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Perspectives on Australian, Indian and Malaysian approaches to STEM education

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ABSTRACT

STEM education faces an interesting conundrum. Western countries have implemented constructivist inspired student centred practices which are argued to be more engaging and relevant to student learning than the traditional, didactic approaches. However, student interest in pursuing careers in STEM have fallen or stagnated. In contrast, students in many developing countries in which teaching is still somewhat didactic and teacher centred are more disposed to STEM related careers than their western counterparts. Clearly factors are at work which impact the way students value science and mathematics. This review draws on three components that act as determinants of science education in three different countries – Australia, India and Malaysia. We explore how national priorities and educational philosophy impacts educational practices as well as teacher beliefs and the need for suitable professional development. Socio-economic conditions for science education that are fundamental for developing countries in adopting constructivist educational models are analysed. It is identified that in order to reduce structural dissimilarities among countries that cause fragmentation of scientific knowledge, for Malaysia constructivist science education through English medium without losing the spirit of Malaysian culture and Malay language is essential while India need to adopt constructivist quality indicators in education. While adopting international English education, and reducing dominance of impact evaluation, India and Malaysia need to prevent losing their cultural and social capital vigour. Furthermore the paper argues that Australia might need to question the efficacy of current models that fail to engage students' long term interest in STEM related careers. Australian and Malaysian science teachers must be capable of changing the personal biographies of learners for developing scientific conceptual information. In addition both Malaysia and Australia need to provide opportunities for access to different curricular programmes of knowledge based constructivist learning for different levels of learner competencies.

1. Introduction

In an age when major social and environmental problems are threatening human survival, high quality science and mathematics education is central to ecological sustainability and economic prosperity (The Royal Society, 2010; UNESCO, 1999). Global problems such as climate change, overpopulation, resource management, agricultural production, health, biodiversity, declining energy and water sources among other issues put even more pressure on developing science and technology and require an international approach to resolving these issues. Science is seen as a powerful way of thinking and understanding the basis of these problems. However, numerous studies have noted a declining level interest towards science, technology, engineering and mathematics (STEM) both in terms of enrolment (Ali and Shubra, 2010; Sjøberg and Schreiner, 2005) and student motivation towards science learning (Elías, 2009; Osborne et al., 2003) especially in many western countries and powerhouse economies of Asia. In contrast, various studies suggest a greater interest among school aged children in developing countries such as India and Malaysia towards STEM than Western counterparts (Shukla, 2005; Sjøberg and Schreiner, 2005). The high level of interest in non-developed countries is desirable given the Declaration of Budapest (UNESCO, 1999) which argued that:

> As scientific knowledge has become a crucial factor in the production of wealth, so its distribution has become more

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inequitable. What distinguishes the poor (be it people or countries) from the rich is not only that they have fewer assets, but also that they are largely excluded from the creation and the benefits of scientific knowledge. (p. 463)

As recently as December 2011, the Durban Platform for Enhanced Action (United Nations Framework Convention on Climate Change, 2012) has committed action on global climate change with major implications for countries such as India and China to develop or adopt technological solutions to pollution. In particular, STEM education is an essential element of the global response to climate change or any of the other technological issues facing contemporary society. In this paper we explore the educational challenges faced by India, Malaysia and Australia in terms of priorities, philosophy and practices. All three countries have strong historical and economic relationships but different priorities for their future development. Australia has provided educational training for students from both India and Malaysia since the 1950s and many scientific leaders in both India and Malaysia have experienced their professional training in Australia. Common to all three is the role English has played in education and governance. But also common is the philosophical heritage given the influence of Islamic science and contributions of Indian science and mathematics on western science. The question we ask is what lessons can be learned from science education practices across three that can inform and guide future directions for each.

