COMMENTARY

Significance and Challenges of Scientific Inquiry in Science Education

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"Crucial to science education is hands-on involvement: showing, not just telling; real experiments and field trips and not just 'virtual reality'".
-Martin Rees

ACCORDING to the U.S. National Research Council (1996), scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work; in science education, science inquiry activities are those conducted by students to develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. The Framework for K–12 Science Education advanced by the National Research Council (2012) outlines eight primary scientific inquiry practices of students: asking questions; developing and using models; planning and carrying out investigations; analysing and interpreting data; using mathematics and computational thinking; constructing explanations; engaging in argument from evidence; and obtaining, evaluating and communicating information. Certain researchers deem asking questions, gathering and interpreting evidence, and communicating explanations as the chief components of student scientific inquiry (Grigg et al., 2013).

The significant roles of scientific inquiry in science education have been widely recognized. First, it fosters students' critical thinking ability, enabling them to learn science through posing meaningful questions and finding answers by evaluating evidence, identifying patterns, and reasoning, rather than merely through memorizing scientific concepts. Second, it helps students cultivates problem-solving skills, which are essential for them to navigate complex real-world issues in a creative way and through trial-and-error processes. Third, it encourages active learning. In the process of inquiry, students do not receive information passively but instead, discover knowledge through investigation, experimentation, and exploration. This active engagement can significantly enhance their

comprehension and retention of knowledge. Fourth, scientific inquiry demonstrates how science research is truly played out. Through inquiry-based education, students gain a deeper understanding of the nature of science (Burgh & Nichols, 2012). Lastly, it is beneficial for students' development of communication and collaboration skills, because they typically work in groups in inquiry-based learning, designing experiments, sharing observations, and debating on findings.

Furthermore, it is noteworthy that the process of scientific inquiry must not be routinized. Having students complete fixed experimental steps is far from sufficient; rather, they should be encouraged to actively and carefully observe and reflect on the experimental processes. Burgh and Nichols (2012) emphasize the necessity of teaching students how to conduct systematic reasoning, formulate hypotheses, and analyze their thinking processes in science education, which is crucial for students' grasp of scientific knowledge and development of critical thinking, imagination, and creativity. Tang et al. (2010), through observations of real science classes, found that while step-by-step scientific inquiry is relatively easy for the teacher to manage, it tends to constrain the inquisitiveness of the students. This implies that science teachers should focus more on the essence of scientific inquiry and the cultivation of scientific thinking skills in students, rather than on the instruction of rigid, procedural experiment processes. Hence, adopting appropriate approaches to scientific inquiry in science education is a topic deserving in-depth research.

For successful enactment of scientific inquiry in science education, it is essential for the science teachers to develop a thorough understanding of it and a mastery of relevant skills. Exploring Pre-service Chemistry Teachers' Understanding of Scientific Inquiry Skills through the Chemistry Laboratory Course in this issue is an investigation of pre-service chemistry teachers' ability to incorporate key science inquiry skills in classroom activity design, using the method of action research. The study finds the teacher candidates paid a lot of attention to components like "defining the question or problem" and "planning and conducting research" but often neglect "making evidence-based explanations and producing solutions" and "evaluating and sharing knowledge." Also, it recommends providing pre-service teachers with more opportunities to design and implement teaching practices that explicitly target scientific inquiry skills, as well as encouraging them to reflect on and self-assess their application of these skills (Kabapınar et al., 2025). Despite its relatively small sample of only 16 participants, the study offers valuable implications for the training of scientific inquiry skills in pre-service teachers.

References

Burgh, G., & Nichols, K. I. M. (2012). The parallels between philosophical inquiry and scientific inquiry: Implications for science education. Educational Philosophy and Theory, 44(10), 1045-1059. DOI: https://doi.org/10.1111/j.1469-5812.2011.00751.x

Grigg, J., Kelly, K. A., Gamoran, A., & Borman, G. D. (2013). Effects of Two Scientific Inquiry Professional Development Interventions on Teaching Practice. Educational Evaluation and Policy Analysis, 35(1), 38-56. DOI: https://doi.org/10.3102/0162373712461851

Kabapınar, F., Tekin, D., & Tetik, S. (2025). Exploring Pre-service Chemistry Teachers' Understanding of Scientific Inquiry Skills through the Chemistry Laboratory Course. Science Insights Education Frontiers, 28(2): 4657-4673. DOI: https://doi.org/10.15354/sief.25.or794

National Research Council. (1996). National science education standards. Washington, DC: National Academies Press.

National Research Council. (2012). A framework for K–12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: National Academies Press.

Tang, X., Coffey, J. E., Elby, A., & Levin, D. M. (2010). The scientific method and scientific inquiry: Tensions in teaching and learning. Science education, 94(1), 29-47. DOI: https://doi.org/10.1002/sce.20366.

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