Challenges of Teaching Science to Address Global Sustainability

Lilia Halim
Faculty of Education, National University of Malaysia
Malaysia
lilia@ukm.edu.my

Abstract: For a liveable condition in this post- industrial era, it would depend on our ability to understand and use the science and technology advancement in a responsible manner. Water pollution and global warming phenomena are outcomes of scientific and technological advancement that has been mismanaged. One way to achieve global sustainability is through science education and the development of a scientific literate citizen. This paper, based on the literature and research work in science education in Malaysia, outlines how scientific literate citizen can address global sustainability, assess the level of scientific literate of Malaysian students and discuss the challenges in teaching science to develop scientific literacy and hence global sustainability.

Keywords: secondary teaching, scientific literacy, sustainability, pedagogical content knowledge

1. INTRODUCTION

A scientific literate individual has the following combined knowledge, skills and dispositions- positive attitude towards science; skills and knowledge of science; ability to apply inquiry process and ability to explain a phenomenon based on scientific evidence. In making decision based on socio-scientific issues, the process also involves consideration from various perspectives such as economy, social, ethics and politics (Driver, Leach, Millar & Scott 1996). Thus, it can be concluded that the quality of making decision increases with the amount and quality of content knowledge acquired. In addition, two types of skills important in one's ability to make decision are a) thinking and b) reasoning in scientific contexts.

In sum, individuals who are scientific literate: are those who know and smart in science. Smart here means to be able to draw on the body of scientific knowledge, the processes and values associated with it in making an informed decision when dealing S &T issues related to personal life, environment, community, work place and country as a whole.

By being a scientific literate individual, one is able to increase one's involvement in the society and develop civic consciousness among the society members towards socio-scientific issues encountered in everyday situation. Recent situation in Malaysia was the issue of development of a nuclear plant in Kuantan. Thus by knowing and being smart in science, one can address and help to overcome environmental issues towards global sustainability

2. CHARACTERISTICS

A scientific literate individual are combination of the following:

1) able to acquire scientific knowledge and able to interpret a phenomena scientifically,
2) adopt and practice the inquiry,
3) able to make informed decision based on scientific evidence;
4) d) to understand the development of science and technology is a human activity influenced by the cultural perspectives, ethics and moral in solving socio-scientific problems.

3. CHALLENGES TO DEVELOPING SCIENTIFIC LITERATE INDIVIDUALS

3.1. Conceptual Understanding

Students conceptual understanding is needed to understand and interpret a problem in a scientific context in order to make an informed decision and it is often seen as not achieved, whereby misconceptions still exist among them; despite the fact that students and teachers had gone through for at least 12 years of science learning (Halim 1998; Samad 2007). This phenomenon also exists among

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students in other developing and developed countries. Various factors contribute to the development of misconceptions and in turns affect the acquisition of the concepts.

One of the factors is teachers. They indirectly contribute to the misconceptions held by students. For example in a recent study, on kinetic theory, only two out of 10 science teachers were able to provide the correct understanding of the concept (Treagust et al. 2013). The irony is that this question is often taught at school and tested in public examination.

3.2. Inculcation of inquiry practice

The inculcation and acquisition inquiry method is the main characteristics in the science discipline. Often, the inquiry method is formed through laboratory activities that are supported by the science process skills. In fact, students like science because this is the subject matter that involves laboratory activities. However, if laboratory activities are conducted, students are not given the opportunity to explore and construct their understanding by themselves of the phenomena that they are investigating. This is because most of the laboratory activities are in the form of 'cook book' in which the lab activities are conducted by following steps with the aim to endorse known theories.

Laboratory activities are seldom conducted in schools. One of the factors is time constrain whereby teachers aim to cover the syllabus in preparation for the national examination. The overemphasis on the national examination achievement appears to be the main contributing factor to the teaching approach that is mainly didactic and less inquiry based. Other contributing factors are the lack of laboratory apparatus and rooms.

Teachers' conception of science activities as an activity to confirm scientific theories reinforces teaching approach that is not inquiry based. Teachers' competencies in science process skills also affect their ability to teach the skills. Hence, students might not acquire the more complex integrated skills such as making inferences and generalizations, which are important in making informed decisions related to socio scientific issues.

Inquiry skills are enhanced when there is interplay with theory and laboratory activities. Currently, students are taught theory in class and the theory, concepts or principles are proofed through laboratory activities. The physical layout of the laboratory can change the interplay between theory-proof of laboratory activities.

For schools without sophisticated labs, the learning and teaching approach that is hands on and uses the environment as well as low cost material is also able to facilitate students to acquire the inquiry skills. This alternative approach takes into account the needs and abilities of rural and marginalized students, hence giving equal opportunities in science learning.

Inquiry skills can also be inculcated through project or research based science activities. My research have included two work: a) A model of science teaching and learning integrating the discipline of science and entrepreneurship. This model is able to develop both the science process skills as well as creative and innovative thinking. The underlying concept of this model is based on the thinking and process of entrepreneurial scientists in developing creative and innovative product (Buang et al. 2009). The creation of the products is based on science concepts.

The integration of design thinking process in engineering in the learning of science, mathematics and technology or commonly known as STEM. Through STEM education, students are encourage to solve problem collaboratively, solve everyday problems close to their surroundings (e.g. use of energy), improved understanding of concept and improved 21st century skills.

3.3. Scientific Attitude

Unconsciously or consciously, every day we are forced to make evaluation on socio scientific issues. For example, is it true that the H1N1 virus could be transferred from human to human? Is cloning issue of animals allowed in Malaysia? These questions are not only important for policy makers but also important for society members so that one can make informed decision and its impact on the wellbeing of the individual, economy and environment.

