.

**Lesson study as a pedagogy for teacher learning**

The Japanese practice of “lesson study” gained prominence in the United States following the publication of reports from the 1998 TIMMS study, particularly in the descriptions of lesson study practice by Stigler and Hiebert (1999). Commonly known as *kenkyuu jugyou* in Japan where it is widely practiced as a form of teacher professional development, lesson study is a process by which groups of teachers research each others’ teaching practice by planning a lesson together and then observing as one of the group teaches the lesson. After the observed lesson is completed, the group discusses the lesson in light of their shared goals, and revise the lesson plan based on observations of students’ learning. In lesson study, a cycle of lessons is often taught and retaught as the teachers build upon the outcomes towards a refined lesson that can be shared widely within and beyond the group.
Lewis (2002) notes that lesson study has four main characteristics: teachers have a shared goal, the subject matter is deemed important, the focus of the study is on the students, and live observations of teaching are undertaken. These outcomes of lesson study practices as described by Lewis include: helping teachers think carefully about goals for particular lessons, units, and content areas; helping teachers think about the long-term goals they have for students; allowing teachers to study the best lessons; improving teacher’s content knowledge; developing instructional expertise in modifying lessons to better reach students; building capacity for professional collegial learning; and helping teachers develop “the eyes to see students,” (p.12).

Though it has not received the widespread adoption in the United States as exists in Japan, the Japanese lesson study model has been occasionally adapted in the U.S. (e.g. City, 2009), and is similar to the tradition of collaborative action research in the United States that has grown out of the scholarship on teacher self-study (Cochran-Smith & Lytle, 1992). There are numerous examples of the use of lesson study in preservice teacher education, most notably in math and science teacher education efforts (e.g. Bjuland & Mosvold, 2015; Cajkler, Wood, Norton, & Pedder, 2013; Hiebert, K. Morris, & Glass, 2003; Lewis & Perry, 2014; Marble, 2006; Mutch-Jones, Puttick, & Minner, 2012; Parks, 2008; Sims & Walsh, 2009).

As will be described below, the present study draws upon the lesson study model primarily in the co-planning and observation components, though unlike the Japanese model, participants in this study were limited to video observations of the enacted lessons for logistical reasons. Particularly salient in this study is the process of teacher *noticing* (Sherin & van Es, 2005; van Es & Sherin, 2002) in the recorded video clips, a process scaffolded though the design of the lesson study activity in the methods class as participants focused on the practice of
eliciting student ideas. This teacher noticing served to frame the aspects of teaching that were targeted for revision in the lesson study cycle undertaken here.

**Methodology**

**Setting and participants**

This study was conducted at two different institutions by the same investigator over a period of four non-consecutive years. The first two years of the study took place at a large research university in the Midwestern United States in 2006 and 2007, and the final two years took place at a mid-sized university in the mid-Atlantic United States in 2014 and 2015. The author was the instructor for the methods course in secondary science teaching in each case, and students completed all project activities as part of the course. A total of 33 participants—18 from the first site (Groups 1a, 1b, 1c, 2a, 2b, and 2c) and 15 from the second (Groups 3a, 4a, 4b, 4c, and 4d) — were involved in this study over the four years, and were selected because of their enrollment in the science teaching methods course taught by the author in which this elicitation activity took place.

Both institutions serving as sites for this study have a strong historical commitment to teacher education, and preservice science teacher preparation in particular. At the first university, prospective teachers were part of a two-year undergraduate teacher education program, with a half-time middle or high school student teaching placement during the third semester—when this study took place—and a full-time student teaching placement in the fourth semester. At the second university, prospective teachers were part of a 13-month intensive teacher residency program that included coursework and field work each semester. The program began with an intense summer semester of coursework and fieldwork followed by a school-year residency.

