Participatory Action Research as Pedagogy in Elementary Science Methods

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Abstract

Participatory action research (PAR) is a methodology where the traditional lines dividing researchers and participants are blurred. In this article, a description of how PAR was used to cocreate a science methods course is explored with specific focus on the challenges and benefits it can bring to teacher education. Using PAR as pedagogy provided a way of teaching that centered students' questions, experiences, ideas, and perceived needs as future science teachers. This way of teaching impacted our class community and opened space for students to create their own meanings of science and views of themselves as science teachers.

> I want to become the kind of science teacher that I never had. I had a love for science as a young girl and lost it during high school. I want to allow my students to freely participate and be active in the classroom. I will be a creative science teacher.
>
> —Susan

Basing her idea on the science teacher she never had, Susan, an undergraduate education major, wrote these words in our first elementary science methods class meeting. Reports of negative experiences, such as those described by Susan, are commonly found in research when elementary teachers are asked to reflect on their experiences with science (Avraamidou, 2016). School science can be a place where the "mystique of science" and stereotypical views of what science is and who can do science are perpetuated (Lemke, 1990, p. xi). Efforts to reform practices in science education—for example, moving away from memorization of facts to exploration—often begin in teacher education programs, specifically in science methods courses (Avraamidou, 2014).

Elementary schools offer a unique place to focus on teaching science in ways that reconceptualize stereotypical views and allow students' natural curiosity to lead. Although elementary teachers are prepared to teach all subjects, including science, they may not feel a tie to the science community. According to Mensah (2016), "Unlike secondary teachers of science or majors of science, elementary teachers' identities in science are far from a strong sense of self as a science person or a tight relationship with the professional identity of science" (p. 51). With these concerns in mind, as an elementary certified and former middle school science teacher, I began to explore science teacher identity development specific to

elementary teachers with the goal of creating a greater understanding of what preservice elementary educators need to see themselves, as Gee (2000) would say, as a science "kind of person" or teacher. I had previously taught two sections of science methods, once independently and once as a coteacher. In both courses, I followed the syllabus as written and added resources to supplement the week's goals. While teaching these courses, I realized that I was presenting a specific way of being a science teacher, which was based on a syllabus someone else had written, and not allowing students to share their thoughts on becoming science teachers.

Research shows the importance of experiences and reflection in elementary teachers' identity development as science teachers (Avraamidou, 2014; Mensah, 2016). A 5-year, longitudinal study by Avraamidou (2014) posed the question: "How do teachers develop identities for science teaching?" (p. 223). In this study, Avraamidou suggests that "the development of a teacher's science teaching identity is a complex and multidimensional process, which is influenced by the combination of a great number of experiences situated within various contexts" (p. 235). This statement speaks to the complexity of studying science teacher identity and the importance of centering students' experiences to support their science identity development.

Preparing to teach a section of elementary science methods, I began to reflect on how my experiences had influenced the way I presented science teaching and the effect this might have on how students see themselves as science teachers—or not. In traditional elementary science methods courses, the instructor creates a syllabus and curriculum based on their own ideas about science and science teaching. What would it look like to invite students into this process? What might it look like to not only invite students into the planning and design but also into the question-asking and analysis of their own ideas about science and who they are as science teachers? In this study, participatory action research (PAR) was chosen as a pedagogical approach to open up my own conceptualizations of what it means to be a science teacher and work with preservice teachers to explore this together.