This attitude and habit of thinking, which always asks questions and makes decisions based on data, is necessary in evaluating socio-science dilemmas related to political, moral and economy realm. This habit is called scientific attitude, another characteristic of a scientific literate individual and understanding the nature of science helps to develop this attitude.

Understanding the nature of science involves, one to identify, be aware and appreciate that a) experimental data influences the development of scientific knowledge, b) theory is different from data, c) scientific concepts and theories are tentative and subject to changes when new theories are developed and d) the society culture influences the scientific discovery

However, studies have shown that physics teachers' view about science is found to be absolute. In other words, the generation of scientific knowledge is seen to be free of political and economy influences. The objective of science activity is to expose the truth. Thus, teachers are inclined to teach scientific knowledge as the truth and indisputable (Osborne et al. 2003). The implication is that students will also adopt the view that science is an absolute knowledge and not tentative

Align with the nature of science and the inquiry nature of scientific activity, teachers should be encouraging students to enquire, ask questions, to think critically, able to make decision or solve problems based on evidence, able to withhold decision until it can be explained based on scientific evidence and be open minded. Such an orientation and values of thinking skills is known as scientific attitude (Osman et al. 2007). Such a habit of mind is often applied in solving problem, evaluate information and make decision in science.

This attitude is needed to overcome issues related to socio-scientific such as 'Can jamu reduce weight?' This question is both important for politicians and the community that impacts on ones' well –being. Rosnani (2000) argues that, scientific attitude is important in making decisions related to socio-politics.

Various studies have shown (Halim et al. 2003, Ikhsan et al. 2006, Osman et al. 2007) that teachers and students level of scientific attitude is low namely objectivity and suspend judgement. The profile of scientific attitude among students increases according to age. Students of 18 years of age display better scientific attitude compared to students of 14 years old. This result aligns with the cognitive development. However, the level of acquisition of scientific attitude among the 18 years old students is still low. This shows that despite the many years of schooling the science teaching and learning experience it appears that the inculcation and the development of scientific attitude is low.

At the same time, the Asian culture (Halim et al. 2004, Ismail 2001) appears not to reinforce or encourage scientific thinking. Children are brought up in an environment that does not encourage or emphasise on scientific thinking. For example, we are told not to cut our finger nails at night without a reason. This normative culture such as 'this cannot be done' without an explanation reinforces the thinking that one has to follow instructions and not argue.

Discussion about nature of science namely development and discussion of science is bound by the scientific community hence social effort needs to be inculcated in the teaching and learning of science. Study on students' knowledge and attitude towards issues of biotechnology and its application (Meerah et al. 2012) demonstrates that students are aware of its importance and application towards the development of community well-being. However, students are unaware and unable to evaluate also make judgements on the ethical values about the biotechnology application that could bring about problems in personal lives and environment.

Having a comprehensive view of the socio scientific issues in terms of its advantages and disadvantages, the more able the student as a member of the community to make effective decisions based on scientific evidence. At the same time, the future development of science and technology also depends on the future citizens of such ability.

The sensitivity and action towards environment also an indicator related to the ability to make informed decision on socio scientific issues. Reflective activities on the impact of science and technology on the environment is not emphasised in the teaching and learning of environment across curriculum (Sharina & Halim 2011).

It was found that science teachers lack the pedagogical knowledge in teaching environment across the curriculum. They need assistance in conducting project based learning, games, track activities, excursion, and camps. Such teaching activities and learning experiences allow for opportunities and interaction as well as exposure to environments in the real context. Cutter (2002) argues that knowledge acquisition based on students' experience with environment may be limited unless the knowledge along with the motivation to actively care for the environment for the sake of self, community and Earth. This needs can be inculcated through the development of scientific attitude.

4. CHALLENGES TO TEACHING SCIENCE

Two challenges were determined based on the studies. The first challenge is to ensure that all students are scientific literate. This should be done in a holistic manner through the curriculum, teaching and learning process, evaluation and teaching and learning materials. Indeed, there is a need to ensure alignment between those educational elements. For example, when inquiry method is the way to teach science then the assessment must also assess for the acquisition of knowledge, skills an attitudes related to inquiry. The curriculum must also emphasize on inquiry and the content of the curriculum must not be overloaded. Hence, teachers

will not be trying to finish covering the syllabus and teach didactically.

It appears that the conception of science and its nature, which emphasizes on inquiry, even though embrace in the science curriculum and syllabus and its being documented, but the teaching and learning process does not reflect that and not being experienced by students.

This brings to the second challenge mainly to encourage science teachers to change the teaching and learning approach to be more hands on and inquiry based. The development of scientific literacy can be enhanced through the development of quality science teachers. In particular they too must understand and acquire the conception of science and translate it into the appropriate pedagogy. In other words, each dimension or each characteristic is to be acquired and practiced by science teachers.

The training and professional development of science teachers must be based on the conception of science and science literacy so that the implementation of the science curriculum is aligned with the conception of scientific literacy. For student teachers their training is shown to be effective based on action research based training. Being novice, they need to be trained to reflect on and in their actions so that they could plan for an effective and meaningful science teaching and learning (Halim et al. 2010)

5. CONCLUSIONS

To conclude, developing scientific literate citizen is one of the ways to address global sustainability- in terms of environment, economy and health. To achieve this, the conception of science needs to be understood both by the students and teachers. Quality teachers are the key to implementation of curriculum that is inquiry oriented. Thus their professional training both pre-service and in-service should be content specific and reflective thus will ensure continuous quality improvement in their practice.

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