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In order to avoid issues of coercion by authority, the author adhered strictly to IRB and human subject research guidelines.
placement in a single classroom. These residents took a full day of coursework in the fall—part of which included the secondary science methods course in which this study took place.¹

**Study design**

The design of this study takes advantage of the fact that the participants had responsibility for teaching at least one class in their placement site, and also takes into account the fact that participants taught in different schools, grade levels, and subject areas. Prior to the task, the preservice teachers were familiarized with a wide range of elicitation strategies from the Ambitious Science Teaching website,² the “Uncovering Student Ideas in Science” series, (e.g. Keeley et al., 2005), and other literature on formative assessment practices (e.g. Donovan & Bransford, 2005; Wiliam, 2011).

The task, which participants completed as part of a larger course assignment, was to work in a team of three to plan a 5–10 minute elicitation activity (which is referred to as a “lesson segment”), which one member of the taught and videorecorded.³ The next week during class, each team viewed the videorecording together, and made revisions in the elicitation activity based on their interpretation of how well the initial lesson segment design elicited student ideas for the lesson. The task of modifying the initial elicitation strategy was usually quite straightforward, even when the subsequent lesson was in a different subject area or topic. This revised lesson segment was then taught by a different group member, videorecorded, and viewed again by the team. As a final step, the team analyzed the video and discussed possible further

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¹ Owing to programmatic realities, one of the students in the year 4 cohort was seeking a mathematics certification, but participated in all of the coursework completely and participated fully in the elicitation lesson study assignment with his middle school mathematics students.

² Specifically, the first two planning tools whose names have changed over time, which we referred to informally as “The Big Idea Tool” and the “Eliciting Students’ Ideas Discourse Tool.” Current versions of these tools may be found at [http://ambitiousscienceteaching.org/](http://ambitiousscienceteaching.org/)

³ Though they were instructed to elicit ideas about a specific phenomenon related to a topic currently under study, as the findings will show, initially this proved challenging. In years 3 and 4 of the study, the task instructions were clarified to ensure that ideas were being elicited about a puzzling phenomenon, and more time was devoted in class to the challenge of selecting appropriate phenomena.
revisions, then each member of the team prepared a reflection on the whole process to be submitted to the methods instructor. In some cases, a third member of the team chose to enact another revision of the lesson prior to writing the reflection.

**Data Sources**

There are three primary data sources for this study: written coursework for assigned tasks, videorecordings (in years 1 & 2) or written accounts (years 3 & 4) of planning conversations, and electronic portfolio entries. Though the nature of the data sources changed slightly between the first and second site, the data collected at each site was largely congruent. Each of these sources is discussed below.

**Assigned coursework.** In each of the four years of this study, contextual factors in each program shaped the exact wording of the assignment presented to students. For each year of this study, the requirements for this class project had the following features in common:

- **Planning conversation #1:** Group discussion of the topic for teacher #1 and selection of an elicitation strategy
- **Video #1:** A 5-10 minute video clip of teacher #1 enacting the selected elicitation strategy in the classroom.
- **Planning conversation #2:** Group viewing of teacher #1 video clip, and evaluation of the effectiveness of the elicitation strategy. Group discussion of the topic for teacher #2 and revision of the initial elicitation strategy for teacher 2’s class.
- **Video #2:** A 5-10 minute video clip of teacher #2 enacting the selected elicitation strategy in the classroom.

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*Video clips of actual middle and high school classroom teaching were *not* collected as part of the data set for this study. In order to comply with human research subject protections under both IRB approvals for this study, care was taken not to include any audio or video of the classrooms themselves in the videorecordings taken during group discussions in the methods class.*
Final conversation: Group viewing of teacher #2 video clip and evaluation of the effectiveness of the elicitation strategy

Group summary: As a group assignment, each group submitted a description of each elicitation strategy, a segment of each lesson plan containing an elicitation activity, and a rationale for the changes made in the strategy between teacher #1 and teacher #2.

Individual reflection: Written reflection on the whole process of planning and revising elicitation strategies in this class project.

Recordings and written accounts of planning conversations. During the first two years of this study, the three planning conversations were recorded in cases where all three group members provided written consent. While these videorecordings provided ample evidence for student teacher reasoning in this study, ultimately they proved an excessive and time intensive data source in pursuit of the research questions, and group summaries of these discussions in years three and four of the study adequately served the purpose of understanding the rationale for changing elicitation strategies. Data from both the transcripts of the videorecorded group discussions and the written accounts of the planning conversations were analyzed in this study.

