Challenges of teaching Scientific Inquiry Approach in Science laboratories of high schools in India: Case study of three schools in Delhi NCR

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Abstract: This study looks at the framework of K-12 Science Education embedded in the Next Generation Science Standards and provides a rationale about how the model emphasises and supports Inquiry in Science education. It also looks at the challenges of bringing Inquiry Approach in Laboratory investigations at the high School curriculum in India based on laboratory classroom observation, interviews of laboratory technicians and Science teachers of three schools. This paper summarises the challenges and looks at the implications of teacher education in the context of Scientific Inquiry.
Key words: Scientific Inquiry, Laboratory investigations, Next Generation Science Standards

Introduction

In the context of Inquiry teaching in science education it is important to understand the changes to science education required by the K-12 Framework(National Research Council, 2012) and the Next Generation Science Standards(Achieve2012). A major innovative shift has been done from teaching of Science as Inquiry to teaching science as practice.Chapter 3 of the NRC Framework provides a rationale both for what the practices are and their significance in the learning of science.

A list of the abilities to do scientific inquiry (National Research Council, 2000)
1. Identify questions that can be answered through scientific investigations
2. Design and conduct a scientific investigation
3.Use appropriate tools and techniques to gather, analyze and interpret scientific data
4.Develop descriptions, explanations, predictions and models using evidence
5.Think critically and logically to make the relationship between evidence and explanations
6. Recognize and analyze alternative explanations and predictions
7. Communicate scientific procedures and explanations
8. Use mathematics in all aspects of scientific enquiry

In a shift that is reflected in The set of scientific practices found in the Framework for K-12 Science Education
Scientific practices
1.Asking questions and defining problems
2.Developing and using models
3.Planning and carrying out investigations
4. Analyzing and interpreting data
5.Using mathematical and computational thinking
6.Constructing explanations and designing solutions
7.Engaging in argument from evidence
8.Obtaining, evaluating and communicating information

In order to understand why Science as a Practice is more viable and applicable, it is important to know how a scientist makes sense of the world and What is the Nature of Science.

While

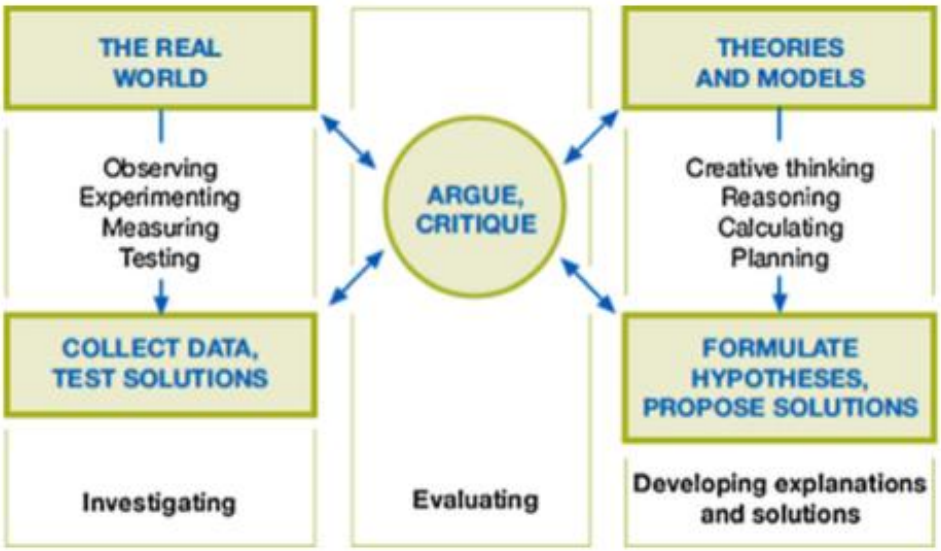

Fig. 1 A model of scientific activity; combining Klahr and Dunbar (1988) and Giere et al. (2006). This diagram was first published in Osborne (2011) and subsequently in the Framework for K-12 Science Education (NRC, 2012)