PAR as Pedagogy

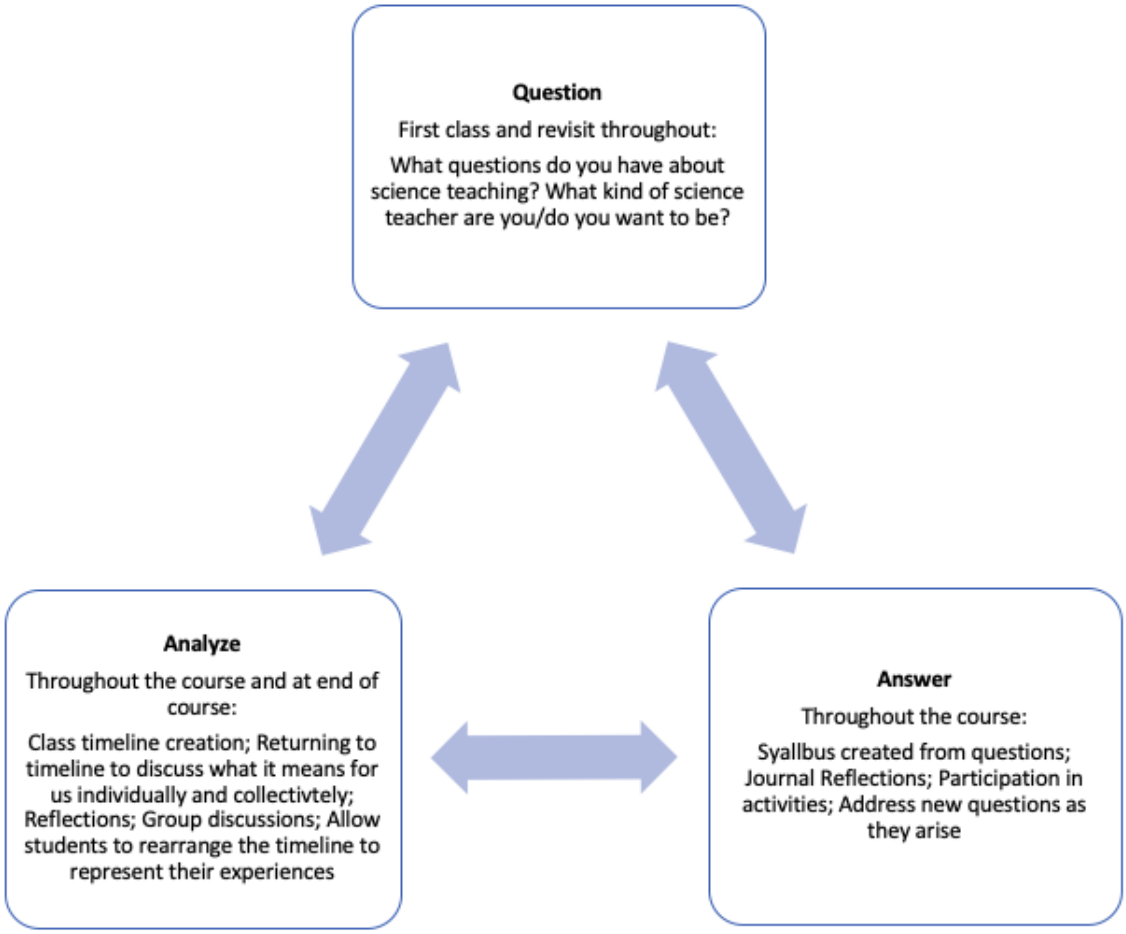
According to Baum et al. (2006), the driving force of PAR is self-reflective inquiry by both researchers and participants:

> PAR seeks to understand and improve the world by changing it. At its heart is collective, self reflective inquiry that researchers and participants undertake, so they can understand and improve upon the practices in which they participate and the situations in which they find themselves. (p. 854)

What can this idea of research bring to teacher education? PAR as pedagogy gives teachers and students a way to create authentic learning environments by creating their own questions to meet specific needs in their classrooms. Through PAR, teachers and students question, answer, and analyze together. The readings of Foucault (Fornet-Betancourt et al., 1987), hooks (2014), and Emdin (2016) guided my thinking toward teaching and researching with participants, rather than on participants, by utilizing PAR as pedagogy in our science methods course. Figure 1 shows the ways in which we took up components of PAR in our class. This will be discussed in more detail in the following sections.

Figure 1

PAR Practices in Our Class



Action research is often found taking place in classrooms; however, PAR moves action research from a place where teachers are researching apart from students to a place where teachers are researching with students (Brydon-Miller & Maguire, 2009). PAR as pedagogy in education has been discussed previously in the literature (Barton et al., 2002; Birmingham

& Calabrese Barton, 2014; Lewis, 2004; Udas, 1998), primarily in educational work with students in after-school programs rather than as a way to teach or train teachers (Brydon-Miller & Maguire, 2009). Similarly, methods of coteaching and cogenerative dialogues are found in K–12 and higher education classrooms (Roth & Tobin, 2004; Siry & Martin, 2010; Tobin, 2006). PAR differs from these in the addressing of research questions and co-analysis: The questions to be answered come from the students, and the students are involved in the analysis of these questions.

Commonly in PAR, or action research in general, one may think of problems of practice being the focus for research. In this course, however, it was not necessarily problems of practice but rather problems of learning. Students were given a chance to share questions they had about their learning and explore their questions throughout the course. It was through their identified problems of learning specific to science teacher education that we were able to question, experience, and analyze together. PAR provides a space to negotiate the traditional power relations between teacher and students and researcher and participants by allowing for an authentic collaboration in which the students' realities lead throughout the duration of the course. In PAR, the lines between researcher and participant are blurred. Using PAR in education also means that the lines between teacher and student may become blurred. PAR, as pedagogy, changed the way in which we—instructor and students—engaged with each other and the curriculum. We left behind the traditionally prescribed curriculum and used our conceptualizations and experiences to cocreate the course.

