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Discussion

Science Education: Issues, Approaches and Challenges

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Abstract

In today's global education system, science education is much more than fact-based knowledge. Science education becomes meaningless and incomprehensible for learners, if the learners are unable to relate it with their lives. It is thus recommended that Pakistan, like many other countries worldwide should adopt Science Technology Society (STS) approach for delivery of science education. The purpose of the STS approach lies in developing scientifically literate citizens who can make conscious decisions about the socio-scientific issues that impact their lives. The challenges in adopting this approach for Pakistan lie in four areas that will completely need to be revamped according to STS approach. These areas include: the examination system; science textbooks; science teacher education programs; and available resources and school facilities.

Keywords: hands on learning, Pakistan's national science curriculum, science education, Science Technology Society (STS) approach

Science is generally considered as the study of facts related to natural and material world. Modern era; however, has brought a shift in the views about science education from objective fact based knowledge to practical activity which caters to the learners' skills, attitude, and values along with understanding (Donnelly & Jenkins, 2001). Pakistan's National Science Curriculum (2006) states the purpose of science education, which covers all dimensions, including human and philosophical significance, scientific significance, and personal significance (Ratcliffe, 1998). Yet, in practice it is very difficult to keep a balance between all these goals due to the dilemmas associated with science education in Pakistan. In this article,

the purpose and issues of current science education in Pakistan are discussed along with the needs and emergence of Science Technology and Society (STS) approach in the light of literature. Further, the critical discussion would highlight some implications and recommendations for the successful implementation of STS in the future.

Science is the amalgam of cognitive activities that include emotional engagement and practical experiences. However, there are many issues which influence learners' perceptions and practices about science education in Pakistan. First, is the nature of science textbooks, which overemphasizes on factual information and lack personal relevance and appeal for students. Osborne and Collins' (2001) study shows that due to the intangible entities, abstract concepts, and scientific language in science textbooks, science appears to be a difficult and boring subject for students. They do not see any connection of this subject with their social and personal life, hence they get disinterested in the subject. Another issue in the traditional science classroom is the teacher's dominance. A teacher is considered as the sole source of knowledge, having a responsibility to transmit the same to students (Tobin & McRrobbie, 1997). As a result, students hardly see any autonomy in science classrooms. Further, traditional teachers consider the fundamental knowledge and skills important for students' future career and therefore, prefer to use traditional teaching approaches to transfer the required knowledge. Then there is the high stake examination system that has a dominant influence on teachers' practices and thus permits them to maintain control on task completion, content delivery and coverage, and transmission of facts. On the other hand, public examination limits teachers' freedom and authority for the content selection and delivery. Teachers are pressurized to cover the entire content in a limited time at the cost of students' enjoyment and learning. The fourth aspect is the extent and nature of practical work in a science classroom.

Many studies emphasize on hands-on and minds-on activities in science classroom to provide a wide range of scientific skills from basic mathematical calculations to more analytical skills (Bekalo & Welford, 2000; Osborne & Collins, 2001; Watts, 1991).

Wallace and Loudon (2002) raise the importance of practical work to be authentic in order to bridge the gap between school science and real science. However, usually updated teaching techniques in school laboratories are very limited and specifically reduced to a set of routine exercises of pre-decided answers (Donnelly & Jenkins, 2001; Zin, 2003). The reasons of limited scope and frequency of this practical work are based on the teachers' own skills in designing and conducting inquiry tasks and examination requirements that focus on set steps given in prescribed books. Practical work is considered as second priority in schools due to its time consuming nature, less weightage given in overall exams, and large classes with limited equipment.

The above stated issues of traditional science teaching raise a demand of science education reform in Pakistan. There is a shift needed in science education from scientist focused curriculum to learner focused by changing socially isolated content to interesting, engaging, and relevant content. Science Technology Society (STS) approach has potential to make science relevant and practical for students as its vision is rooted in the notion of developing a scientifically literate citizenry which can take comfortable decisions about the socio-scientific issues that impact on their lives. It targets science education for all children and not specifically for future scientists (Rennie, Goodrum & Hackling, 2001).

