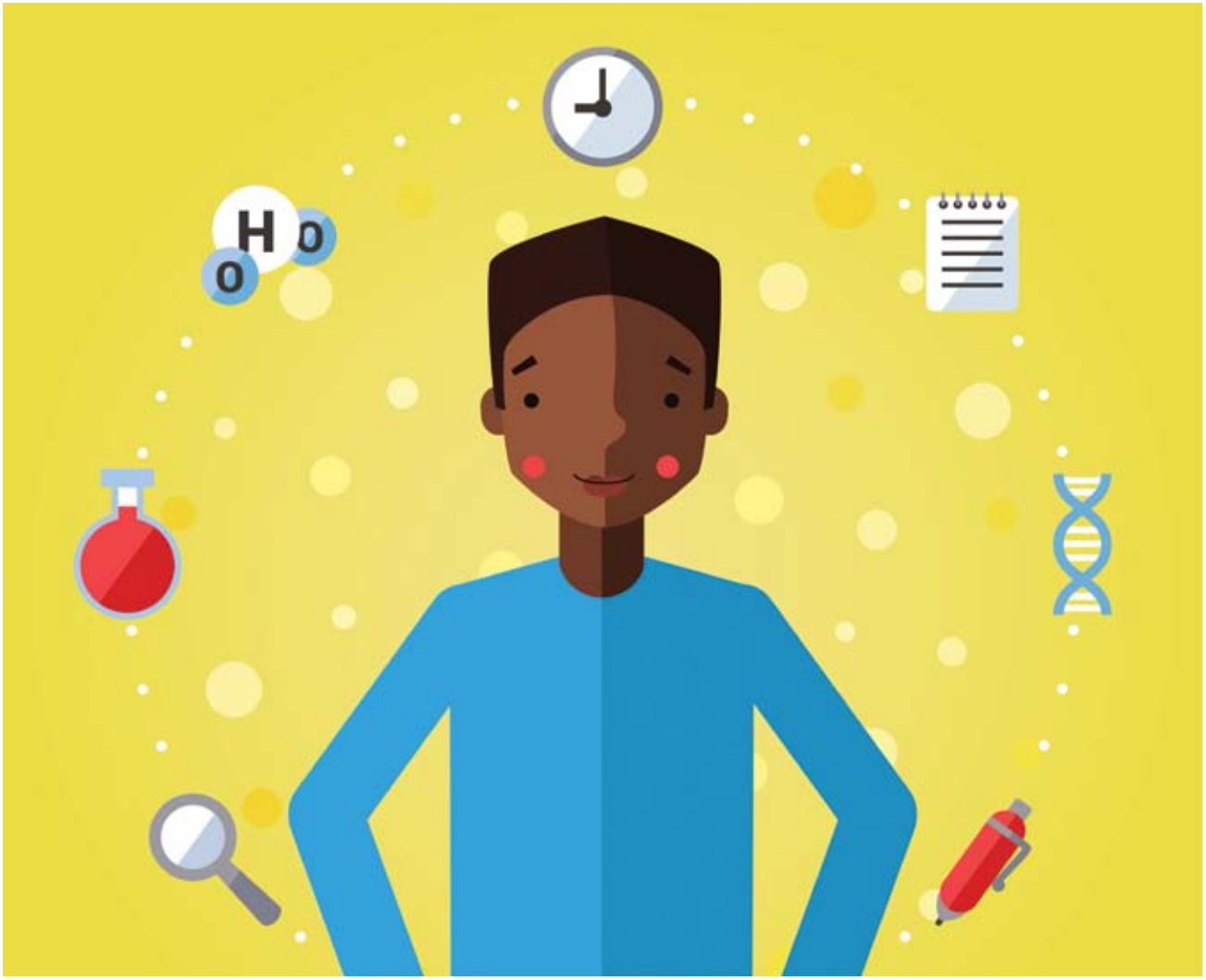
Learning About Learning in Science

PBL helps students see how knowledge is acquired and built upon

BY COREY NAGLE & JOHN PECORE



As we prepare our students for success now and in the future, we can begin by teaching them to explore and acquire knowledge, evaluate it to ensure it is sound, and share it.

In his TED Talk titled *A Visual History of Knowledge*, Manuel Lima describes how humans began organizing information and knowledge as a tree—a main trunk of knowledge with many branches *(www.ted.com/talks/manuel_lima_a_visual_history_of_human_knowledge)*. However, this view has changed as we have become

more connected. We now look at knowledge as a web or network of ideas flowing back and forth between contributors of information.