Putting PAR Into Practice

Students in preservice teacher education programs are traditionally told what kinds of teachers to be with the goal of making them into a certain kind of teacher (Sharma & Muzaffar, 2012). Using PAR as grounds for cocreation in our course, we disrupted this notion by opening it up to different ideas of what it means to be a science teacher.

Class Structure and Design

Participants in this study included six students and me, the instructor. The students were enrolled in an undergraduate elementary science methods course and accepted into the teacher preparation program (see Table 1 for demographic information). Our class met for 3 hours one night a week for 16 weeks. IRB approval was received prior to the course. Students could refuse to participate in the research with no adverse effects on their grades or standing in the course, but all consented to participate. Students could choose to use their real names or a self-selected pseudonym. During this semester, students were in a K–3 classroom once a week observing and teaching.

Table 1

Participant Demographic Information

Name	Role	Gender	Race	Age (approximate)
Anna	Student	Female	White	21
Ally	Student	Female	White	21
Lauren	Student	Female	White	23
McKenzie	Student	Female	White	21
Rachel	Instructor	Female	White	31
Ronnie	Student	Female	Black	50
Susan	Student	Female	White	50

Preparing for the First Class

The (un)planning that took place was not the normal practice of preparing for a semester, which contributed to my tension and unease going into the semester. Ultimately, this proved a beneficial process for me as an instructor and for my students as future teachers. Before the course began, I did not plan anything beyond the first class. As I planned the first class, I chose activities to help lead reflections of ourselves as elementary science teachers, both individually and as a group.

Prior to the first class, students were emailed to inform them that there would not be a traditional syllabus posted until after we met. The email included an article on the ideals of democratic schooling (Kohn, 1993) to help them begin to think about how our nontraditional course would function. This article was chosen for its accessibility and discussion of the benefits of allowing choice in classrooms. In the article, Kohn (1993) discusses misconceptions about allowing choice in classrooms while questioning traditionally accepted practices. This reading was intended to get students thinking critically about the practice of teachers choosing all aspects of what happens in a classroom, allowing us a place to begin our discussion about creating the course together. Along with this reading, students were asked to bring in two objects to class: one representing what science is and one representing who science teachers are. Each of these items—addressing the lack of syllabus, providing a reading, and requesting that students bring in objects representing science teaching—gave opportunities for reflection on choices in curriculum and conceptualizations of science.

First Class Meeting

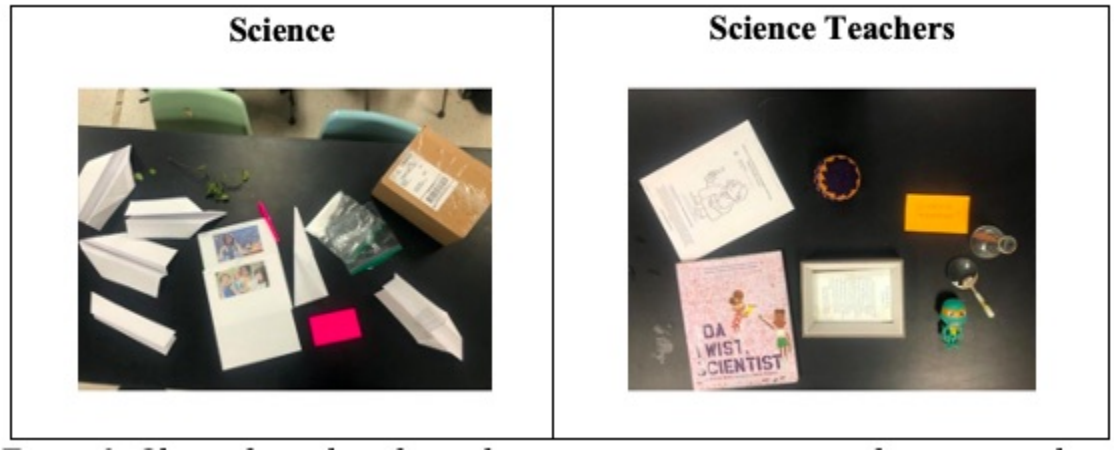
The first class consisted of various activities with the purpose of introducing the project and obtaining consent, getting to know each other, reflecting on our experiences with and in science, and constructing a list of ideas for the syllabus (see Supplement). More detail about pieces of the first class will be given in this section.

Objects Representations: Science and Science Teachers

Five students brought objects from home, and one student collected objects from our classroom. The objects, as shown in Figure 2, guided our first reflections about our experiences with and in science as individuals and as a group.

