Using Adapted Primary Literature in the Science Classroom

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Scientific inquiry processes are important for students to understand, especially in an era where less than half of the news media, business leaders, and elected officials believe that scientists act in the public interest (Funk 2020). Understanding how researchers navigate hypotheses, design experiments, and replicate their findings to solve problems related to health, the environment, and basic natural history is essential to developing students and young adults who can make informed decisions. Understanding the scientific method is a cornerstone of the *NGSS* and aspects of it appear frequently in the science and engineering practices for both middle and high school curriculums (NGSS Lead States 2013). In addition, the College Board has emphasized the scientific method and experimental design in their AP course and exam redesign for both the AP Environmental Science and AP Biology curriculums in recent years (College Board).

Despite the importance of understanding how science is conducted, many teachers are not formally trained in scientific research practices—around 60% of public secondary school teachers hold any type of post-baccalaureate degree (Irwin et al. 2021; see chapter 2). It is hard for teachers without research experience to convey the importance of technical aspects of the scientific method like topic appropriate experimental design, replication and randomization, statistical analysis, and limiting confounding factors (Capps and Crawford 2013).

Teachers often rely on traditional methodology to teach students scientific inquiry processes through direct lecture, visual flow charts, and "cookie cutter" lab experiences that have students work through guided experiments in the classroom (Lustick 2009). Typically, labs guide students through the scientific method, but rarely leave room for trial and error or include time for the hypothesis-experimentation cycle that is essential to the Nature of Science (NOS). Students do not get to practice the critical thinking required to design experiments, or learn from failure if teachers are not trained to guide students through this process (Krim et al. 2019).

One option for teachers to impart knowledge about scientific inquiry and NOS is to expose students to more examples of scientific research that show students how science is conducted in the real world. Students could read peer-reviewed scientific journal articles which detail how science is conducted within the framework of scientific inquiry (Phillips and Norris 2009). Unfortunately, most peer-reviewed scientific journal articles are inaccessible for both teachers and students because of their complexity, specificity, jargon, statistical analysis, and technical details. This is in addition to being located behind subscription paywalls that many teachers and schools cannot afford to access.

A solution is to use peer-reviewed scientific journal articles that have been adapted to make them more understandable and accessible for both teachers and students, called adapted primary literature (APL). APL can be used successfully in many science classrooms to enhance scientific inquiry and NOS discussions (e.g., Norris et al. 2009), but creating true-to-science adaptations can be hard for teachers without training.

Fortunately, there are organizations whose missions are to create free APL resources for middle and high school teachers to use in their science classrooms. Science Journal for Kids (SJK) and Frontiers for Young Minds are just two examples of these types of organizations. Both work with original researchers to create adaptations understandable to both teachers and students, and ensure that each adaptation represents the research and results correctly.

To assess whether the use of APL actually enhanced student understanding of scientific inquiry processes, SJK conducted a controlled study in three different AP environmental science and biology classrooms across eight sections of students in 2017. Teachers used SJK article adaptations for the intervention treatment and used alternative print resources for the control treatment. All instruction included class or partner discussions of experimental design and importance of the science topic in general. To assess understanding of scientific inquiry processes following the lesson, teachers had students answer Free Response Question 1D from the 2003 AP Environmental Science Exam, which required students to design a controlled experiment to determine whether worms changed forest ecosystems. Teachers anonymized and graded responses based on the College Board published scoring guidelines. Results indicated that students scored significantly higher when exposed to SJK article adaptations in comparison to other print materials (Siegner and Dimitrova 2017).

There are also additional features of organizations that create APL that can

help students further understand scientific inquiry and make designing lesson plans around APL easier for teachers. For example, SJK also provides links to related lesson plans designed by SJK or found elsewhere on the internet (many of which are exploratory or inquiry related). On the SJK website teachers can also search for adaptations and lessons using *NGSS* standards, grade level, and topic. Another feature provided by SJK that helps students make connections between the scientific process and real research is video interviews with the researchers that allow students to see and hear directly from real scientists about their research. Frontiers for Young Minds, on the other hand, involves students in the process of creating adaptations, challenging students to understand scientific inquiry by providing direct feedback on those adaptations.

It is important to make real science more accessible to teachers and students in ways that will enhance understanding of scientific inquiry and the nature of science. In a world where 35% of people think that the scientific method can be used to "produce any result a researcher wants" (Funk 2020), it is essential that we teach scientific inquiry processes thoroughly in schools and work with students to show how they are used in the real world. Using APL is one way to do this, but many teachers who lack research backgrounds may be prevented from developing these resources themselves. That is why is it so important for organizations like SJK and Frontiers for Young Minds to develop free resources so that teachers can do their jobs more easily and help train a new generation of scientists.

ONLINE CONNECTIONS

Science Journal for Kids: *https://sciencejournalforkids.org/*

Frontiers for Young Minds: *https://kids.frontiersin.org/*

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