Analysis

In the first stage of analysis, text from each of the data sources (course work, transcripts from video data from the first two years, and portfolio entries) was consolidated and imported into NVIVO for Mac 10. These data were then coded to identify elements that related to the three research questions. Specifically, the data was coded by the labels “elicitation strategy revision choice,” and “rationale for revision,” (for question #1) “changes in thinking,” (for question #2). Data coded in these categories was then further analyzed in three iterative passes of the data in
which increasingly detailed descriptions within the three primary codes were applied. These
descriptions were then re-examined to identify emergent themes in the data. The unit of analysis
in this study is the collective work of the three students who comprise each group, and the
presentation of the findings from this analysis below are best understood as characterizations of
the range of possible outcomes of teaching elicitation to preservice science teachers through the
lesson study approach. Rather than make specific causal claims about teacher learning, this study
seeks to map out potential pathways and progressions of understanding as preservice teachers
learn to elicit student ideas.

**Findings**

The findings from this study are presented in terms of each research question noted
above, and aggregated into the categories that emerged during the analysis. In the first part of
this section, the most common revisions and rationales are presented, and illustrated with
examples from the data. Next, data drawn from the participants’ reflections is presented to
support claims of changes in thinking about the nature and purpose of elicitation as a
consequence of the lesson study cycle.

**Revisions to elicitation strategies**

Following the assignment guidelines, all of the groups initially created a lesson plan
segment in which they elicited student ideas about some phenomenon related to a curriculum
topic under study. Given the emphasis on student discourse in the methods classes, one feature
common to all of the groups’ elicitation activities was an initial task prompt followed by a class
discussion of some sort.

Many groups had difficulty in choosing a phenomenon primarily because they were still
uncertain as to what constituted a phenomenon and what did not. For example, Group 1c selected
“the metric system” as their phenomenon, and thus they were limited in terms of what ideas they could elicit from students. For some, even when an appropriate phenomenon was selected, selecting a puzzling aspect of the phenomenon or structuring the prompt in such a way that it elicited student ideas was challenging. Other groups conflated the notion of a phenomenon with the general topic, and the elicitation prompts resembled more conventional assessments. For example, one group (Group 1a) sought to elicit students’ ideas about the periodic table, and structured their elicitation as a set of knowledge recall questions. The details of each group’s elicitation task design and revisions are shown in Table 1 below.

There were many features of the elicitation tasks that groups maintained from the first teacher to the second teacher in the lesson study cycle. Indeed, looking across the specific prompts and task structures from each of the groups, it is notable that many of the changes in structure were additive in nature. That is, the overall type of task stayed the same, but features such as more time, more individual writing, and more discussion—as detailed below—were added. For example, Group 3a used a version of a card sort activity for both teachers, first in a middle school physical science class on biotic and abiotic factors and then in a high school chemistry lesson on acids and bases. In the second lesson, the group decided that students needed to justify their categorization in writing, and this became part of the enacted elicitation.

Revisions to increase participation. Each group decided that there was an aspect of the elicitation prompt or task that they wanted to revise based upon what they noticed in the video. One of the most prominent themes in participants’ observations of the video clips concerned the degree of participation by the students, and indeed this was the most common rationale for

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1 To be clear, the metric system is not a phenomenon because it is not an event or process requiring explanation. Much like the periodic table, Newton’s laws, or plate tectonics, the metric system is a human developed set of conceptual tools used to investigate and make sense of phenomena. In this study, it was not uncommon for students to initially conflate phenomena with concepts, and in the class discussions on this point after year 1 of the study, this distinction was emphasized.
changes in the elicitation activity. Initially, only three of the eleven groups required individual students to either write or draw a response to a prompt prior to any group or class discussion. After revising their task prompts, an additional six groups decided to have students make some written record of their ideas before sharing them as a way to ensure full participation of the students.