Figure 2

Objects Brought in by Students to Represent Science and Science Teachers



Each discussion of objects helped us reflect on how our experiences in science shape how we view ourselves as science teachers. Specifically, race, gender, and location of experiences in relation to science surfaced during these discussions and continued throughout the course. These reflections led us into the next activity in which we could visibly analyze our reflections by creating a class timeline.

Class Timeline

Before creating the syllabus, we continued with a period of self-reflective inquiry. After presenting our conceptualizations of science and science teachers, we each reflected individually about a “high and low” moment in science (Birmingham et al., 2017, p. 825). This prompt was left open to allow each student to reflect on her conceptualization of science and what is meant by high and low. After completing this initial reflection, students discussed their responses in pairs, noting any similarities and differences. Finally, we came together as a group to share and create a class timeline that showed our responses to prior high and low moments in science (Adriansen, 2012). The timeline was made using a large white sheet, multicolored neon notecards, and safety pins. Students decided initially to join all high

experiences and low experiences together by arranging them in waves chronologically based on time of life (e.g., early childhood, elementary, or high school), placing the high moments at the top of the sheet and low moments at the bottom as seen in Figure 3.

Figure 3
Class Timeline With High and Low Experiences After the First Class

Syllabus Creation

After this conversation about our previous experiences in science, students were asked to list expectations and goals for the class. After individual reflection, students shared ideas in small groups, and then we created our plan based on their responses. The questions that guided this process were: What kind of science teacher do you want to be, and how can we get there? Through self-reflective inquiry (Martin et al., 1988), we worked together to understand the experiences the students identified as necessary for them to become science teachers.

Following the processes of PAR, the data produced were based upon our experiences as a class (Castillo-Burguete et al., 2015). Students first wrote their ideas in their journals and then shared to add to our class list. Only the ideas voluntarily shared by students were added to our class list of questions, goals, and expectations (as shown in Figures 4 and 5).

After creating these lists, we moved on to discussing ideas for assignments. The two assignments that were nonnegotiable in the syllabus due to the college of education requirements were: planning and teaching an elementary science lesson in their placements and taking a 40-question, multiple-choice content exam at the end of the course. Students offered ideas for other assignments that included watching others teach science lessons, planning a unit as a group, and taking a seemingly “boring” standard and planning a lesson with it.

Students were reminded that in the creation of a course, and the way in which we would grade was not set, so grading was up for discussion as well. Although the college requires an assignment of a letter grade (A–F), we could decide what that meant for us. This discussion proved challenging at first because grades are not something traditionally questioned. What does it mean to grade differently? Students would contribute to and approve the ideas for assignments, and I would provide feedback on their submitted work. If there were any needed modifications or clarifications, students would complete them as necessary. If students continued to turn in the assignments and respond to feedback, they would receive an A.

Figure 4

Questions Shared by Students During the First Class Regarding Teaching Science

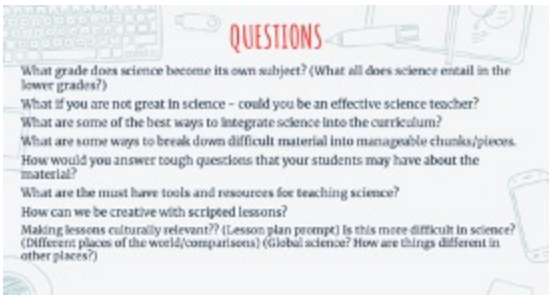
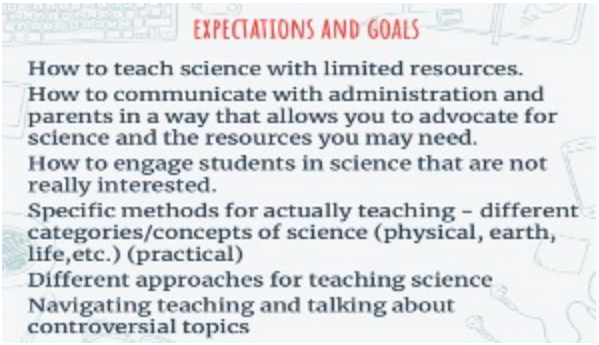


Figure 5

Student Expectations and Goals for Our Elementary Science Methods Course



Moving Ahead After the First Class

Due to a holiday break, there was a week without an in-person meeting between the first and second classes. To create the syllabus, I took the students' questions, expectations, and assignment requests and created a table that, in my mind, connected these items. From there, I listed broader topics that included multiple aspects and aligned them to the students' questions, expectations, and assignments, as shown in Table 2. (Note that this table is not the complete table but only a sample.)

