Reflecting on a 5E Lesson with Preservice Elementary Teachers: Providing an Opportunity for Productive Conversations about Science Teaching

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Abstract

This article describes a guided reflection activity in an elementary science methods course. The author details how she videotaped model “Explore” and “Explain” sections of a 5E lesson in her methods course and then systematically reflected on the teaching episodes with her students (Bybee et al., 2006). Templates for data collection and guiding questions for the reflections are included along with a student work sample. The author outlines what she and her students learned from the experience.

Introduction

Reflection has been touted as an important tool for professional growth for novice and experienced teachers alike (Schön, 1983). As science educators, we frequently ask our preservice teachers (PSTs) to reflect on science lessons that they observe or teach to prompt them to think in meaningful ways about the science teaching episodes. The PSTs enrolled in my elementary methods class are required to design a 5E lesson plan (Bybee et al., 2006) around a topic from our state curriculum and implement at least a portion of it in an elementary classroom during the internship that occurs at the end of the course. Though their plan is written as one 5E, it may take them several days to implement in the context of their classrooms. Afterwards, they reflect on the experience and what they learned using a series of questions to guide their responses. For example, I ask PSTs to describe how the Explore section of their lesson supported students’ science understanding and to provide examples that let them know that students did or did not understand the core science content of the lesson. Over a number of semesters of using the reflection assignment, I was dissatisfied with the quality of the responses that I received because of their superficial nature. While I asked PSTs to use evidence from their teaching episodes to support the key points they made in their reflections, I did not feel that was happening. Even with the prompts, PSTs tended to comment on the student engagement level and how much fun they had teaching rather than on student learning and teacher actions that had encouraged success. I began to think about how I might provide forms of scaffolding in the course that would enable the PSTs to think more deeply about their own teaching. At the same time, I had recently engaged in planning and teaching several lessons with elementary teachers in their classrooms. These experiences had prompted me to think carefully about the complexity of teaching inquiry-based science lessons at the elementary level (Bradbury,

Wilson, & Brookshire, In Press). I wanted to better prepare the PSTs to be successful in implementing the first science lessons that many of them would have ever taught to elementary students because I felt that if their first experiences teaching science were negative, they would be less likely to try again once they have their own classrooms.

This combination of events led me to conclude that a helpful approach to support my PSTs would be to video myself teaching an elementary-appropriate 5E lesson in the science methods course and then to reflect on it together. My primary goals for the reflection activity were to 1) model how to reflect on a science teaching episode using specific instances from the lesson and 2) have PSTs critically examine the role of the teacher during a 5E lesson so that we could make some of my teacher thinking during the lesson explicit for the PSTs.

Teaching Context

In my setting, the PSTs that I teach are seniors, enrolled in my class in the semester before they student teach. In the group reported on here, I taught 19 PSTs, 17 of whom were female, traditionally-aged students . The PSTs are a cohort who take an internship course and their science, social studies, math, and language arts methods courses during the same semester. During the first ten weeks of the semester, they attend classes at the university Monday through Thursday and spend Friday in an internship in an elementary classroom . The two schools where the PSTs complete their internships are both Title 1 schools located in a rural area near our university. The PSTs intern in K-5 classrooms. In the last five weeks of the semester, the PSTs go to their internship classes on a daily, full-time basis. During these final weeks of the semester, they implement and reflect on the lessons that they planned during their methods courses. In science methods, each PST is required to plan an entire 5E lesson and teach at least a one-hour portion of it individually. Given the variability in their classroom placements and the preferences of the teachers that they are placed with, some PSTs are able to teach their complete 5E over a number of days, while others are only able to meet the minimum requirement.

For the first ten weeks in the semester, I meet with the PSTs two times per week for two and a half hours at a time. In class, I regularly model 5E lessons that would be appropriate for implementation in an elementary setting. Each day of the course is designed to provide an opportunity for the PSTs to learn science content and think about pedagogical aspects of teaching science at the elementary level such as the importance of teacher questioning during a lesson or the use of multimodal approaches to teaching science content (Jewitt, Kress, Ogborn, & Charalampos, 2001). While the PSTs are required to take two introductory level science content classes as part of their program, they only have one science methods course in which we address multiple content strands in our state elementary science curriculum as well as strategies for teaching at the elementary level.

