Title:

Opportunities and Challenges of Facilitating Educators' Understanding and Use of the Next Generation Science Standards

Abstract:

This symposium will focus on five projects' professional development efforts to enhance educators' understanding and use of the Next Generation Science Standards (NGSS). Involving educators from preschool to middle school levels in diverse contexts, each project has worked in this problem space in different ways. Of central importance to all the projects is how the NGSS necessitate productive classroom discourse, but the projects differ on how to support educators to achieve "rich science talk." For example, an "assessment for learning" lens guides one group's work, while recognizing language and argument as epistemic tools is the driving conceptual framework for another. In this symposium, project leaders discuss the decisions and dilemmas of, and the lessons learned from, their work.

This highly interactive session includes brief introductions from each project followed by time for interaction with the projects' researchers and materials. Projects will bring materials such as scaffolds for collaborative instructional planning, a formative classroom observation tool to support teachers' use of productive classroom discourse, and examples of instructional units with 7 curricular features designed to support the vision of the NGSS. The session will culminate with time for crosstalk and discussion.

Proposal

Introduction

Across the globe educators are working to support learners in developing interest, skills and knowledge of science and engineering (Johnson & Mohr-Schroeder et al., 2020). In the United States, the Next Generation Science Standards (NGSS Lead States, 2013) offer a nuanced and sophisticated three-dimensional (3D) framework in which disciplinary content knowledge (ideas and theories), science and engineering

practices (habits of mind and ways of doing things) and cross-cutting concepts (foundational ideas that are interdisciplinary such as "patterns" and "cause and effect") are integrally linked. More than half of U.S. states have either adopted the NGSS whole cloth or developed similar standards that include the 3D framework (Kagubare, 2019), meaning that in many parts of the country practicing teachers need to learn how to use the 3D framework to guide their instructional decisions. As Nollmeyer & Bangert have stated, although "the three dimensions individually share similarities to previous standards ... the integration of these dimensions in the NGSS framework represents an epistemological shift" (2017, p. 22). Teacher learning that involves a foundational shift in epistemology is complex and multifaceted (da Jong & Ferguson-Hassler, 1996), and as members of the NARST community work to improve the science and engineering teaching and learning for the next generation, concerted efforts to support teacher learning to enact the vision of the NGSS are necessary (National Academies of Science, Engineering, & Medicine, 2015; Floden, Richmond & Andrews, 2017).

As described in a recent National Academies of Science, Engineering and Mathematics report, to teach in a way that is congruent with the NGSS, "teachers will need new knowledge of the ideas and practices in the disciplines of science, an understanding of instructional strategies that are consistent with the NGSS vision, and the skill to implement those strategies in their classrooms" (2015, p. 1-2). Engaging in science and engineering instruction is challenging at all grade levels (Hixson, Stohr, &

Hammer, 2013) and new standards, such as the NGSS, though they are intended to improve educational opportunities for learners, take time for educators to digest and utilize (Reiser, 2015). Thus we need many ideas and tools to support educators to engage in NGSS-aligned instruction.

Purpose of this Symposium

Given the many challenges of facilitating educators' understandings of the NGSS (Hanuscin & Zangori, 2016), the presenters for this symposium wish to engage in conversation about different ways to support educators work to cultivate learners' interest in and increased knowledge of and skill with science and engineering design (as well as positively impact student learning outcomes in other domains such as math and literacy).

As an organizing premise, presenters at this symposium will examine how their professional development projects approach and support educators' understanding and use of the Next Generation Science Standards. A key feature of the symposium will be that leaders of the projects will discuss (a) why they have made the decisions they have made regarding how to increase educators' understandings of the NGSS, (b) how they have dealt with the dilemmas they have faced, and also, (c) what they have found to be productive (with supporting evidence).

Description of the Projects:

This symposium brings together researchers involved in five different projects all aimed at increasing educators' knowledge, understanding and use of the NGSS and its three-dimensional vision for robust science and engineering design instruction. Spanning preschool to middle school in diverse contexts, each project has worked in this problem space in different ways. Below is an overview of the projects as well as brief descriptions of each with information about the particular materials each project team plans to discuss and share during the symposium.

Table 1. Overview of Projects (in grade-band order)

Project	Grade Level	Focus
1	PK-3rd Grade	Improving student outcomes via multi-layered professional development for NGSS-aligned instructional planning and enactment in early childhood contexts.
2	K – 2nd Grade	Improving classroom discourse to promote science, oral language and literacy development.
3	3rd – 5th Grade	Increasing educators' adaptive expertise through greater understanding of the epistemic complexity of science.
4	3rd - 5th Grade	Multi-dimensional assessment and instruction within professional learning communities.

5	Middle School	Development and in-depth examination of instructional, assessment and professional development materials in diverse middle school settings.