In video clips where the teacher simply asked a question to elicit students’ ideas and only a few students responded, it was abundantly clear to participants that most students were not able to contribute their ideas and was disengaged from the elicitation activity generally. For example, one group selected the prompt, “What do you know about cells?” for use in a high school biology class. The group later described what they noticed about student activity in the video:

Some students responded with knowledge about the cell life cycle, different types of cells, cell division, a cell nucleus, a cell membrane, and a cell wall (in plants). While students were sharing their thoughts, [The teacher] wrote key concepts from their ideas up on the board. Although some students were raising their hands and discussing their ideas, a majority of the class was not heard from….We talked about allowing students time to write a list of their ideas on a sheet of paper then share with the rest of the class. We decided that one of the aspects we wanted to improve upon was to actually have some written documentation of the student’s ideas. (Group 1a, group summary)

Another strategy for fostering greater participation was to limit the size of student groups. For example, a teacher from Group 1b passed around packaged foods with ingredient lists and nutrition tables on their labels. In groups, the students examined these for words they thought were macromolecules. Students responded out loud as the teacher made a list on the board. The
group reported that upon watching video of this teaching segment, a main concern was the inclusion of all students in the activity. They noticed that having four large groups of 6–8 students each (as per the existing seating arrangement in Teacher #1’s classroom) allowed some students to retreat out of the activity and allowed other more dominant group members to share their thinking and do most of the talking. For the revised task, the student group size was limited to 3–4 students as a way to foster more involvement.

**Revisions to increase opportunities for thinking.** A number of groups decided that they had not provided students with enough time to adequately consider their response to the task prompt, and chose to deliberately structure the task time in the revised lesson segment. Many groups also made the observation that they had ended the elicitation of ideas and subsequent discussion too soon, and that there were clearly more students whose ideas did not become part of the class discourse. A member from Group 4d exemplified both of these points when she wrote: “After watching the video of me implementing the Do-Now, our team realized that the students really wanted to go over their ideas of where rust comes from…For this reason, we decided to have Teacher #2 allow time to make this happen.” (Group 4d member, individual reflection).

In a few cases, groups recognized that the nature of the task being presented to students was not as clear as it could be. For example, one group began by dividing the class into small groups before posing two questions, "Where does soil come from?" and "What is soil made of?" The students then worked in their groups to complete concept maps based on the questions. They noted “too many students spent time trying to understand what the question wanted instead of thinking about what they knew about the topic.” They also found that “not everyone knew what a concept map was.” (Group 1b member, individual reflection)
In addition to making task prompts clearer, a number of groups also recognized that their elicitation prompts were more oriented towards the “right answers” than they had recognized in the planning stages, and many sought to revise the prompt so that it led to more divergent responses from students. Three groups explicitly revised their task prompts to include a mention that the task was not about right or wrong answers, but rather about students’ ideas. After eliciting ideas about the answer to a force-vector equilibrium problem in a physics class, one group noted, “Rather than looking for a single, right answer for a question, the group agreed that the question should be more open-ended.” From this response, it appears that the group’s initial characterization of elicitation was actually an assessment of the acquisition of knowledge, rather than of the cognitive resources that students bring to learning. The group decided on a complete overhaul of the prompt for the second group member’s biology class. They decided to formalize the writing of ideas in each group as well as to ask a question with the potential for more divergent answers: “What are all the things that could eat this apple core if I threw it out at the park?” The high-level of student engagement to this subsequent prompt surprised the group:

Much to my surprise, some scholars who were normally quiet in class became the spokesmen for their groups. Given the nature of a special needs classroom requiring differentiation, the probe elicited ideas at different levels of thinking. Because only one student per group was recording the ideas, it also made it feasible for everyone in each group to participate to the best of his or her ability.

(Group 4b member, individual reflection)

This particular prompt also provided an opportunity for students to bring their diverse experiences and ideas into the classroom, as students discussed whether a homeless person who frequented the park next to the school was part of the same food web. This group was also the
only one in which a participant referred specifically in the reflection assignment about how the student idea elicited here was an entryway into making their teaching culturally responsive (Gay, 2002; Villegas & Lucas, 2002).