I knew that given the time constraints in the class, we would not be able to reflect on all portions of the 5E, so I focused on the “Explore” and the “Explain.” I chose these portions because I expected the PSTs to implement at least those sections of their lesson plans in their internship classrooms, and I knew from experience that managing the “Explore” was often very difficult for them. For many of the PSTs, the science methods course was the first time that they experienced science taught in a way other than the traditional “stand and deliver” method. They enjoyed the more active approach used in the course and felt that it was an appropriate way to teach elementary students. However, previous PSTs had become discouraged when the engaging lesson that they had planned ended in chaos when they tried to implement it with elementary students. Former PSTs tended to get so caught up in the direct experiences of the exploration that they did not focus on helping elementary students construct an understanding of the science content. My perception from reading PSTs reflections was that their focus was on elementary students having fun. The PSTs seemed to think that the science investigations in the Explore were sufficient for students to construct their understanding of the science content. They did not seem to grasp the importance of the scaffolding and questioning provided by the teacher to help students understand the patterns in their data or what those patterns might mean. The PSTs struggled with connecting the direct experiences and data collection in the Explore with science content and vocabulary development in the Explain. I hoped that the reflection activity that we participated in related to my teaching would support PSTs as they thought about the role of the teacher in facilitating a 5E lesson. In transitioning from being a student in a 5E lesson to being the teacher, PSTs had to consider their role as facilitator including planning the lesson, understanding science content, managing materials, managing students, supporting student development of science content knowledge, helping students connect the science ideas to their own lives, and assessing student understanding. When PSTs participate in the student role, these activities are occurring throughout the lesson, possibly without the PSTs being aware that they are happening. However, each of these components is critical in a 5E. I hoped to help make the importance of these activities more explicit for the PSTs through our process of group reflection.

Implementing and Reflecting on the 5E Lesson

To facilitate the reflection activity, I began by videoing a 5E lesson in the methods class. Appendix A provides an overview of the two sections of the lesson (Explore and Explain) that were videoed. I chose this lesson on heat transfer because it occurred near the beginning of the semester. I wanted to record early to give myself time to re-watch the video and choose appropriate excerpts before we reflected on them in class. While the lesson I videoed focused on heat transfer, any science lesson would work for the reflection activity. The reflection process could also potentially be used with any type of lesson, even those without a science focus since the guiding questions for the lesson are not specific to science.

Based on the recommendations of technology specialists at my university, I used an iPad mounted to a tripod to capture the video and audio used for the reflections. I placed the iPad on a counter in the back of the room so that most of the classroom was included in the video. I explained to the PSTs that I was recording the lesson for a class activity that we would complete later in the semester. Because I was planning to use PST data collected during this semester for a larger research study, I had submitted my plans to my university IRB for approval and PSTs had signed consent letters allowing the use of their data. However, if the video had only been used for educational purposes as a regular part of class activities, the recordings would have been exempt from the consent process.

While the iPad did not enable me to capture all of the small group conversations in the class, it did allow me to record what I, as the teacher, was doing and saying. This set-up also provided video that enabled us to see a general sense of what multiple PST groups were doing during the Explore portion of the lesson. Some conversation from the groups closest to the iPad was also documented. For the lesson that I chose to video, the Explore section of the lesson lasted approximately 35 minutes. Because I planned to devote sections of class time to reflecting on the Explore and Explain on different days, I stopped the video and restarted it between those two portions of the lesson so that I would have two separate video files. The video for the Explain section of the lesson lasted about 30 minutes.

Table 1 provides a timeline with an overview of the implementation of the reflection activity. Two weeks after I recorded the video, the PSTs and I reflected on the Explore in class together. I felt that the timeframe of two weeks provided enough opportunity for me to prepare for the next step in the process, but remained close enough to the actual lesson that the PSTs would still remember their experiences as students participating in the lesson. The PSTs memories of the event supplemented the data that had been captured in the video. Additionally, by the time that we participated in the first reflection in class, the PSTs and I had been together for three weeks. During this time, we had begun to develop a community of learners and a sense of trust. These characteristics are essential for the success of the reflection activity (Shulman & Shulman, 2004).

Table 1 (Click on image to enlarge)

Timeline of Events

Week/Day	Events
1/1	PSTs complete a 5E science lesson in the methods class related to matter and are introduced to the core components of a 5E.
1/2	PSTs complete a second 5E lesson related to energy and heat transfer in class that I videotape and upload to Google Drive.
3/1	PSTs and I watch selected video clips from the Explore portion of the lesson and participate in small-group and whole-class discussion about the clips. The discussion lasts approximately 1 hour.
4/1	PSTs submit their written reflection assignment about the Explore prior to the beginning of class. During class, PSTs and I watch the selected video clips from the Explain portion of the lesson and participate in small-group and whole-class discussion about the clips. The discussion lasts approximately 30 minutes.
5/1	PSTs submit their written reflection assignment about the Explain prior to the beginning of class.

