Board 164: Engineering Interventions in My Science Classroom: What's My Role?

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Engineering Interventions in My Science Classroom: What's My Role? (WIP)

Abstract

This work in progress paper draws on data from year one of a multi-year project aimed at integrating engineering into middle-school science classes. The expectation that middle school teachers integrate engineering into their science curriculum may be challenging as engineering-related content has not historically been part of teacher preparation. Particularly in rural areas, in-service teacher training related to engineering may be absent or difficult to access due to proximity or financial or time costs. Therefore, it is important to develop effective professional development (PD) that works within the actual teaching context and makes few demands on teachers beyond their regular workload. In partnership with teachers and local industry workers in rural and Appalachian areas, the Virginia Tech Partnering with Educators and Engineers in Rural Schools (VT-PEERS) project developed extended classroom engineering activities for students that also served as teacher PD related to teaching engineering in locally relevant ways. As part of this work, a qualitative analysis was conducted to understand how teachers, from their perspectives, envisioned their role during the interventions. Data were collected prior to and after interventions (within an academic year) to further understand if, and if so, how, teacher perspectives of their role changed. Results reveal three initial roles; classroom manager, learner, helper, and unsure. The post intervention data revealed all teachers indicated being a "learner".

Introduction

This work in progress (WIP) paper draws on first year data from a multi-year program aimed at integrating engineering into middle-school science classes. Specifically, the data are related to teachers' perceived roles during engineering activities involving industry and university partners. The expectation that middle school teachers integrate engineering into their science curriculum may be challenging as engineering-related content has not historically been part of teacher preparation and there are no teaching licenses for teaching engineering (Katehi, Pearson, & Feder, 2009). Particularly in rural areas, in-service teacher training related to engineering may be absent or difficult to access due to proximity, financial, or time costs. The Virginia Tech Partnering with Educators and Engineers in Rural Schools (VT-PEERS) project partnered with local industry and teachers in rural and Appalachian areas to develop classroom engineering activities for students that also served as teacher professional development (PD) for teaching engineering in locally relevant ways. To support teacher PD related to engineering activities, it is important to understand teachers' envisioned roles to allow for improved in-situ PD.

Background

In this analysis we explored how teacher roles changed over the first year of the VT-PEERS project, which is described in greater detail elsewhere (Carrico, Grohs, Matusovich, Kirk, & Schilling, 2021; Grohs et al., 2020) but we offer an overview herein. VT-PEERS was a research and practice partnership to design and implement engineering activities in rural middle school science classes as a way to introduce and increase awareness of engineering and engineering careers to students and teachers. In addition to the student exposure to engineering a goal of the project was to build capacity for schools to sustainably integrate engineering skills and knowledge of diverse engineering related careers and educational pathways. As part of that second goal, this project served as in-situ PD for teachers in middle school classrooms.

The project partnered university researchers with teachers in three school districts and three industries for three years in rural Appalachian areas to provide in-class engineering activities aligned with science class learning objectives. Professional development (Desimone, 2009) and community building frameworks provided structure and a Design Based Research (DBR) approach (Brown, 1992) was used to guide all project phases, allowing for the intervention and professional development effectiveness to be evaluated and modified as informed by the study. A core feature of Desimone's (2009) conceptual framework for professional development is collective participation. For our project collective participation translates to teacher engagement in the engineering activities. Thus, understanding how teachers initially perceive their roles and expectations versus their as actual participation and experiences may aide intervention designers as they negotiate pre-intervention expectations.

Methods

As part of a larger project, the participants, settings, and methods are described in detail in Grohs, et al. (2020). For this WIP, open coding was used to examine qualitative interviews and the codes were then analyzed with Desimone's professional development model as a lens. Participants were nine sixth grade science teachers from three rural and Appalachian school systems who engaged in the first year of the VT-PEERS project. The participants were interviewed prior to the first intervention activity, at the end of the first academic year, observed during interventions, and asked to fill out an online questionnaire to capture their demographic information. The interviews lasted approximately 30-minutes. Pertinent questions for this analysis were: "What influenced your decision to participate in this project?"; What role(s) do you expect to have during this collaboration?"; "What role(s) do you expect other partners (Industry or University) to have?"

