Conceptual Article

Nature of Science' in B.El.Ed. Course

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Abstract

The degree course B.El.Ed. (Bachelor of Elementary Education) is a four year undergraduate programme in elementary teacher education. It is offered in nine constituents' colleges of University of Delhi. The programme is one of its kind in India and is listed as one of the innovative programmes in Position Paper 2.4, National Focus Group on Teacher Education for Curriculum Renewal, NCERT, 2005. The course structure of B.El.Ed. has two compulsory and one optional paper on pedagogy of science. The compulsory courses are titled 'Core Natural Science' and 'Pedagogy of Environment Studies'. The syllabi of 'Core Natural Science' just mentions 'Classification, Property, Concept, Relation, Law'. Is it sufficient for pre service teachers to understand what nature of science is? How is scientific knowledge created? Is science objective or subjective? How do scientists work? Is there something called 'A Scientific Method'? We asked B.El.Ed. students to explain in their own words 'What is Science?' An analysis of their definitions shows that they do not understand science and its nature. They have no recognition of the tentative nature of some scientific knowledge and hold outdated positivist or empiricist views of the NOS. In such a scenario how can they translate it to students? What should be done in pre service programmes, so that teachers develop the conception of nature of science? This paper attempts to answer such questions.

Keywords: *Bachelor of Elementary Education (B.El.Ed.); Nature of Science (NOS); Pre-service teacher education; Science pedagogy; Scientific knowledge; Teacher conceptions; Curriculum renewal; NCERT; Scientific method.*

Science teachers' knowledge about the nature of science was researched by Gallagher (1991). It was found from observation of science classes that teachers try to "cover" the content contained in the text; a strong emphasis on memorization of content and the vocabulary of science, with little emphasis on understanding of knowledge that is presented and application of scientific knowledge to students' experiences. Teachers have had no formal education in history, philosophy or sociology of science, nor has their scientific training provided them with much understanding of the processes by which scientific knowledge is formulated. Most of the teachers stressed the "steps of the scientific method" and the objectivity of scientific knowledge. For these teachers objectivity was an important distinction between science and other subjects like social studies, language. Science was portrayed as objective knowledge because it was grounded in observation and experiment, whereas the other school subjects were more subjective because they did not have benefits of experiment, and personal judgements. However, this belief about science was never put into practice. As the 'body of scientific knowledge' was the major focus of science study. The textbooks used by them in their classes tend to reinforce the role 'teacher as presenter of the factual content of science'.

He concluded that teachers placed most of their emphasis on the body of knowledge of science. Teachers. had limited understanding about how knowledge of science is formulated or validated. It was also found that both prospective and practicing secondary science teachers have a limited knowledge of the history and philosophy of science, because they have had very little opportunity to study these fields. There was overemphasis of the factual base of science in classrooms and failure to characterize scientific knowledge as tentative and scientific work as creative.

This research was conducted almost twenty years back. Science classrooms today are still the same!! Now, I come to teacher preparation course.

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Science' just mentions 'Classification, Property, Concept, Relation, Law'. Is it sufficient for pre service teachers to understand what nature of science is; How is scientific knowledge created? Is science objective or subjective? How do scientists work? Is there something called 'A Scientific Method'?

Pre Service Teachers' at Elementary Level: Understanding Of Science

We asked around 120 B.El.Ed. students to explain in their own words 'What is Science?' and also asked them to imagine how would a scientist look like and to draw a scientist.

First, let us see the analysis of their explanations of science. Their explanations have the following key words about science:

Science as Knowledge: Knowing about Truth and Facts, Study of phenomenon, Theories : Principles and Laws, and Field of study.

Science involves:

- Inquiry, Exploration, Logical reasoning, Problem solving, Explanation, Divergent thinking, Understanding
- Discovery, Inventions, Verification/ proof, investigation.
- Experimentation for Finding answers which has steps for collection of data, Hypothesis. formation, Interpretations, and Generalizations.
- It is 'A method / the Scientific Method'. Science is Objective.

Students' explanations have comments like 'science is experimentation', 'Scientists do experiments to find answer', 'science involves scientific method', 'Science is objective', 'Science has theories and laws to explain the world around', 'Science is the study of phenomena', 'Science involves logical reasoning and problem solving'.