Prior to the day that we reflected as a group, I uploaded the videos for each of the “Es” into a folder on Google Drive that was shared with all PSTs in the class. I posted a template on our class website that we used to frame our discussion. A copy of the template can be found in Appendix B. I told the PSTs that we would use the document in class and that they should download it and bring it on their electronic device so that they could add to it in class. If that approach wasn’t feasible for them, I suggested printing a paper copy that they could use for note-taking. I also previewed the video for the Explore and chose excerpts that I felt were critical incidents that we should discuss as a class. While the example in Appendix B provides space for six clips which was the number the PSTs and I reflected on in our discussion, the document could be easily revised to include any number of clips that the instructor feels is appropriate. I chose particular clips because I believed that they represented important aspects in managing a science lesson that might go unnoticed by the PSTs. Examples of these excerpts included explaining the directions for the activity, constructing the format of the data table as a group, material gathering prior to completing the Explore, interacting with PSTs during the activity, and concluding the activity. Many of the excerpts chosen were heavily teacher-focused; however, that was part of my goal for the discussion – to think critically about the role of the teacher in facilitating an activity that enabled science learners to have direct experiences with materials in a science lesson. As I selected clips, I recorded the time stamps from the video so that I could find them easily during our discussion. The excerpts that I chose lasted anywhere from 1 minute, up to about 4 minutes.

Before we watched each video segment, I provided a brief explanation setting the context for the clip. For example, I might say that we were going to watch the portion of video where I provided directions for the Explore. PSTs added this brief description in the first column of the table. After we watched one of the pre-selected video clips the PSTs recorded a more thorough description of what happened during the clip in the second column of the table, possibly including direct quotations from the teacher or PSTs. They then spent from three to five minutes talking with their 4-person table groups about what they noticed in the video. The focus for this discussion was what the PSTs and teacher were doing during the clip with

an emphasis on aspects of the lesson that seemed to be effective and contributed to the success of the teaching episode, as well as portions that might need modification. We then came back together as a whole class and discussed some of their ideas . During these discussions, the PSTs noted that even though the materials were out on a table and organized into groups of like items, the PSTs were still somewhat confused about what they needed which led to a congregation of people around the materials table. We talked about the implications of that issue if they had been elementary students rather than college seniors. Additionally, PSTs observed that I demonstrated with the actual materials as we worked out a set-up that would enable a fair test of our question for investigation which the PSTs felt helped to facilitate the discussion of testing procedures.

I knew that the PSTs might struggle with providing critiques of my instruction, but I felt that discussing their ideas in small groups first might give them more confidence to communicate their thoughts. I explained that teachers, including education professors, always have room for growth and that it was an eye-opening experience for me to watch myself on video. I made it clear that I was open to their ideas about what seemed to be working in the lesson and areas that needed improvement. I shared the first suggestion for how I might have improved the clarity of my instructions. With the ice broken, the PSTs participated in a meaningful conversation about the lesson. We continued this process for the remainder of the clips. As the groups and whole class engaged in the discussion, each individual PST completed their own template. Appendix C provides a sample excerpt from one PST's completed template. I devoted approximately an hour of class time to watching the clips and reflecting on them.

After class, each individual PST was responsible for using the information they had recorded during the small group and whole-class discussion to answer the six reflection questions at the bottom of the template (Appendix B). Completing the questions using the information that had been collected during class was a homework assignment which the PSTs had one week to complete. I encouraged them to go back and watch the video if they wanted to remember what had happened in more detail. Their completed assignments were graded based on the level of detail that they included in their data collection templates along with the level of thoughtfulness in response to the "questions for reflection." A detailed rubric can be found in Appendix D. The questions guiding the reflection on the Explore were heavily focused on management aspects of the lesson. This emphasis was a deliberate choice on my part. There is research evidence to suggest that management is a crucial aspect for the success of novice teachers as they implement inquiry-based instruction. Until they have confidence in that aspect of their science teaching, it is difficult for them to implement meaningful learning experiences for children (Mullholland & Wallace, 2005).