2. Background

Extensive research on how students learn science particularly in North America, Europe and Australasia has led to the advocacy of constructivist philosophies of learning (Mintzes et al., 2005). In response, various jurisdictions have adopted curricula that promote student-centred learning, outcomes-based educational practices (Jones and Brader-Araje, 2002) and inquiry-learning approaches (YouthLearn Initiative (US), 2009). These approaches are also being explored in India and Malaysia to varying degrees. For instance the series of conferences hosted by the Homi Bhabha Centre for Science Education since 2004 has featured research on educational issues related to science, mathematics and technology which draw on contemporary educational doctrines. Similarly, in Malaysia constructivist inspired student-centred approaches have been actively advocated although it is reported that teaching is mostly didactic (Zin, 2003).

However, the OECD's (2009) Teaching and Learning International Survey (TALIS) which provided the first internationally comparative perspective of the practices of secondary teachers and concluded that in northwest Europe, Scandinavia, Australia and Korea teachers are more inclined to regard students as active participants in the process of acquiring knowledge than to see the teacher's main role as the transmission of information and demonstration of "correct solutions". The report noted that the "strength of preference" in Malaysian teachers was the smallest compared to the majority of countries. India was not a participant of the TALIS study.

This review sets out to analyse some of these challenges faced by STEM educators in three countries, India, Malaysia and Australia and draws on understanding of three components that influence STEM education in these countries – national priorities, educational philosophies and educational practices. We begin this review by examining the tensions that exist between national priorities, approaches to STEM teaching and educational outcomes in Australia, India and Malaysia. We focus on the relationships and coherence between stated educational policy and priorities, the philosophical perspectives adopted to implement policy, and documented practices within schools.

3. Methodology

Broadly, a descriptive case study approach was adopted that compares research literature, policy documents and educational philosophies of three countries. Literature includes contemporary publications emanating from each of the countries as well as material published by international agencies. The literature themes were complemented with data acquired through participant observation of educational practices in each of the countries. Author 1 has taught in all three countries (tertiary/secondary/primary) and author 2 has firsthand experience of educational policy and practices in Malaysia and Australia. We present our interpretation case by case addressing in turn the themes that emerge in relation to the national priorities, educational goals and teaching practices.

4. Perspectives

4.1. Australia

Significant changes have occurred in Australian science education in the past five years. The Australian Government has, after over 20 years of negotiation with the state governments who control education, mandated a national curriculum in science and mathematics have been prioritised (ACARA, 2010). The national curriculum in science is organised around three strands the three strands namely, Science Understanding, Science Inquiry Skills and Science as a Human Endeavour. The rationale behind the curriculum is to enable students to develop "the scientific knowledge, understandings and skills to make informed decisions about local, national and global issues and to participate, if they so wish, in science-related careers". The curriculum aligns science education with the Australian Government's national priorities.

4.1.1. National priorities

The following section highlights the main national priorities in Australian STEM education such as the need to promote inquiry-based learning and teacher qualities as well as the cultural and historical approaches that support these priorities. Like many other Western nations, student enrolments in the Australian post-compulsory schooling as well as in tertiary STEM-related courses have been declining consistently and consequent skills shortages have been increasing (Goodrum and Rennie, 2008). Seventy-six percent of Australian industries have acknowledged a serious skills shortage in areas related to STEM (Baker, 2009) in a context where Australia faces substantial competition as a result of increasing investment in its major Asian trading partners in research and higher education (Ranck et al., 2006).

Two significant documents present competing perspectives. Goodrum and Rennie (2008) proposed a national plan for science education which was presented to the Australian Government. They argued the fundamental purpose of science education is to develop scientific literacy. Scientific literacy was seen to be a fundamental attribute of every citizen enabling them to "understand more about science and its processes, recognise its place in our culture and society, and be able to use it in their daily lives" (p. 3). Three areas for action were called for: reforming curriculum, improving the quality of teachers and engaging with the community. Arguably the area of action that has received significant funding is curriculum reform with the development of a National Curriculum. However, Tytler (2007) in his report to the Australian Council of Educational Research went further