Another group found that their revisions did not actually foster a more robust elicitation of student ideas, and in their reflection, they noted the effect of the requirement for students to respond within pre-existing categories (e.g. biotic/abiotic, acid/base/neutral):

I see now that the activity may not have been formatted in the best way to gather students’ ideas because of how specific the activity was to the content vocabulary. Without this knowledge, the students weren’t able to properly show what they really thought about the substances shown in the worksheet. (Group 3a member, individual reflection)

What is notable about this particular case is that in both versions of the group’s elicitation task, they selected phenomenon that were familiar to students as a way to make the content relevant. Doing so, they reasoned, would present more opportunities for students to engage with the topic. However, because they also insisted that students’ ideas be characterized in terms of specific academic language, this had the effect of decreasing the sharing of student ideas to explain the differences between items in the two categories. An awareness of the unintentional constraints imposed on students’ thinking was an important theme in the reflections from this group.

**Planned responses to elicited student ideas.** A final major point of revision concerns the ways in which participants planned for the emergence of student ideas in these elicitation activities. Overall, students found this aspect challenging to manage—in most cases, this simply entailed making an ongoing list on the board at the front of the room—and only two groups in
the study revised their lessons to explicitly make written public records of students’ ideas that could be maintained for reference beyond the elicitation activity itself.¹

In a number of the revisions, groups anticipated the necessity of pressing students to justify their responses as a way to respond to the students’ ideas. At least four of the groups revised their elicitation task explicitly to include more opportunity for students to justify their ideas, either verbally or in writing. In the reflections, groups that chose to revise their elicitation to include more justification described a need for more information about their student ideas. In Group 2d, this increased emphasis on justification led to a better understanding of the students’ confusion between the terms “dominant” and “recessive.” Such an understanding on the part of the participants indicates awareness that the basis for a student’s idea can be just as informative as the sharing of an idea itself.

Changes in preservice science teacher thinking

There were four main categories of changes in preservice science teacher thinking as identified in participants’ reflections in the analysis: student-centered teaching, addressing elicited ideas in instruction, identifying gaps or misconceptions in participants’ subject matter knowledge, and rethinking the nature of misconceptions. Even though these were self-reported, there is little reason to doubt the face validity of these findings, given that the task for participants from which these data are drawn was to “write a 1-page reflection on the whole process” for each of the four years of the study. That is, these categories emerged across all four years of data from an open-ended prompt.

Student-centered teaching. Participants remarked on a number of ways in which eliciting students’ ideas changed the classroom dynamics, and most of these were characterized

¹ Maintaining public records of ideas over time is a key component of the Ambitious Science Teaching approach (Windschitl & Calabrese Barton, 2016).
as a shift towards more student-centered instruction. Most commonly mentioned was the impact that elicitation had on fostering a classroom climate of respect, comfort and participation.

Many participants identified a need to better design lessons that fostered an environment of student comfort, as in a reflection from group 3a member who highlighted a greater need for support in students sharing of their ideas: “I could have set this activity up better to make sure that the students are unafraid to give their ideas and not worried about being wrong.” A number of groups also described that making the lesson more student-centered entailed explaining to students why their ideas were even being elicited, because apparently doing so was quite different from students’ typical experiences in science class:

One of the most important lessons that we learned from [C’s] video is that we should always explain the purpose of our classroom activities. Seventh graders do not like to be left in the dark. The students in [C’s] class were very curious about why they were doing the activity that we gave them…Students have a right to know what they are doing and why we are asking them to do it. (Group 2a, group summary)

Another aspect of making the lesson student-centered appeared in response to an awareness of the need to allow students adequate time to think; and this was considered as a component of a safe socio-emotional environment:

First you need to give students time to flesh out what they know. This may seem like time wasted but it allows you to gear your lessons to what the students are confused about. Second you need a classroom where students feel safe to share thoughts and ideas they are not sure about. (Group 2b member, individual reflection)
Beyond student engagement and classroom management, six of the eleven groups noted that the elicitation activity provided a connection between student experiences and the intended content understandings. As one group noted, “We also learned that if we can connect what we are doing with students’ experiences they are much more likely to understand a topic than if we just leave it on its own,” (Group 2b, group summary). Similarly, another group described how the elicitation activity had forced them to consider the lesson from the students’ perspective: “A problem that I saw was that I was thinking about misconceptions from my end rather than the students end—a source that I need to tap into to construct lesson plans localized to the understanding of my students,” (Group 4a member, individual reflection). This finding can be taken as an archetypical example of the way in which lesson study allows teachers to see lessons “through the eyes of their students,” (Lewis, 2002, p. 12).