As PSTs reflected on the experience, they indicated that they realized the importance of direct experiences in a science lesson. They also recognized how management aspects of the lesson were important to learning. In her reflection, Megan said, "Science teachers must provide hands on experiences in order for students to gain understanding. If we just talked

about how sand and water heat up at different rates, I don't think I would have taken much away from the lesson." In thinking about the management aspects of the Explore, Lindsey felt that it is important to prepare materials and think about how to handle their distribution. She stated that, "Lots of time and chaos can be created when the teacher has to disrupt the flow of the lesson to prepare or distribute materials. You are less likely to lose student focus and have positive behavior if materials are prepared and ready for an effective delivery." Megan and Lindsey's comments are representative of the responses of other PSTs in the class. Their responses affirmed that PSTs were connecting pedagogical ideas presented in the class with actual science learning experiences.

From my perspective, it was extremely eye-opening to see what a science lesson in my class looked like from the PSTs' view. I had thought that I was modeling clear and explicit direction-giving and appropriate management of materials. I carefully reviewed the directions and had PSTs repeat them back to me. I had laid out all of the needed materials on one table prior to the lesson, and had grouped like items (cups, thermometers, etc.). In the video, we could see that the PSTs were still confused about some of the materials that they needed to gather from the supply table and there were a large number of PSTs who ended up congregating there, making it difficult for everyone to access the needed materials. As a class, we agreed that this confusion happened because I had given too many instructions at once. This lesson was designed to match with the fifth-grade content standards in our state which are currently not aligned to the NGSS standards (NGSS Lead States, 2013). As a group, we discussed what would have happened in a fifth-grade setting if the materials had been handled in a similar fashion. We brainstormed how the materials and directions might have been managed differently to lead to less confusion in the classroom. We also discussed how the teacher's movement throughout the room during the Explore was essential to the success of the lesson. The PSTs could see how my interactions with each group helped keep them focused on key science aspects in the lesson.

Reflecting on the Explain

The next week, we used a very similar process to examine the Explain part of the lesson in more detail. There was one significant change between the two reflections. For our Explore reflection, I had chosen each of the video excerpts. While I felt that approach was appropriate for our first attempt at reflection because there were key aspects that I wanted the PSTs to focus on, I wanted the PSTs to have more autonomy in our second round of reflection. Therefore, I chose 5 brief excerpts ranging from one to three minutes from the Explain video that we discussed as a class. In this case, the clips focused on making connections between the science concepts and the PSTs' lives, linking the data collected in the Explore with the science content, and questioning as an important component of a science lesson. The PSTs then had to choose four more excerpts on their own to include in

their template and reflection. I wanted to determine which aspects of the lesson they felt were important rather than have all the chosen clips be based on my thoughts about the teaching episode.

We used a similar process for our Explain reflection as we had for the Explore reflection in that we watched an individual clip together as a class, and then small groups reflected before our whole-class discussion of the clip. While the template for collecting data from viewing the clips was the same as in the Explore, the guiding questions for the reflection were modified to better match the goals of the Explain. The guiding questions can be found in Appendix B. As with the Explore, the PSTs had one week to complete the reflection assignment for the Explain.

As PSTs reflected on what they had learned about science teaching from looking carefully at the implementation of an Explain, they frequently mentioned the importance of questioning and connecting the science content to everyday life. Sarah recognized the multiple functions of questioning in science lesson writing, “Another important science teaching take-away is that questioning is key for student success in science. Questioning has so many purposes…. Questioning can be used as formative assessment, it can probe for deeper understanding, and can also redirect students so that they are discovering concepts on their own.” Mary recognized that hands-on experiences on their own are not a sufficient learning tool and she recognized the importance of helping students connect ideas from science to their everyday lives. She said, “While it is important to provide students with hands-on learning experiences, I have really learned that those experiences won’t be as influential if students aren’t able to connect those experiences to real world contexts. Throughout this activity, students are provided with the opportunity to learn information and see how it applies to their real life. If students are able to connect material to occurrences that they understand, they will be more likely to retain that information.” Melanie noted that it was important to remember to include multiple connections to students’ lives because not every person comes from a similar background. As a class, we discussed the idea that it would have been better had I made additional connections between the idea of radiation and students’ lives because not all people had been to the beach, which was an example we had focused on in our discussion. In her reflection Melanie said, “In this clip, I have seen how much deeper students’ understanding can become when they are able to connect the science content with the familiarities of their own life. Also taking into consideration what life connections will resonate with my students, it is important to remember to provide multiple examples to give students multiple opportunities to understand and connect.”

I feel that the PSTs and I both benefitted from watching the clips in the Explain together and discussing them. In our discussion, PSTs observed that watching the video helped them to see that teaching a science lesson was more complex than they had initially thought.