Our approaches to helping students acquire and construct knowledge should reflect this shift. Our goal as teachers is to make instruction relevant to our students now and into the future, preparing them to be both constructors and consumers of knowledge. Project-based learning (PBL) can help meet that goal.

PBL uses real-world, authentic questions or tasks to engage students in learning content and skills. PBL can provide opportunities for students to both acquire information and construct knowledge, even if the learning is about how knowledge is acquired!

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PBL and Science Inquiry

Despite decades of emphasis on teaching science inquiry, many teachers in middle level science classes still focus on students learning and using the scientific method, as if only one method exists. PBL can encourage students to practice 21st-century skills focused on finding, using, and building knowledge by experiencing how knowledge is acquired through science inquiry.

Improving students' understanding of how knowledge is constructed while teaching skills to become active learners is possible using a PBL unit with the anchoring question, "How do we know things?"

Learning About Learning

Martyn Shuttleworth's article, "History of the Scientific Method" *(https://explorable.com/history-of-the-scientific-method)*, can provide students with the context for the discussion of knowledge, both in general and specific to science. (The higher Lexile® level of this article may require scaffolding and modeling of reading strategies.)

Before assigning the article for student reading, divide it into five sections, each of which provides students with background information and impetus for investigation. As students read sections of the article, they are able to identify ways knowledge is acquired and constructed. Students are also able to practice methodologies for gaining knowledge and inquiry skills relevant to science content.

1. The first section describes how Plato's understanding of knowledge as pure reasoning was revolutionized by Aristotle's introduction of empirical measurement. This introduces a discussion of what students previously learned to be sound methods and measures in science. Students begin considering a specific question about science content, practicing how they may arrive at an answer through reason and then through basic experimentation.

2. Moving beyond basic empirical measures, students read about additions of the Muslim scholars in the form of controlled, repeated experiments and measurements along with the beginnings of a peer-review process. Students can revisit the question that they considered after reading the first section of the article, reinvestigating through the ideas presented by the Muslim scholars.

3. Students can revisit the science question after reading the third section of the article that focuses on contributions to science during the Renaissance. The discussion can include standardized systems of measurement, such as the metric system. Students can gain an appreciation for why standardized measurements are beneficial when learning and communicating with other scientists.

4. The fourth section of the article brings scientific practices into the 20th-century, including discussions of differences between the "hard sciences" and "pseudoscience." The background presented in this section can foster discussion about gaining information when an experimental method cannot be applied due to considerations, such as ethics and population variations, that do not provide for a true control group.

The discussions and practice stemming from this section

EXTRA! Check out a webinar with Alexis Martin & Shannon Zaret about Next Generation Science Standards at *www.amle.org/webinars/martin.*

of the article fit well with the crosscutting concept of modeling presented in the Next Generation Science Standards, which allows for revising our understanding as we gain new evidence.

5. After reading the fifth section of the article focused on the future of the scientific method, students can hypothesize how the method will change in the future and what will cause these changes. This section of the article can be supplemented with Manuel Lima's TED Talk. The article and TED Talk can help students visualize how we gain, share, and create knowledge in our lives.

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The example of tracing the history of scientific practice provides a structure for discussions and investigations centered on gaining knowledge. As each section of the article is read and discussed, the teacher can challenge the idea of a single method for gaining information in science and allow students to construct knowledge about processes for gaining and using information.

These activities allow the teacher to scaffold learning skills, literacy skills, and content skills necessary to meet expectations of the Common Core Standards and the Next Generation Science Standards.

Providing authentic opportunities for practicing skills centered on students' knowledge may provide long-term benefits as students set educational and life goals.

The Outcomes and Implications

This history-based PBL activity allows students to gain an appreciation of the thought processes used by scientists to gain knowledge. The reading and discussion of text can improve literacy skills, including academic vocabulary and reading comprehension. PBL unit design and implementation offers another student-centered pedagogical approach for improving student application of skills and understanding of content.

While this example focused on knowledge construction in science, similar approaches could be used in other subjects.

Social studies teachers may find a natural progression of using historical events to inform decisions and answer questions.

Following the progression of a writer's process or series of works may direct English language arts students' writing processes. Mathematics teachers may use an historical PBL approach to the mathematical thinking that resulted in the theorems and practices used to solve a variety of mathematics problems.

A Student-Centered Approach

As teachers and students, we can use the experiences of other scientists and scholars to better understand the processes of thinking that lead to knowledge acquisition and construction. Teachers can also benefit by improving the process of modeling and scaffolding skills that relate standards such as the Common Core Standards and the Next Generation Science Standards to the lives of students in a student-centered approach. AM

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