Table 2

Sample of Syllabus Creation Table

Question(s)	Expectation(s)	Assignment(s)/activity	Topic(s)
• What grade does science become its own subject? • What all does science include in the lower grades? • What are some of the best ways to integrate science into the curriculum?	• Different approaches for teaching science • How to engage students who are not really interested in science.	• Integrated literacy and science unit • Unit curriculum planning in a group (5 lessons—highly supported in class; prevent overexertion; not just the same as done in social studies methods course)	• Science standards: NGSS and state • Science integration
• How would you answer tough questions that your students may have about the material? • What if you are not great in science—could you be an effective science teacher?	• Practical, specific methods for actually teaching—different categories/concepts of science (physical, earth, life, etc.) • Different approaches for teaching science	• Watch and reflect on science lessons being taught in elementary schools (including my own story and teaching) • Video resources for elementary science teaching: https://ngss.nsta.org/ngss-videos.aspx	• What is science? Nature of science • Science content/standards: NGSS and state
• What are some ways to break down difficult material into manageable chunks/pieces?	• Practical, specific methods for actually teaching—different categories/concepts of science (physical, earth, life, etc.) • Different approaches for teaching science • How to engage students who are not really interested in science.	• Taking a standard & discussing what can be done with it (if it seems factual/not interesting)—TN Standards/NGSS Standards	• Planning • Science pedagogical content knowledge

In an attempt to provide multiple ways of thinking on these topics and not solely rely on my experiences, I reached out to other elementary science methods instructors and asked for any resources they had and compiled a library of elementary science methods resources (such as lesson plan templates, articles, and various assignments). Not all of the assignments in the final syllabus were suggested by students; however, we discussed them together, and the students gave their approval on all assignments that were included. As an instructor and co-collaborator in the class design, I felt that suggesting activities and structuring the course design was necessary; however, this was a constant negotiation on my end to reflect on the inherent power dynamics of the traditional student–instructor roles. To that end, I kept a journal for reflection and made it a point to constantly check in with students regarding their thoughts on how the course was going and if they thought that anything should change. Some assignments, such as readings and the numbers in each group for unit planning, were renegotiated during the course to meet the needs of the

students, which will be discussed in a later section. When I felt that the syllabus represented the students' ideas, I sent them a draft, along with a separate assignments document, for their review. Their homework for the following class was to review the documents and bring in any questions or revisions. Because no students had any recommended changes, we moved forward with the proposed syllabus (see Supplements). However, the syllabus was viewed as a working document so that we could continue to make changes as needed.

Journaling

As previously mentioned, self-inquiry and reflection are key pieces in PAR projects (Baum et al., 2006). To focus on these concepts, each student kept a science journal. In this journal, students could write anything they wanted from class (e.g., notes, drawings, or investigations) and had to respond to reflection prompts at the end of each class. Weekly, we completed self-reflections in our journals that included thinking on our ideas of science education, science teaching, and who we are as science teachers. These reflection prompts were specifically kept in the science journals to note the connectedness of our experiences (see Table 3). The first week, I created the prompts from student questions about science and my questions about how we view science and ourselves as science teachers. After the first week, student questions, expectations, and goals were used for the weekly end-of-class reflection prompts, as shown in Table 3.

Table 3

List of End-of-Class Reflection Prompts by Week

Week	Prompt
1	What is science, and who are science teachers?
2	What do you remember about science in elementary school? What does science in elementary school include?
3	What are some ways to integrate science into the curriculum?
4	What if you are not great in science—could you be an effective science teacher?
5	What are some ways to break science concepts down into manageable chunks?
6	How can you engage students in science that don't seem interested?
7	How can you make science lessons culturally relevant?
8	How can you make science lessons culturally relevant?
9	What are the must-have tools for teaching science? How do you teach science with limited resources?
10	How can you engage students who don't seem interested in science? How can you make science lessons culturally relevant?
11	What are practical ways to teach life/earth/physical science?
12	What are practical ways to teach life/earth/physical science?
13	What is science, and who are science teachers?
14	What kind of science teacher are you, and what kind of science teacher do you want to be?

Activities and Assignments

As mentioned above, there were two assignments that were required as part of the course. Students were required to write, teach, and revise a science lesson in their placement classroom and complete a multiple-choice science content exam. Other assignments, based on student expectations and questions, included a textbook evaluation, student interview surrounding a phenomenon, group unit plan, and science classroom design project. Within each, students were given choices about how to complete the assignment. For example, the unit plan, completed in small groups, consisted of five various unit planning templates for students to choose from and use. Textbook evaluations were completed using either the text from their placement classrooms or curriculum found online. In the classroom design project, students could present their ideas however they wanted. Presentations ranged from PowerPoint to Padlet to scrapbook pages.