Making sense of student thinking. In nearly all of the reflections, participants acknowledged that eliciting student ideas carried some risk of students’ incorrect ideas about science concepts being reinforced. Yet many were also quite thoughtful about the apparent contradiction, as evidenced by this quote:

Prior to studying common misconceptions and the importance of eliciting student ideas, I had assumed that teachers were supposed to start at the beginning of a lesson with the assumption that students do not have background knowledge on the topic. I had not thought that students could have already cognitively arranged their own personal ideas on topics. Nor did I think that growing up in different environments and cultures impacts the background knowledge a student acquires and brings into the classroom. (Group 4d member, individual reflection)
Two of the groups (1a and 4c) described the purpose of eliciting ideas initially for the purpose of “fixing the students’ misconceptions” (Group 1a, group summary), but both found this rationale less convincing once they had completed the lesson study activity. In their reflections, participants in these groups consistently noted that eliciting student ideas before instruction helped greatly with planning. Though more than one group wondered how they might build such elicitation activities and discussions into each lesson, they saw value in doing so.

Another change in thinking across groups was recognition of the need to keep track of student ideas beyond the initial elicitation. Many also noted that they had significantly underestimated the number and range of misconceptions that students possessed, and that this impacted their ability to directly address them in instruction:

- I misunderstood the level of understanding that the students would have regarding salt dissolving in water. (Group 4a member, individual reflection)
- I think we failed to address how many questions the students may have had on the ideas we chose. (Group 4c member, individual reflection)
- If we do not understand the misconceptions that our students bring to the classroom it is very difficult to address where student understanding breaks down. We also learned that no idea is too outrageous for a student to believe. (Group 2a member, group summary)
- In every case of teaching our lessons that were supposed to get at student misconceptions, we were surprised at what the students knew. What also surprised us as a group was the trouble students had in transferring what they knew to what they were doing. Asking students to apply knowledge is where many of their misconceptions came out. (Group 2b member, individual reflection)
This last example points to another commonality in the reflections, namely, a reconsideration on the participants’ part concerning the nature of misconceptions.

There was also a shift in some participants’ thinking about what it was they were actually eliciting. In the case described above with group 3a conducting a card sort for eliciting student ideas about biotic/abiotic factors and then substances that were acid, base, or neutral, there were clear right and wrong answers for both teachers’ elicitations. In this case, the group had followed task instructions in terms of selecting puzzling phenomena, however the “puzzling” aspect was how the phenomena were characterized within broader conceptual models, rather than being a phenomenon that required the development or revision of an explanatory model, and the groups’ reflection demonstrated the limitations of this approach.

**Identifying gaps in participants’ own subject matter knowledge.** One surprising consequence of the elicitation of student ideas in this study was in the impact on participants’ own subject matter knowledge, a finding consistent with the literature on lesson study. At least 4 of the 11 groups described an instance of holding some similar misconceptions as their students, either in the past or at the time of the study. For example, one member of a group that elicited ideas about cells wrote in a reflection, “I can remember believing that photosynthesis was the opposite of respiration and that respiration could only occur at night. These ideas were significant stumbling blocks for myself as I entered higher level biology coursework,” (Group 1a member, individual reflection).

Others simply described their own knowledge gaps that became evident as they planned on how to respond to student ideas in instruction. A member of group 3a wrote:

At first, I was not able to structure the lesson enough because of my lack of evolutionary biology content….This was very important because I couldn't
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pinpoint exactly what the main evolutionary puzzling phenomenon was that I wanted my students to examine and think about. (Group 3a member, individual reflection)

This finding points to the necessity of adequate subject matter knowledge as a prerequisite for selecting appropriate puzzling phenomenon for the elicitation of student ideas, and suggests that perhaps this particular task ought to be more thoroughly scaffolded than was done in this study.