Pedretti and Hodson (1995) broadly categorize the goals of the STS approach into two areas: personalization of learning and politicization of science education. Personalization goal of STS emphasizes on constructive philosophy of learning, which focuses on learners' own experiences. This relation of school science with learners' life makes learning meaningful and easy by linking new ideas with existing concepts and by applying learning in the new situation (Gabel, 1998). On the other hand, the politicization aspect of STS focuses on social enterprise, where students get the opportunity and freedom to play their role in society. The literature suggests many instructional techniques for STS teaching, like simulation, cooperative action project, debates, small group discussion, role play, survey, case studies, oral presentations, and written reports (Aikenhead,

1994; Hodson, 2003; Oulton, Dillan & Grace, 2004). Students' involvement and actions during learning process result in improvement of students' knowledge, higher order skills, attitude towards science, process skills, and ability to apply concept in new situation and creativity (Hodson, 2003; Oulton, Dillan & Grace, 2004; Pedretti, 1996; Siegel, 2006; Yager, 1995; Zin, 2003). This reflects the goal of holistic development of a child rather than that of impacting merely on cognitive aspect.

Besides diversified learning outcomes for students, STS approach has many challenges that make its implementation difficult, for example, the nature of STS encourages alteration of instructions and content whenever required. One argument supports this alteration to make science more relevant and interesting, but the other argument could raise questions of its importance at the cost of precious time and opportunity needed for the study of pure science concepts (Altschuld & Kumar, 2000). Also, flexibility is needed in the STS curriculum to focus more on local issues (Hodson, 2003), which sounds challenging for curriculum developers to decide what to select and what to leave (Lumpe, Haney & Czerniak, 1998). Furthermore, STS needs the complete involvement of students in the process of inquiry, as Bennett, Grasel, Parchmann and Waddington (2005) raise the importance of students to be well motivated and self-sufficient. Usually in classrooms, the majority of the students need support and are unable to do independent work. This raises concerns about students' ability to get involved and participate in the STS action for its successful implementation. Simultaneously, teachers' role is also very crucial for this application based teaching approach. Teachers need to be aware of the nature of the issues and how to implement various tasks through their teaching strategies (Oulton, Dillan & Grace, 2004), which may be difficult for Pakistani teachers due to their limited skills and knowledge.

These challenges point out several implications at the policy and implementation level that need to be considered before expecting successful science education reforms in Pakistan. First is the current examination pattern which is very much focused on theoretical

and factual knowledge. This is the main barrier to STS implementation as it influences on the willingness of all stakeholders besides their motivation for this approach. Orpwood (2001) claims that in the marks oriented culture, the best route for any curriculum innovation is through changing direction and focus of examination. Therefore, there is a greater need to bring reforms in the assessment policies and practices to make its objectives aligned with that of STS science teaching.

The second aspect is the science syllabi and textbooks. Though national curriculum keeps STS emphasis in focus, it is not translated into the syllabi and textbooks which are still pre-dominantly focused on scientific content and concept. It is therefore important that STS objectives should be reflected in all aspects, including chapters, content, exercise, and activities.

The third is the reform in Science Teacher Education Program. Teachers are STS implementers in the science classroom and therefore should be skilled and knowledgeable. This highlights the need of pre-service and in-service training programs for teachers to provide ground for developing knowledge and skills, discussing issues, and putting ideas into practice through educational research (Northfield, 1998). This would result in their increased confidence and readiness for STS approach and would also lead to smooth process during implementation. Dass (2005) considers teacher education programs as the best route to provide experiential learning of STS benefits and implementation for teachers. For this, objectives, focus, content, and methodology of science teacher education should be parallel to that of STS approach.

The fourth aspect is the available resources and school facilities. These have a major impact on teachers' experience and willingness of use inquiry based approach. Important needs for STS science integration are resources, adequate teaching space, equipment, and support staff to organize and manage science investigation activities. Large class size also limits effective science investigation activities and puts extra burden on individual teachers to facilitate every stu-

dent. This highly raises the need of arranging resources and supporting staff to facilitate inquiry based approach in the science classroom. These aspects of the current educational system need to be carefully looked into, before taking decisions about the STS approach for science education.

Conclusion

One cannot overlook STS's benefits for students in spite of the challenges as students experience the usefulness of scientific information outside the school, the applicability of science for future career, and the place of technology in daily living. Therefore, Halai (2006) highlights the importance of an adaptive approach of STS for giving a local flavor in the context. Instead of anticipating a radical change in classroom practices, one might start implementation on a low scale by adopting some of the STS features and strategies during the science teaching. This gradual initiation will provide confidence and skills to teachers as well and make them able to balance between the demands of stakeholders, interest of students, and purpose of science education.

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