understanding the global framework is important, it is also necessary to contextualise Science Education in High Schools in the framework of National Curriculum. 'Criteria of Ideal Science Curriculum: What is the 'nature of science'? As we know, the physical world is explored and understood with the help of science….' NCF2005.
It further emphasises on cognitive validity as one of the purpose of Science Education in India. The laboratory manuals of grade11 and 12 Physics, chemistry and Biology mention teaching investigations as Inquiry.
science instruction in the secondary environment offers unique opportunities to capitalize on not only the growing capabilities of adolescent students, but their teachers' greater specialized expertise. Secondary teachers are trained in science as a discipline. They tend to have undergraduate degrees in discipline specific domains such as chemistry, biology, and physics. Their content knowledge allows them to model thinking and acting like a scientist in their discipline and affords an opportunity for supporting students in domain-specific inquiry.

Role of teachers in fostering Science as Inquiry:
1. Foster productive learning environments.

2. Promote active engagement based on connections to students' personal interests and career goals.

3. Develop requisite knowledge, skills, and dispositions necessary for science literacy and to support nascent science career choices.

4. Capitalize on learning progressions by revisiting earlier content in more depth.

5. Promote an inquiry and problem-based learning approach to science instruction.

6. Use assessments that focus on higher-order learning.

Methodology:

Descriptive method was used with qualitative analysis of the findings. The study was carried out in three steps:

1. Study of the laboratory manuals of grade XI and XII published by NCERT. The list of the experiments and scope of Inquiry based investigation was analysed.

2. Awareness of Teachers on Scientific Inquiry and Science as Practice was investigated through a set of questionnaire and semi structured interview.

Findings:

Under the domain of Content for laboratory investigations the challenges are:

1. Developing student's own ideas and curiosity,
2. Guiding children in designing valid experiments for their hypotheses,
3. Scaffolding data interpretation and discussion.

Under the domain of Teacher preparedness the challenges are:

1. Lack of clarity on the levels of Inquiry such as Structured Inquiry, Guided Inquiry and Open-ended inquiry
2. Incomplete understanding of hypothesis
3. lack of clarity in the difference between Scientific Method, Scientific Inquiry and Science as a Practice

Conclusion:

If we are to build our students' capacities to construct explanations, analyze and interpret data, develop models and engage in argument from evidence then it is necessary for teacher educator to have some plan of the structure they hope to build and its constituent elements. In order to achieve this it is recommended that:

1. Inservice workshops on Science as a Practice be organised for Science Teachers.

2. STEAM be introduced within the science curriculum.

This paper is a part of the detailed research work on the context of Scientific Inquiry in laboratory investigation.

References

1. https://www.phys.ksu.edu/ksuper/seminar/Osborne14%20-%20Teaching%20scientific%20practices%20Meeting%20the%20challenge%20of%20change.pdf

2. https://mhrd.gov.in/sites/upload_files/mhrd/files/Draft_NEP_2019_EN_Revised.pdf

3. http://egyankosh.ac.in/bitstream/123456789/46662/1/Unit-4.pdf

4. https://www.researchgate.net/publication/226608306_The_Challenges_of_Science_Inquiry_Teaching_for_Pre-Service_Teachers_in_Elementary_Classrooms_Difficulties_on_and_under_the_Scene

5. Ashbrook, P. (2008). Air is a substance. Science and Children, 46(4), 12-13.
Feher, E., and Rice, K. (2006).
6. Shadows and anti-images: Children's conceptions of light and
vision II. Science Education, 72(5), 637-649.

7. Consortium for Policy Research and Education. (2009). Learning progression in sci- ence: An evidence-based approach to reform. Prepared by T. Corcoran, F. Mosher, and A. Rogat. Center on Continuous Instructional Improvement. Teachers College- Columbia University. Available: http://www.cpre.org/images/stories/cpre_pdfs/lp_sci- ence_rr63.pdf.