

ROLES OF EPISTEMOLOGY IN EDUCATION: DO TEACHERS UNDERSTANDING THEY ARE EXPECTED TO TEACH?

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Abstract

Malaysia Education Blueprint (2013-2015) has emphasised the development of strong content knowledge in science subject with the objective to ensure that its students are being equipped with the knowledge and skills required for success in life and global recognition with knowledge and higher-order thinking skills. In order to achieve this aspiration an effort to produce students who are able to think scientifically, have high scientific literacy or science literacy needs to be disclosed. Two major questions arise to be answer; What is the concern of the epistemology? Why epistemology is important for science education? The studies state that science literacy can be achieved better through epistemology. Therefore it also related with understanding of scientific concepts, improve the quality of teaching and improve a better explanation to the issues of science to students, enhance the ability of students to understand science concepts, raise the level of scientific literacy and play an important role in the teaching process. The study also review the term of epistemology orientation that use in research and epistemology instruments and level of epistemology use in epistemology research. This study know far better understanding of the structure of science teachers to ensure content knowledge submitted stimulate students to think with the higher levels.

Keywords: Epistemology 1, Science 2, Teacher 3

1.0 Introduction

Malaysia believe that education is one of aspect that can provide a better youth that can compete in global labour market as well as Malaysia plan such as New Economic Model, Economic Transformation Plan and Government Transformation Plan. For this need, education system requires a transformation, new perspective that can enhance students develop 21st need skills and lifting achievement for students. Malaysia Education Blueprint 2013-2025 (MEB) (KPM, 2013) has been developed to provide a comprehensive plan for a rapid and sustainable transformation.

One of MEB aspiration is for Malaysia to “be placed in third of countries in terms of performance in international assessments” (KPM, 2013) and the in international assessments; TIMSS and PISA outcome will be deliberate within 15 years. TIMSS and

PISA currently test for literacy, Mathematics, and Science. `But result from those two assessment show that Malaysia students still struggle with higher-order thinking skills. (MOE. 2013 pp E-12).

Result from international assessment has become the world's premier yardstick for evaluating of education system such as in the quality, equity, and efficiency of school systems. These three elements was need in order to developed students that not just great in what they have learnt but they can apply their knowledge in both in and outside of school. The fact that the approach will reflects modern societies which is reward individuals not for what they know, but for what they can do with what they know.

In addition, MoE also believe that the emphasis of education is not just knowledge but also thinking skills such as critical, creative, and innovative thinking skills, problem-solving and reasoning and learning capabilities. MoE also believe that process of teaching and learning in the classroom is a major key for quality education but contrast science education faced many issues in terms of schools , administrators , teachers or students who are difficult to apply effective learning process (Nor Farahwahidah , 2013) and instructional based on exam oriented. In contrast, science with classroom-based inquiry need the ability to approach and answer question in reasoned manner that need teacher' content knowledge. This content knowledge will lead a deep understanding of science.

2.0 Literature Review

The study of epistemological has finally shown signs of being assimilated into the mainstream of cognitive development research. In USA, epistemology plays the roles in their intellectual development, learning, and education has (Hofer & Pintrich 2002) and has more recently been actively pursued by researchers in other country. However, the limited research regarding students' conceptions of knowledge and knowing in Malaysia.

Epistemology, in simple definition is the theory of knowledge and knowing" (Honderich, in Muis et al, 2006) or a theory of knowledge (Schraw and Olafson, 2008). The theory of epistemology allows us to explain, predict and modify thinking by they desire to know; with the hold in the theories and; and the manner of epistemological grounds are part of and an manipulate on the cognitive processes of thinking and reasoning" (Hofer and Pintrich, 1997). The epistemology is an area of concerned with the nature and justification of knowledge. It related by Hofer (2004) states that epistemology is "a field that examines what individuals believe about how knowing occurs, what counts as knowledge and where it resides, and how knowledge is constructed and evaluated". This theory allow teacher to integrate idea of instruction and modified them to make students more amenable of ways of thinking. Hofer (2002, p. 4) defines epistemology as being "concerned with the origin, nature, limits, methods, and justification of human knowledge."It also refers to the "grounds on which we base our decisions about the acceptance or rejection of scientific knowledge claims" (Duschl & Grandy, 2013).