Through open coding (Miles, Huberman, & Saldana, 2014) we identified three categories of anticipated (planned) role expectations and actual roles. Role expectation was defined as "the teacher's preferred program responsibility" and included three categories: classroom manager, helper, and learner. The categories were based on verbatim wording in the transcripts. Classroom manager referred to teachers having and using their pedagogical content knowledge regarding their classrooms. Helpers indicated a desire to help in whatever ways needed and included a combination of jobs such as classroom manager or to review lesson plans for pedagogical content knowledge (e.g., timing and appropriateness of content for sixth grade). Finally, learners had a specific intent to learn more about engineering and to participate in the activities.

Results

Synthesis of the Role Expectation code yielded initial expectation categories (Miles et al., 2014) of "learners" (three), "helper" (three), "classroom management" (two), and "unsure" (one). Analysis of the post intervention data revealed that regardless of anticipated role, all participants reported being a "learner" and having an intention to be more active in teaching the engineering activities during the second year of the VT-PEERS program.

Classroom managers. Classroom managers specified their knowledge of managing a sixth-grade classroom while the University partners would have the engineering content knowledge. Classroom managers provided specificity of their role that was more confined than the helpers. For example, 32T2 stated,

> I always viewed this as when they come in, I would probably **take more of a backseat** and let them kind of do what they want. I feel like **I would be better served with just classroom management.** Just **keeping the students on task** because I know **the people that are coming in aren't necessarily trained in classroom management.**

Helper. Helpers indicated they were open to any assignments they were given. Helpers were unsure of their exact role, but were ready to help the University partner during the activities, to help group students into teams, or to help with the classroom logistics. The teachers included as helpers did not see their primary role as learning about the activities, though some indicated they wanted to know more about the activity so they could help.

Learners. The learners' key role expectation was to learn, from the University partners how to instruct the activities. For example, 22T1 initially thought her role would be "instead of a teacher, as a learner, more of a student". During the pre-interview, 11T1 indicated "**I hope that I can help them and I can learn too.** And, I'm always adapting. **I see something I like and I steal it**, and tweak it a little, and use it in another way. So, that's what I see my role as."

Post Year 1 Interviews. All participants commented on the advantage of being able to learn during the intervention. For example, 22T1, who was a learner, noted that what she learned was different than she originally thought,

> I thought my role was going to be, they teach me how to teach them [the students], instead of me learning how to lead them, leading them to find their answer on their own instead of just me telling them the answer.

Likewise, 32T2, who indicated a role of classroom manager, explained that her perceptions had changed and that she'd grown,

> Now that we've gotten a year under our belt, it's now, **I'm pushing to make sure this comes back** because **I've seen the dramatic results from it** all... **I think I've grown**. **I've changed through it all** and I know the kids did too. **I think my perceptions have all changed**, and how I feel about it, yes. I think it has all changed.

Conclusion and Future Work

Recall, the second goal of VT-PEERS was science teacher PD related to teaching engineering activities. Using Desimone's (2009) framework, collective participation is necessary for good PD which, Desimone posits can lead to increased teacher engineering knowledge and change in instruction. The quotes from year 1 post interviews suggest that teachers, as learners, may have gained confidence to teach engineering and plan to change their instruction in year 2. Importantly, none of the teachers indicated in their pre-interviews that they planned to continue teaching engineering activities, even though some indicated wanting to learn.

In conjunction with other findings from this study, we argue that possible explanations for the shift to becoming learners include recognizing that they have more engineering-related knowledge than originally believed and that engaging in the activities develops confidence in teaching engineering through practice. The latter is similar to the observed impact of leading STEM activities for elementary school students on high-schoolers and mentors who found themselves empowered to expand their roles from learners and take on more leadership roles (e.g., Battel, et. al. (2021), Mandala, et al. (2022)). In addition, recognizing that some teachers assumed their role to be different than a learner, suggests that a discussion on the importance of collective participation, framed in Desimone's framework, might enable additional learning sooner by the classroom managers and helpers.

The data presented in this paper is limited to the first year of a multi-year program and involved only sixth grade teachers. Future years of the program expanded to include seventh and eighth grade teachers. The results from this analysis can be used to analyze additional data gathered, assist with establishing expectations of teachers and their roles in engineering activities, and to help teachers reflect upon and realize their growth and ability to teach engineering activities at the middle school level.

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