There was not a single case which conveyed the fluid nature of scientific inquiry and the diversity of methods employed by practicing scientists. Approximately 65% of respondents explained science as a study of the world.

Perception of Scientists:

The drawings of scientists have the following characteristics:

Only 37% have drawn female scientists, in spite of explicit discussion on female scientists like Kalpna Chawla, Madam Currie, and Rosalind Franklin. Their drawings showed scientists wearing laboratory coat (44%), spectacles (78%) and having beard (44%) in case of

male scientists. Scientists were shown working with materials like test tubes, beakers, tables, and books (70%). Scientists were working indoors in laboratory (70%) and in isolation (100%), doing some kind of manipulative procedures (70%). Only 4% of scientists were shown as if they were thinking. These pictures are similar to the pictures of scientists drawn by children of all ages and across nations which portrayed scientists as bespectacled, rigid man in white laboratory coat, working alone with test tubes in completely haphazard laboratories. There was not a single case which conveyed the fluid nature of scientific inquiry and the diversity of methods employed by practicing scientists. This indicates a limited student engagement with science to daily realistic field work, promoting instead the well-regulated laboratory activity.

However, scientists, both men and women, are as human as rest of us. And they come from all races with and without spectacles. Their size, appearance, and hairstyle vary. As a group, because their methodology focuses so specifically on fallibility and critical thinking, they are probable even more aware than rest of us of how easy it is to be going wrong. There appears to be a limited understanding of scientists working creatively, in collaboration and with imagination to generate explanations of the world in which we live.

These results are consistent with the researches done on students and pre service teachers across different cultures. Some of the researches are- Newton and Newton (1992 and 1998), Haidar (1999), Abell and Smith 1994), Solomon et al. (1996), Song and Kim (1999), Ryder, Leach and Driver, 1999), Moss et al. (2001), Rubin et al. (2003), Abd-El -Khallick et al. (2004), and Kang and Lin (2005).

Pre service teachers do not understand science and its nature, then how can they translate it to school students? It is obvious that teachers cannot possibly teach that they do not understand. To be able to convey to their students adequate nature of science conceptions, teachers should themselves possess informed conceptions of the scientific enterprise. Many science teachers themselves are the products of an education system which has largely ignored the epistemic base and nature of its own disciplines. Thus teachers have no recognition of the tentative nature of some scientific knowledge and hold outdated positivist or empiricist views of the NOS. What should be done in pre service programmes, so that teachers develop the conception of nature of science?

How 'NOS' should be addressed in Pre- Service Teacher Programmes?

The international reforms in Science Education - National Science Education Standards (NRC, 1996) and Benchmarks for Scientific Literacy (American Association for Advancement of Science, 1993) and National Reforms- National Curriculum Framework and Position Paper on Science Education emphasize that teacher of all grade levels are being required to teach their students to develop appropriate views of 'Nature of Science'.

An understanding of the nature of science is taught and learnt implicitly. The first step is to improve pre service teachers' conceptions of NOS (Content) and second, they should be able to translate those conceptions into forms that are accessible to all students (Pedagogy). Akerson and Abd-El-Khalick (2003) found that pre service teachers needed support in their endeavors to translate their new views to students. Pedagogical content knowledge (PCK) is a special kind of knowledge of content that allows teachers to represent the content in ways that are ::attainable by their students. Thus, science teacher educations need to find ways to help elementary teachers develop informed views of NOS, motivation and intention to teach NOS, and translate their views into classroom practice.

Two general approaches are used to improve science teachers' conceptions of NOS - Implicit and Explicit approach. The implicit approach suggests that an understanding of nature of science is a learning outcome that can be facilitated through science process skills instruction, science content course work and doing science; Researches who adopted this implicit approach used science process skills instruction and / or scientific inquiry activities (Barufaldi, Bethel and Lamb, (1977), Riley, (1979). The second approach is explicit in which elements from history and philosophy of science were used in instruction which geared toward the various aspects of nature of science to improve science teachers' conceptions.