Activities completed during class were chosen based on specific student goals and questions. (More information about activities can be found in the syllabus in Supplement 2). Each week focused on a different student question and explored areas such as the NGSS standards; state science standards; "Ambitious Science Teaching" methods (Windschitl et al., 2018); lesson ideas for physical, earth, and life science; watching video of elementary science lessons; and student presentations. Throughout the course, we hosted guest speakers, including current elementary science and STEM teachers. Although these

activities may not appear to differ much from a traditional course, they were tied to student questions and goals, as opposed to a preset syllabus. In each class, there were choices and various methods discussed to show different ways of teaching science.

Returning to the Class Journeys Timeline

The class timeline that was started in the first class remained fluid throughout the course; it could be changed and moved to show how we were changing. Throughout the course, we revisited and added to our timeline, changing the shape from waves to individual circles and, finally, to a flower. The first responses on the timeline were students' high and low experiences in science; however, the prompts for what to add changed each time we added cards based on the previous timeline discussion. For example, the second time we added to our timeline, we focused specifically on high and low experiences in elementary school (as a student and teacher). During the last class, we continued to analyze our timeline and decided the best way to represent ourselves as science teachers through the experiences we had shared. Students could add whatever experiences they chose at this point in an order that would help them analyze how they saw themselves as science teachers, individually and collectively.

Students went back and forth, questioning which experiences represented which part of our timeline. Finally, one student suggested that the notecards cannot be separated by experiences or what they represent because they all represent something different for each person. Students agreed on this idea and decided it would make sense to separate the cards by the notecard color rather than the experience written on them. Additionally, they agreed that they were all part of one flower with separate roots, as they were all connected because of being in this class together. However, they acknowledged that they are each growing and becoming in their own way, which they chose to signify by writing each person's name on a root of the flower (see Figure 6).

Figure 6

Class Journeys Timeline: Last Class

Worthwhile Approach?

At the end of the semester, I had no doubt that the students had appreciated the pedagogical approach to this course based on their comments and evaluations. As an instructor, I also knew I had learned so much and grown in my practice. What was it about this course that made it worthwhile?

Collaboration in Course Design

The questions asked by students about teaching science that led the syllabus creation focused on topics such as resources, curriculum, content, and pedagogy (see Supplement 2). Allowing the students to write and share their questions about teaching science before creating a syllabus supported their ideas, wonderings, and science teacher identities; they asked and shared what they wanted based on their experiences. As shown in Supplement 3, the course-specific objectives, as outlined in the syllabus (which were not cocreated due to syllabus limitations), were covered in the questions and goals that the students shared. Although some of these questions may have been covered in a traditional classroom structure, allowing students to create the driving questions for the class focused my attention as an instructor on their needs. One concern before approaching this topic was the types of questions and content that students would ask or bring up. However, this was not an issue because the students' questions addressed the aspects typically covered in this course. In the traditional syllabus, topics covered included pedagogical approaches (e.g., inquiry and 5E), assessment, teaching all learners, planning and teaching science lessons, and exploring new standards. Our cocreated syllabus included these aspects and focused on other areas not specifically addressed in the previous syllabus version, such as multiple pedagogical approaches, national and state standards, culturally relevant teaching, conceptualizations of science, and motivating students.

It is important to note that my role as an instructor was also negotiated throughout the course as I became a collaborator with students in codesigning the course. As a collaborator, I also presented my ideas about assignments and the content needed for the course. For example, the student interview assignment, which required the students to interview children regarding a science concept in a way that did not include using academic vocabulary, was an assignment that I suggested. At the end of the course, many students recalled this activity as being one that helped change their thinking on teaching science and leveraging student ideas. Including assignments that students did not specifically request but tied to their questions and expectations shows how this course was cocreated. The course was not driven only by student ideas or instructor ideas; instead, we worked together to incorporate our ideas.

Creating Community

The collaboration of design set up the foundation for the course and how our relationship as instructor and students would continue throughout the 16 weeks. In their analysis of our timeline, students showed and shared their experiences throughout the course, specifically, the importance of our class as a community. The students chose to make the timeline a flower with each person's name on a root, saying that, because of this course, we are now a part of each other's story as a science teacher. They chose to represent our class as connected, saying that we cannot separate our experiences because we took this course together; however, we each have our own individual experiences that add to and shape our growth as science teachers. Students reiterated in this activity that each experience had an important part in how we see ourselves as science teachers and the kinds of science teachers we want to become. They acknowledged the connection of experiences, individually and communally. Throughout the course, we shared various things: practices, ideas, challenges, experiences, questions, and answers. Within our community, we each had a personal space to reflect, share, and learn while also being a piece of each other's experience.