Detailed Description of the Projects

Project 1: Within a large-scale professional development effort, this project team has developed materials to facilitate early childhood (preschool - 3rd grade) educators' collaborative and in-depth work with the NGSS, particularly highlighting the interplay of the 3 dimensions of the NGSS. Early in their work with educators they reported that the 3D aspect of the NGSS was conceptually challenging for their participating teachers. Given this, they experimented with various tools and strategies such as lesson-planning templates with embedded questions and prompts. Although the resulting lesson plans were more robust and reflective of the NGSS than those collected prior to the PD, the project team was dissatisfied with the all-too-often perfunctory, check-the-boxes way in which many participants approached the templates. Thus, over the last several years the project team developed and implemented an instruction planning process involving collaborative small groups of educators. In essence the process consists of a set of idea mapping and instructional planning tools. Educators have responded energetically to the maps, tools and interactive process as they grappled with the NGSS performance expectations and planned instruction that has been both 3D in an NGSS sense and

accessible and engaging to the young learners with whom they work. As the project team moves toward scaling the work, they anticipate new challenges. In this session they will share examples of the tools and of the resulting instructional plans generated by groups of early childhood educators and discuss the anticipated challenges of scaling this instructional planning process.

Project 2: With a strong emphasis on increasing generative classroom discourse, this project team has developed materials to facilitate K-2 teachers' learning about and implementing NGSS-aligned instructional practices. In particular, the team has developed a formative observation tool that they use during online professional development (PD) and rounds of instructional coaching to support K-2 teachers in improving the science talk in their classrooms. The project's focus is on talk because young students make sense of phenomena through rich discussions where they are supported in engaging in the science and engineering practices, including disciplinary literacy practices. The results from the pilot testing of the PD suggest that teachers found it difficult to implement the types of science talk being promoted when they used curriculum materials that did not provide rich opportunities for student sensemaking. Project coaches had moderate success in using the formative observational tool to support teachers as they began to implement talk moves, but without the curricular resources, teachers made limited changes in their practice. In the second round of PD, the project's instructional coaches introduced project-designed curriculum materials to

teachers and gave them the option of using the materials in their teaching. Initial findings suggest that partnering the professional learning about productive science talk (PD and coaching) with NGSS-aligned curriculum materials allowed teachers more opportunities for rich science talk. In this session, project team members will provide an outline of their formative observation tool and examples of ways in which coaches used the tool to support teacher learning. In addition, they will provide examples of ways in which this system of resources led to instances of rich science talk.

Project 3: Project 3's team views the NGSS as focusing on the epistemic basis of science. With this perspective, the researchers involved in this project emphasize that language, argument, and dialogical interaction are epistemic tools that teachers can use to support students in learning. In this project, the aim of the professional learning opportunities is to help grades 3-5 teachers rethink the idea of a learning environment and engage in an argument-based inquiry approach. For this symposium, this project team will share some teacher questionnaires that they have developed to ascertain teachers' understandings of language and argument.

Project 4: This project, focused on grades 3-5, is working to better understand how to build and sustain the capacity of elementary science teachers to instruct and formatively assess students in ways that are aligned with contemporary science education frameworks and standards. In this project a group of teachers has co-designed a set of multidimensional assessments for classroom use. As part of this work,

the project team has found it crucial to support teachers in their knowledge of science content and practices, giving them the confidence to share ideas about assessment tasks with the whole team. Additionally, they have worked with teachers to shift their thinking from identifying interesting phenomena related to disciplinary core ideas to considering how to craft a task centered around an interesting phenomenon that requires students to use and show their knowledge in multiple dimensions. Finally, this team has found that teachers are enthusiastic about the task development work and that they see how it benefits their instruction. However, the project researchers have also found that there is a need for frequent reminders to the teachers involved to think from an assessment for learning lens rather than a strictly instructional lens. In the session, members of this team will share documents that they have used with teachers to guide the assessment development process. Attendees to the symposium will be able to access the project's online portal to view tasks under development as well.

Project 5: The fifth project's team has built upon the work of others to create and examine an 8 week online middle school level life science and engineering design curriculum. The curricular materials incorporate 7 key features Penuel & Reiser (2018) identified as being supportive of the *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012) which is foundational to the NGSS. The team has also engaged in an iterative process with educators in diverse contexts to create and refine a system of assessment and professional development materials to

facilitate productive use of the curricular materials. As described by Penuel & Reiser (2018), the 7 key features found in curricular materials that support the *Framework* are: 1. Three dimensional learning, 2. Central role for phenomena and design challenges, 3. Incremental sensemaking, 4. Coherence from the students' perspective, 5. Support for equitable participation, 6. Multiple opportunities for teachers to elicit and interpret student thinking, 7. Support for teacher learning. The project team will share the challenges and dilemmas they have encountered while working to realize these curricular features.

Plan for the Symposium

This highly interactive 90 minute session will include brief introductions from each project (total 25 min.) followed by 45 minutes for attendees to interact with the different project teams. If in person, attendees will be able to visit posters with more information about the projects and interact with materials project teams will have brought. If it is necessary to hold the symposium virtually, following the whole group introductory component, participants will be able to attend three different break out groups (15 minutes each) with the different project teams. In both scenarios, this break out time will be followed by discussant remarks (up to 10 min.) and time for questions, crosstalk and discussion with the whole group (10 min.)

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