It cannot be over emphasized that the above distinction should not be taken to mean that implicit and explicit approaches differ in terms of "kind". That is, not every science process-skills instructional sequence or scientific inquiry activity is an implicit attempt to enhance learners' conceptions of nature of science, nor is every instructional sequence in history of science an explicit attempt to achieve that end. The basic difference between implicit and explicit approaches lies in the extent to which learners are helped to come to grips with the concept - NOS, which would enable them to think about and reflect on the activities in which they are engaged.

Recent studies (Abd-El-Khalick, 2001; Akerson et al., 2000) indicated that using an explicit reflective approach to help elementary teachers achieve informed NOS views might be even more effective, especially if such an approach was undertaken from within a conceptual change framework. Explicit instruction refers to drawing the learner's attention to key aspects of NOS through discussion and written work following activities in which they are engaged. Reflective instruction requires learners to think about how their work illustrates NOS, and how their inquiries are similar to or different from the work of scientists. Teachers can periodically ask their students to take "time out" to "step back" and analyse the knowledge which they have been asked to learn. Such classroom discussions may prove to be invaluable with respect to the development of students' conceptions of the nature of scientific knowledge.

In the research by Khishfe and Lederman {2006) two sections of ninth grade students were randomly assigned to the two treatments: integrated and non-integrated NOS instruction. In the integrated approach, NOS was taught in relation to the regular science content about global warming. Explicit reflective discussions about NOS aspects followed and were related to the science lessons about global warming. Thus, NOS was embedded within the science content. In the non-integrated group, the teaching of the science content and NOS was separate. NOS was taught by engaging students in several generic, non-content embedded activities. NOS instruction was followed by instruction about global warming. However, the overall results do not provide any conclusive evidence to favour one approach over the other. The results merely highlight the relative effectiveness of both approaches in enhancing NOS understanding. There do not exist clearly evidence of one approach better that the other. Thus, the teacher education programme should prepare teachers to make a choice of an approach according to her own classroom context.

Pre-service teachers also should be required to teach during their internship (Practice teaching) target aspects of NOS in the context of c3:n _elementary, classroom to: (a) provide an experience to allow pre-service teachers on which to reflect about teaching NOS to children; and (b) solidify their own understandings of the target NOS aspects in the context in which they will be applying these notions.·

The crucial translation of pre service teachers' conceptions of the NOS into classroom practice needs to be reinforced by the culture of teacher preparation. Pre service teachers should be given much more extensive experience in teaching and assessing the NOS. They need

support in their field experiences. Extensive efforts should be made to help pre service teachers avoid the apparent tendency to think that the NOS can be taught implicitly through student participation in classroom activities. Pre service teachers need knowledge of the nature of science, but they also need to engage in an articulation and exploration of their developing beliefs about teaching itself. Teacher education programmes must strive to ensure that pre service teachers are given the opportunity to reflect in context on how and why they teach in certain ways and where they experience tensions in their overall development. Encouraging this kind of reflection at the formative stage of pre service teachers' beliefs is more likely to ensure that a productive accord between beliefs and the pedagogical implications of ideas about the nature of science is established.

Once teachers have internalized the importance of the nature of science and their intentions to address the topic are firmly in place, both beginning and experienced teachers will need to develop the instructional skills and abilities necessary to transform their knowledge into classroom practice. However, beginning teachers first, need support for developing a wide variety of instructional routines and schemes for classroom management and organization. As classroom management has been a perennial concern. of beginning teachers. And later, the focus should be on specific instructional approach that can be used to influence student's conceptions of science.

It is likely that in schools the 'coverage of content', will need to be reconsidered to allow ample time to integrate this complex activity into ones teaching throughout the year and across grade levels. This work ideally would begin in teacher preparation programmes. Our aim is to integrate nature of science activities throughout our pre service programme. In doing so, we hope it would then become an integral facet of science instruction for all new teachers.

Therefore, a major test for elementary science teacher educators is to improve elementary teachers understanding of NOS so that they can help their own students develop appropriate ideas. Science teacher educators must redouble their efforts to help future teachers first to help them understand the nature of science and then equip them of the ways to translate their understanding in the classroom context. Our teacher education programme should focus on questions such as-

How can we adequately prepare classroom teachers with an understanding of the nature of science that they can use to design effective classroom activities? How can we encourage

teachers to view teaching the nature of science as important in their own classrooms? How can we enhance their self-efficacy in this area?