**The nature of misconceptions.** Lastly, it appears that a number of preservice teachers were unable to distinguish between open-ended elicitation prompts designed to produce divergent responses and more closed-ended elicitations oriented towards assessing students’ ability to give “right answers.” A number of the groups discussed the value of understanding the range of misconceptions that students may have about a given topic, and how this relates to their own thinking about the subject matter and the overall practice of airing “wrong ideas” in their classrooms:

Knowing the misconceptions will allow the teacher to recognize and concentrate on correcting these misconceptions. While reflecting on misconceptions, I think that teachers such as myself are a little afraid to bring up misconceptions in fear that the students will not be able to grasp the correct knowledge. However, the more I think about my own studies I realize that I had some doubts that could have been cleared up if brought up by a teacher. (Group 4d member, individual reflection)

This passage demonstrates an internal conflict about the role of eliciting student ideas in teaching that occurred throughout this study. At issue is the counterintuitive notion that the “right” ideas in science class can be taught by comparing them against the “wrong” ones; or further, that the
focus for ideas is their explanatory power in a model, rather than their “correctness.” Such a finding speaks to the magnitude of the challenge of overcoming traditional transmissionist models of science teaching—practices that Stroupe (2016) collectively calls “delivery pedagogy”—and that understanding the role of student ideas in learning science will likely remain a challenge for a great number of prospective science teachers for years to come.

**Discussion**

Though the primary focus of this study concerns the development of high-leverage elicitation practices, it also serves to affirm the value of providing preservice teachers the opportunity to observe and reflect upon the details of teaching practices that they had a hand in designing. It is also noteworthy that the preservice science teachers in this student were able to see the impacts of very small changes in practice from one lesson to the next, such as the addition of a single word in a task prompt, or providing students time to write a response prior to a class discussion. This study also demonstrates that eliciting students’ ideas and working productively with those ideas in science lessons are two related but distinct sets of practices (Windschitl & Calabrese Barton, 2016).

The varied ideas, roles, and purposes that participants in this study found for elicitation practices point to a need to make distinctions between the different kinds of elicitations that emerged in this study, because frankly some elicitations did not appear to be serving the intended high-leverage function of a core practice, even though they may have appeared to do so superficially. The three types of elicitations identified here are: resource, reasoning, and evaluative elicitations. The first two generally served the purpose of a core practice, while the last did so only occasionally.
The first kind, resource elicitation, concerns the eliciting of student ideas to take stock of cognitive and cultural resources for planning instruction. The prompts for these elicitations may take the form of a “What do you know about…?” question. Examples from this study that would provide elicited responses illustrating the resources students bring to science class include the questions “Can you think of a reason why we need a microscope?” and “What do you know about atoms?” Such questions are divergent in nature—having multiple possible answers—and the responses by students will likely inform the teacher about the resources that students bring to their existing understanding of the topic.

The second type, reasoning elicitations, concerns the eliciting of student ideas specifically for model building and explanation. Both types of elicitations benefit from being centered on a particular phenomenon that is accessible to students, but only the second type explicitly requires a puzzling phenomenon, such as the prompts by group 4d asking students to explain their ideas about how metal rusts or how a hot air balloon works. Though reasoning elicitation for model-building can certainly be considered a form of assessment, the purpose for doing so from the perspective of Ambitious Science Teaching is less about measuring outcomes, and more about activating students’ cognitive resources and fostering sense-making and metacognition opportunities (Windschitl & Calabrese Barton, 2016).

Evaluative elicitation, the third type of elicitation represented in this study, measures the conceptual distance between existing and desired outcomes, a common feature of educational assessment (Black & Wiliam, 1998). This was actually the most common form that the elicitations in this project took in the first iteration of the lesson study—for example, students were asked to categorize matter, define genes, and solve vector problems. Though responses to evaluative elicitations may certainly inform instruction or detail students’ sense-making
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processes, the purpose is ultimately comparative, and in this study such responses to these kinds of elicitations were typically measured against scientifically accepted “right” answers. Subsequently, with evaluative elicitations there are fewer opportunities to identify the various kinds of resources available to students as they engage in learning the subject matter.