Conceptual Change: What Is Science?

At the end of the course, students reflected on what they thought about teaching science before and after this course. These responses show how their thinking about themselves as science teachers changed throughout the duration of the course (whether it be in the course or outside of it). Each student communicated different ideas about what they thought regarding science teaching and, after taking the same course, came away with different ideas of what they think about science teaching now. These changes often represented tensions and unanswered questions when thinking about who we are as science teachers.

It was evident from the reflections, class conversations, and coursework that we were all constantly in the process of discovering what it meant for each of us to be science teachers, and the setup of this course supported those changing ideas. As shown in Figure 7, students saw science in ways that challenged their previous thinking about what science teaching meant, showing both the complexity and excitement involved in teaching science.

Figure 7

Students' Conceptualizations of Science Throughout the Course

In Figure 7, each color row represents a different student, and each circle represents a different conceptualization that they wrote about science during the course. The first column shows students' responses to defining science in the first class. Although the descriptions vary, four of the six mentioned some form of content (i.e., facts, formulas, nature, and real life), and two described science in terms of processes (i.e., creative and understanding how and why). In the second column, students responded to the same question midway through the semester. At this point, all six responses shifted to epistemological (i.e., no definite meaning, can't be put in a box, everyday life, and constantly changing) and pedagogical views (i.e., discovery and exploration). The third column shows students' ideas about what science is from the last class. These conceptualizations focus on pedagogical approaches that differ from the previous responses. This is not to say that using PAR is the only way students' ideas about science and science teaching change; we know that students' conceptualizations can change in the length of a methods course. However, revisiting and reflecting allows time for students to continue to think through what science is and what kind of science teacher they want to be (see Avraamidou, 2016; Luehmann, 2016; Mensah, 2016; Siry & Martin, 2010). PAR as pedagogy requires students to ask and analyze questions. Specifically, in our science methods course, it allows us to forefront these ideas and concerns to lead our learning.

Multiple Ways of Be(com)ing a Science Teacher

Not only did students' conceptualizations of science change throughout the course, but their views of themselves as science teachers changed as well. Seeing multiple ways of being a science teacher provided ideas for each student to take and grow with as they continue on their own journeys as teachers.

Different ways of viewing science teaching were evident in the end-of-course reflections. As Ally stated, “After the course I feel extremely prepared to teach my own science class.” Susan’s reflection acknowledges seeing a different way to teach science and, therefore, more for her to consider as she continues on her journey as a teacher: “Before the course, I thought that I knew everything there was to teaching science. And that it was easy. Now I realize that there are so many aspects to teaching science that I wasn’t aware of.” Different ways of being a science teacher were shown through activities such as acknowledging their personal experiences and ideas about science, watching different teachers in various grade levels teach science (via video), providing multiple templates for planning, and sharing various ways to teach different science content. Reflecting on her time in the course, McKenzie said,

Before this course, science scared and intimidated me. I didn’t care for science and tended to think that it was boring. I felt that science was overwhelming and was not interested in teaching it. After this course, WOW! I feel that my eyes have been opened to the world of science! I can’t wait to be creative and teach amazing science lessons! Now, I find science so interesting and definitely want to teach it.

Each of these students entered the course with various conceptualizations of science and themselves as science teachers, and each left the course with changed—but still different—ideas about science teaching and themselves as science teachers.

Lessons Learned

It was clear that the cocreation process supported students. As one student said when leaving the first class, “We’d much rather a teacher ask us what we want to do than just tell us.” However, the cocreation process was not without challenges. This course is required in the teacher education program, meaning that there were certain standards in place and two assignments that could not be changed. In other words, there were still prescribed ways of becoming elementary science teachers that we had to work with. As the instructor, I was challenged to provide various resources, content, and ideas for all the students’ questions, expectations, and goals. I was, of course, limited by my own experiences, knowledge, and access to resources for different ways of teaching science. It was a constant struggle between talking too much about my ideas of teaching science and leaving discussions open so that students could have a space to discuss what science teaching means to them. I also kept a journal during this class and found it helpful to reflect on my own practices, challenges, and the insights that I was gaining as an instructor.

During the course, students were hesitant to suggest changes to the syllabus. Teaching and learning with PAR is different from traditional courses in which the curriculum is not often questioned. Within the first few weeks, I noticed that students were struggling to complete the assigned readings. During the next class, we discussed why and what we should change. We took out some readings and moved some to occur during class. In future courses, I would like to allow students more say in choosing what articles to read. I thought that providing options of readings would help; however, by doing that, I was still making specific choices and missing the opportunity to involve the students more. The second modification to the syllabus came from the students. As the deadline for the unit plan was approaching, the students brought up being overwhelmed with assignments and unsure how they would be able to get everything completed. Initially, they brought this up to ask if I could review the information about the unit plan expectation. In talking about this, we decided to change from groups of two to groups of three. These changes—readings and group unit planning—were the only ones made to the syllabus sent to students after the first class.