Considerations for Implementation

While I understand that there is the potential for setting up a negative relationship between professor and PSTs when using this reflective process, we thankfully did not have those issues in my class. I think that there were several strategies that enabled us to mitigate the potential negatives. Though I recorded the video during the first week of class, we did not complete the reflections until the third week, giving our group more of a chance to develop trust before putting all of us in a vulnerable situation. Prior to our first discussion of a clip, I reminded PSTs of the importance of providing constructive feedback that enabled all of us to grow as professionals from the experience, rather than giving advice that was simply critical. As we discussed some of the clips where there was the greatest room for improvement, I laughed at myself with the students. I felt that including some humor reduced the potential tension in the situation. I tried to model being open to receiving feedback from my students.

While I will continue to use these two reflection assignments as part of my methods course, there are changes that I have made over a number of semesters of using the assignment, as well as additional changes that I plan to make in the future. One modification that I have made is changing the lesson that I video in different semesters. I feel that varying the lesson that is being videotaped keeps me looking at the lesson with fresh eyes. It also helps me to think about revisions to make in multiple lessons that I teach, rather than just one. A second change that I made between the first implementation and second was that I chose to do the Explore and Explain reflections on different days because I felt the PSTs gained more from the experience that way. The first time that I incorporated the video reflection activity, I had tried reflecting on both the Explore and Explain on the same day. Using this approach meant that we spent almost an entire two-and-a-half-hour class session watching videos and reflecting. I felt that the PSTs became overwhelmed and bored and tuned out before we were done. Splitting the two sections into two days has yielded better results.

One limitation to the approach to videotaping that I have used so far is that it doesn't allow us to focus on small group conversations that are occurring as the PSTs participate in the activities. I am planning to move the tripod and iPad around the room to focus on individual groups once the Explore gets underway so that we can better capture the small group conversation and discuss how those discussions can influence science learning. I am hoping that these changes can provide additional opportunities for learning for the students and me.

Final Thoughts

As a science methods instructor, I feel that the process of videotaping and reflecting on my own teaching with the PSTs has been one of the most beneficial changes that I have made in my instruction in recent years. PSTs also remarked on how much they learned from the experience. They felt that I had "made it look easy" when it came to teaching elementary science in an inquiry-based manner, but through our conversation they were able to recognize how many decisions I was making during the lesson and how many deliberate actions I was taking. The in-class activity provided a useful tool to make some of my thought

processes related to teaching explicit for the PSTs (Lunenberg, Korthangen, & Swennen, 2007). Additionally, the reflective conversations opened a space for the PSTs to ask questions about why certain decisions were made during the lesson in a manner that supported open and thoughtful dialog. Another benefit was that I felt that I was able to model how to receive constructive feedback in a responsive rather than defensive manner which is an important skill for novice teachers who will be receiving advice on their teaching from cooperating teachers, supervisors, and administrators.

The PSTs explained that the exercise helped them to boost their confidence for science teaching. They put so much pressure on themselves to plan and implement the "perfect" science lesson. It was helpful for them to understand that I also made mistakes when teaching a 5E science lesson, but they still learned new ideas about science content and teaching from the experiences. In the end-of-course reflections, one student even commented that she felt that the two reflection activities were the most beneficial aspects of the course.

During our reflection activities, I do feel that the PSTs met my goals for the assignment. Through the process of discussing the clips in small groups and whole-class discussions the students began to use specific data and lesson excerpts to support their key points. This skill was especially evident in their discussions of the video clips that they chose on their own. PSTs clearly connected a specific incident from the lesson with a pedagogical idea about science teaching. I feel that PST comments also indicated that they began to think about the role of the instructor in facilitating a science lesson. It was gratifying to see that they included comments about the importance of questioning and connecting to life experiences in their discussions, as well as the role that management played in successful science instruction. After reviewing the reflections that PSTs submitted after teaching their own 5E lessons in their internships, it was clear that the reflection activities that we had done in class made an impact. PSTs did include themes such as the importance of management supported with specific examples from their own lessons. In their reflections on their own 5Es, PSTs were able to provide specific incidents from their teaching that did and did not support student learning.

While we devote a significant amount of class time to the two reflection activities, I do feel that the time we have spent engaged in our discussions together in class has been time well spent. Both the PSTs and I have learned so much from the experience, and I feel that it has helped us build community and trust as we think systematically about science teaching.

Supplemental Files

Bradbury-Appendices.docx

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