It seems reasonable then to advocate for clarity in both a linguistic and a conceptual sense when discussing the concept of elicitation. If the term “elicitation” is reserved solely for prompts designed to bring forth a divergent set of students’ ideas, it would be clearer that this core practice is meant to focus on the explanatory ideas and cognitive resources of students. It may be preferable for elicitation to be thought of as a process that informs metacognitive aspects of learning—especially if students are working on their own ideas—and not necessarily as a form of assessment at all. Such a distinction may not be trivial in the daily work of teaching, and at minimum the findings of this study point towards a need to better prepare science teachers to view elicitation as an act of discovery, rather than as one of confirmation.

Though the design of the methods class activity in this study was a truncated version of the “lesson study” approach, it is clear that a number of features found in Japanese-style lesson study also appeared here. Participants were better able to view lessons through the eyes of their students, and the process of eliciting their students’ ideas offered them opportunities to identify and address gaps in their own subject matter knowledge. As the field of teacher education moves more towards practice-based approaches (Zeichner, 2012), it is clear that the structure of lesson study (even an abbreviated version) may serve as a powerful tool for scaffolding the later uptake of elicitation as well as other specific high-leverage practices.

It was apparent in this study that the groups had rich discussions about pedagogy in between the teaching of the two lessons. This would suggest that the authentic nature of the
assignment, as well as the shared responsibility for the upcoming lesson, prompted the student teachers to carefully deliberate on the revisions of each lesson component. All of these discussions contained substantive debate about various ways in which an elicitation prompt might be presented to—and perceived by—students, as well as possible outcomes for varied designs of task prompts. In doing so, not only were these teachers thinking about the students’ prior knowledge, but they were also taking into consideration the ways these students made meaning from their instruction.

Conclusion and Implications

This study sought to better understand the choices and rationales preservice teachers had for revising elicitation strategies in lesson study groups, as well as how their ideas about the elicitation of students’ ideas changed over time. Overall, in revising elicitation activities from the first teacher to the second, the participants sought to improve the quality and quantity of student ideas they elicited. Most commonly, groups sought to increase student participation by building individual writing or discourse tasks into the task prompt. Many groups also noticed that the task prompts were not as clear to students as they had seemed in the planning stages, and they concluded that this interfered with students’ opportunities for thinking. Strategies to this end included improving task clarity, allowing for more time for students to think, and selecting more appropriate phenomena. The last major category of revision concerned the need to better plan for responding to students’ ideas, including the need for better public representations and records of students’ ideas.

There was ample evidence that many participants’ ideas about elicitation changed over the course of the lesson study assignment. Many of the participants reported a better
understanding of the type of student-centered pedagogy being advocated in their teacher education programs, and were better able to use the elicited ideas in instruction. A smaller number of participants reported changes in beliefs about teaching and learning, particularly concerning the role that prior knowledge plays in learning science concepts. Finally, there were reported instances of subject matter learning as a consequence of this activity, which is consistent with the broader literature on the effects of lesson study on teacher learning.

One implication of this research concerns the broader challenge of fostering an Ambitious Science Teaching approach in classrooms and schools where model-based inquiry is not commonly used; even in these classroom it is still possible for ideas to be the focus of student work. Additionally, the belief that “wrong answers” should never be voiced in the classroom, lest students remember them instead of the correct answers, remains strong among preservice and in-service teachers alike. Indeed, as has been documented elsewhere (Thompson, Hagenah, Lohwasser, & Laxton, 2015), addressing such issues in science classes may require broad networks of support and plenty of time. Consequently, it is worth keeping in mind that engaging in a high-leverage practice like eliciting students’ ideas around puzzling phenomena for model-based inquiry may require significant changes to curriculum and classroom culture, requiring the cooperation of multiple actors in a given setting. Future research toward this end might productively target cooperating teachers’ knowledge of elicitation practices, or examine broader structures of science teacher preparation that make it more likely that their knowledge and skill with high-leverage practices continues to develop over time.

References


Author. (2012).