Thinking through the lessons learned using PAR as pedagogy, the class journeys timeline, weekly focus questions, and the reflection prompts helped us focus on the analysis of our questions. These practices provided a consistent time to reflect, individually and as a class, on our questions about science and science teaching. Creating a timeline that could be rearranged was done to encourage students to continue moving items around as a form of analysis.

Where to Start?

It can seem daunting to completely throw out a syllabus and allow students to choose questions, topics, assignments, grading, etc.—not to mention scheduling time to reflect and analyze their questions. As described above, planning will need to be done, and outside resources may need to be acquired from various people and places. Small steps, such as those listed below, can be taken to open up teacher education classrooms and to support difference in becoming rather than similarity in identity.

- Before or during the first class, allow students to list questions and things they want to know about the subject area.
- Provide opportunities for students to check in about the syllabus in case they are not used to bringing up suggestions or concerns to an instructor.
- With a larger class, think of ways for students to share individually and in small groups to help with large-group discussion time. Have students only share one question or goal before accepting a second idea.
- Consider posing questions that prompt students to think about their experiences in science and how they envision themselves teaching science. Use these questions throughout to focus discussions on equity in science.

- Let these questions guide the class and return to them often to get students' ideas and thinking about them. Use your knowledge as a science teacher educator to suggest possible assignment ideas that tie to or challenge students' questions or topics.
- Keep a journal to reflect on how you are suggesting or mandating assignments. Check in with students periodically regarding their thoughts on assignments and course activities.
- If using PAR as pedagogy, make sure to discuss research goals and questions (these will be specific to the class and their concerns) with students and give them opportunities to analyze data as the class continues.
- Think about ways in which you can show and support multiple ways of teaching. This can be done by offering choices in assignments and texts and showing a variety of examples. The various methods, planning documents, frameworks, and ideals will support students' different ways of thinking about themselves as teachers.

Discussion and Reflections

> I loved being able to design a class to fit my and our class's needs. In education, we are taught to differentiate in accordance to our students' needs. I felt this course perfectly modeled that. *In this course, I was valued as not only a student but also an adult and future educator*. I enjoyed learning and took ownership in this course because of the way the course was designed.
>
> —Anna

Using PAR in a methods classroom allowed for different experiences to be brought in as students became an active part of creating the course and analyzing how their thinking about themselves as science teachers changed throughout. This constant questioning and relationship of open communication and suggestions gave them, as Anna said, ownership of the learning and provided an example of "differentiation"—things they are told to do in their classrooms with their students. Students' personal experiences were centered, making the course relevant to their needs. PAR as a process is one in which relationships are centered, thus providing opportunities within classrooms to shift traditional power relations (Brydon-Miller & Maguire, 2009).

Thinking about how cocreation supported and challenged us as science teachers, PAR as a pedagogy, as used in this course, did not assume one type of science teacher; rather, the structure of PAR encouraged each person to think for herself and share her ideas of what being or becoming a science teacher meant. It is because of this structure and setup of the course that we, instructor and students, collaborated to create a course that addressed each

students' shared concerns and ideas. To further support this, we embraced tensions and challenges through using various "technologies of the self" (Martin et al., 1988) by constantly reflecting individually and participating in discussions as a group. PAR as pedagogy allowed students—those who felt confident and excited to teach science and those who felt anxious and nervous about it—to bring their experiences and realities into the center of the course (Emdin, 2016). Reflecting and discussing these experiences supported teachers in their development of who they are as science teachers (Avraamidou, 2014; Mensah, 2016).

This experience proved to be community building while providing students a space to question, reflect, and grow in their ideas about themselves as science teachers. Although community, choice, and being heard as a future educator were general themes of experiencing PAR as pedagogy, students also shared how they viewed themselves as science teachers differently throughout the course. Conceptualizations of what science is and who they are—and want to be—as science teachers constantly shifted throughout the course. At the end of the course, students shared common ideas surrounding their interest in and desire to continue growing as a science teacher, recognizing that the way they once thought about science and teaching science had changed.

Using PAR as a pedagogy in methods courses may, as we learned, provide a greater opportunity for community building and create a space where students feel okay to ask questions, suggest changes, and reflect on their own teaching and learning in the process. By cocreating and consistently reflecting on our experiences in science education, we were able to grow towards places individually while recognizing the importance of community in our continued growth as science teachers.

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