There is a need for supporting pre service teachers who have appropriate NOS conceptions and intentions to teach NOS to their students, by helping them:

- Recognize opportunities to teach NOS explicitly in a variety of content areas Contextualize in teaching practice - planning to teach NOS explicitly.
- Sharing case studies of explicit NOS instruction (via video or text or modelled· lessons).

A strong grounding for teachers and students in the science curriculum is required. The idea is that individual's intentions and beliefs play an important role in the translation of knowledge into observable behaviours. Thus, more assessment weightage should be allocated for the nature of science in pedagogy courses and school based internship practicum, which itself reinforce focus on 'Nature of Science'.

REFERENCE

* Abd-El-Khalick, F. (2001) Embedding Nature of Science Instruction in Pre service Elementary Science Courses: Abandoning Scientism, but .... Journal of Science Teacher Education, 12, 3 215 - 233.
* Abd-El-Khalick, F. and Akerson, V.L. (2004) Learning as Conceptual Change: Factors Mediating the Development of Pre-service Elementary Teachers' Views of Nature of Science, Science Education, 88, 785-810.
* Abell, S.K. and Smith, D.C. (1994) What is Science?: Preservice elementary teachers' conceptions of the nature of science. International Journal of Science Education, 16, 4, 475 - 487.
* Akerson, V.L. and Abd-El-Khalick, F. (2003) Teaching Elements of Nature of Science: A Yearlong Case study of a Fourth Grade Teacher. Journal of Research in Science Teaching, 40, 10, 1025-1049.
* Akerson, V.L., Abd-El-Khalick, F. and Lederman, N.G. (2000) Influence of a Relative Explicit Activity-Based Approach on Elementary Teachers' Conceptions of Nature of Science. Journal of Research in Science Teaching, 37, 4, 295-317.

* Barufaldi, J.P., Bethel, L.J. and Lamb, W.G. (1977). The Effect of a Science Methods course on the Philosophical View of Science among Elementary Education Majors. Journal of Research in Science Teaching, 14, 289-294.
* Gallagher, J.J. (1991) Prospective and Practicing Secondary School Science Teachers' Knowledge and Beliefs about the Philosophy of Science: Science Education, 75, 1, 121-133.
* Haidar, A.H. (1999). Emirates pre service and in service teaches' views about the nature of science. International Journal of Science Education, Vol. 21(8), pp. 807- 822.
* Kang, Scharmann, C., Noh, (2005) Examining students' views on the Nature of Science: Results from Korean 6th, 8th and 10th Graders. Science Education, 89, 314-334.
* Lederman, N. and Khishfe, R. (2006) Teaching Nature of Science within a Controversial Topic: Integrated versus Non-integrated. Journal of Research in Science Teaching, 43, 4, 395-418.
* Riely, J.P.II. (1979). The Influence of Hands-on Science Process Training on Pre-service Teachers' Acquisition of Process Skills and Attitu.de toward Science and Science Teaching. Journal of Research in Science Teaching, 16, 373-384.
* Newton, D.P. and Newton, L.D. (1992) Young Children's Perceptions of Science and the Scientist. International Journal in Science Education, 14, 3, 331-348"
* Newton, L.D. and Newton, D.P. (1998) Primary Children's Conceptions of Science and the Scientist: Is the Impact of a National Curriculum Breaking down the Stereotype? International Journal in Science Education, 20, 9, 1137-1149.
* Solomon, J., Scott, L. and Duveen, J.(1996) Large scale Exploration of Pupils' Understanding of the Nature of Science. Science Education, 80 (5), 493-508.
* Song, J. and Kim, K.(1999) How Korean students see scientists : the images of the scientist. International Journal of Science Education, Vol. 21 (9), pp. 957-977.
* Ryder, J. and Leach, and Driver, {1999), Undergraduate Science Students' Images of science. 36, 2, 201-219.
* Moss, D.M., Abrams E.D. and Robbit (2001), Examining student Conceptions of the Nature of Science. International Journal of Science Education, Vol.23, No.8, 771- 790.