

Recent reports on professional learning (NRC, 2015; National Academies of Sciences, Engineering and Medicine, 2015) and research (Garet et al, 2001) provide similar recommendations for supporting science teachers. Specifically, the NRC report *A Guide to Implementing the Next Generation Science Standards* (2015, p. 41-46) argues for the importance of learning opportunities for teachers that:

- Focus on specific content
- Connect to teachers' instructional practice
- Include active engagement
- Support collaboration
- Provide sufficient time
- Offer a coherent and ongoing system of support

These recommendations are fundamental to the design of the professional learning experiences in OpenSciEd. Because these professional learning experiences will be explicitly linked to teachers' middle school science curriculum, they will be grounded in the 3-dimensional learning goals in the curriculum and connected to teachers' classroom instruction. The enactment of the curriculum will offer an opportunity to support teacher learning and build capacity to transform classroom instruction.

Building on these recommendations, we have developed a set of design principles for professional learning for use in preparing teachers to enact the specific units in the OpenSciEd curriculum. In addition to the recommendations above, the design principles also take into consideration challenges to enacting NGSS curriculum that have been identified in recent research, such as teachers oversimplifying science practices or relabeling their current instruction as aligning with NGSS rather than engaging in instructional transformation (McNeill et al., 2017). The design principles also draw on recent research developing NGSS professional development experiences for teachers that offers guidance on how to design professional learning to support teachers in these ambitious learning goals for students (Marco-Bujosa et al. 2017; Reiser et al., 2017).

Threaded across the design principles, we consider issues related to equity to support all students in science as equitable instruction is integral to every teacher learning experience (NRC, 2012). These design principles will inform the development of a variety of professional learning experiences for teachers, including educative elements embedded within the curriculum, in-person professional development and online professional development. The goal is to develop a set of OpenSciEd resources to offer a coherent and ongoing system of support as teachers engage in this important work. This system of

support will prepare teachers with the practical elements of enacting a curriculum for the first time and provide a vision for the long-term goals of the OpenSciEd Project and the implementation of the NGSS and Framework.

- 1. Provide images of classroom instruction.** The professional learning experiences will use videos of classroom instruction and artifacts to illustrate what the curriculum looks like with a range of students. These images will highlight key aspects of the curriculum, such as the introduction of a phenomenon, or aspects that can be challenging for classroom instruction, such as engaging students in critique during argumentation. These images of instruction will support teachers in analyzing student ideas and thinking about best practices for their own students. This will allow teachers to visualize what the curriculum looks like in a classroom and think about how to use the materials to meet the needs of all of their students.
- 2. Offer the student perspective.** The professional learning experiences will provide teachers with opportunities to experience 3D science instruction from the student perspective, such as developing models using the particulate nature of matter to explain phenomena (e.g. smell traveling across a room) or analyzing data on the properties of substances to determine whether or not a chemical reaction occurred (e.g. a nail rusting). These activities will support teachers in considering implementation strengths and challenges that may occur in their classrooms and how to make science learning experiences more inclusive for all of their students.
- 3. Rethink approaches to science instruction.** The professional learning experiences will help teachers think critically about the shifts called for by the NGSS. For example, previous science curriculum may have included more teacher directed discourse, numerous hands-on activities without a coherent storyline, disconnected units or a lack of student sensemaking such as the science practices of modeling and explanation. Consequently, the professional learning experiences will highlight key aspects of the OpenSciEd curriculum such as the inclusion of the science practices, a focus on scientific phenomena, an inclusion of crosscutting concepts and a coherent storyline. They will support teachers in learning about the shift from *learning about* to *figuring out*, in which the science practices serve as a learning goal in themselves as students make sense of the natural world.

- 4. Encourage teacher reflection and application.** The professional learning experiences will support teacher reflection and application to their classrooms in relation to their previous teaching experiences, the needs of their students and their own professional learning trajectory. For example, teachers will be encouraged to think critically about how to enact the OpenSciEd curriculum to leverage students' cultural funds of knowledge and to meet the needs of their specific students. For example, a teacher with a large percentage of English Learners (ELs) in her/his classroom may include additional language supports such as modeling language expectations and encouraging peer talk before students begin writing individual scientific explanations.
  
- 5. Engage teachers in collaborative learning.** The professional learning experiences will encourage teachers to collaborate with each other, with other stakeholders within their school system (e.g. instructional leaders, coaches) and with the developers of OpenSciEd as the curriculum and professional learning materials are developed and revised for future learning. For example, teachers will work with others both in person and online as they share their experiences, successes and challenges implementing the curriculum with their students. These collaborative experiences will range from the practical (e.g. What do I need to know for Day 1?), to current challenges (e.g. How do I make the science ideas personally or culturally relevant to my students?) to more long-term goals (e.g. How do I develop a classroom culture that supports student sensemaking?).
  
- 6. Provide a coordinated system of support.** The professional learning experiences will be integrated with the teachers' implementation of the OpenSciEd curriculum to provide a coordinated and aligned system of ongoing support. The professional learning experiences, including in-person PD, online support, and educative elements within the curriculum will provide multiple avenues for teacher support around different goals. For example, the in-person PD will engage the teacher in student activities from the OpenSciEd units and provide teachers with samples of student work from the curriculum to analyze as they guide their learning about NGSS. The online support will be a collaborative space for discussion and reflection to address the teachers' needs during the school year as they are using the materials. The coordinated system will provide support for both the practical and the long-term vision of the OpenSciEd curriculum materials.

### References

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