The introductory of epistemology was concern in this paper. Thus, literature will be answer the main questions:

1. What is the concern of the epistemology?
2. Why epistemology is important for science education?

2.1 Development of epistemology.

There are broad of epistemology such as epistemology view Kuhn; Lederman 1992; Schwartz, 2004), epistemological development, (Hofer & Pintrich, 1997), epistemology nature of science or scientific epistemology, (Smith and Wenk 2006; Lederman (1992). Table 1 showed the difference of each type of epistemology.

Table 1 : The differentiate of epistemology

Type	Definition	Scholar
personal epistemology	How individuals view knowledge and knowing identifiable set of dimensions of beliefs about knowledge and knowing, organized as theories, progressing in reasonably predictable directions, activated in context, operating both cognitively and metacognitively	Hofer & Pintrich (1997) Hofer (2005)
epistemological beliefs	from a multidimensional perspective, including beliefs about the nature of knowledge, the certainty, the source, the justification, the acquisition, and the structure of knowledge Beliefs about knowledge and knowledge acquisition.	Schommer (1992) Schraw and Olafson (2008)
epistemology understanding	Coordination of the subjective and objective dimension of knowing	Kuhn and Weinstock (1994)
scientific epistemology/ Nature of Science	science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development	Lederman (1992)
epistemological resources	students' conceptions of knowledge and knowing and how they bring them to bear on specific classroom tasks	Hammer and Elby (2002)

Started with Piaget with theory of intellectual development, Perry started to use this thinking as epistemology. Earlier, Perry's main goal was "to illustrate the variety of students' responses to the impact of intellectual and moral relativism" (Perry, 1968). Using in-depth longitudinal studies of college using Checklist of Educational Values; nine positions of developmental pathway that reflect individuals' outlook on knowledge identified. Perry claim that individual want to achieve the level of thinking, they must take responsibility for his opinion. At this level the spirit learnsto stop being an obedient "conformist" and the individual is in a position to commit to own points of view on knowledge (Perry, 1970). Perry's work leading the research line of developing Piagetian stage theories of epistemological development(Kalman, 2009).

Kuhn stated the theory that epistemological perspectives affect how they see the world (Kuhn & Weinstock 2002). Kuhn claim that epistemological understanding can be seen as an extended task of coordinating the subjective with the objective elements of knowing (Kuhn & Park, 2005). In her works, three categorized of thinking was identify, absolutist; multiplist; or evaluative; whichis reflect on a concept of epistemology consisting of proof, expertise, expertise, certainty of knowledge and some other factors that were not directly related to knowledge. Kuhn stated that; one scientific theory replacing another (Kalman, 2009).

The term ‘epistemological beliefs’ has been used to refer to a specific belief about knowledge; personal beliefs about the nature of knowledge and how humans develop knowledge (Hofer & Pintrich, 2002). In developing dimension of epistemology belief Schommer (1990) develop 63 items of epistemological beliefs that lead to five dimensions of epistemological beliefs; stability, structure, source speed of acquisition, and control. Conley et al. (2004) followed Hofer (2000) and Elder (2002) and developed the questionnaire items from based on Schommer (1990) and Elder (2002).

Hammer and Elby (2002) structure of existing models of personal epistemology by introduced epistemology resources. The framework invites an explanation of these different patterns of reasoning in terms of the context-dependent activation of cognitive resources(Hammer & Elby, 2003). In this framework, Hammer and Elby conclude; teachers learn to recognize based on students’ approaches to learning, a given resources can participate in multiple frames of students’ intention, and the resources perspective provides guidance about fostering epistemological change over both short and long time scales.

Nature of science (NOS) or scientific epistemology was begun to emerge since the 1990s by Lederman (2007). It also refer to the values and assumptions inherent in scientific knowledge and its development(Deng *et al* 2014). According to Deng *et al* (2014) five dimensions are commonly reported in the literature; the empirical nature of scientific knowledge, the changing/tentative nature of scientific knowledge, the subjective nature of science, the imaginative nature of science, and the socially and culturally embedded nature of science.

See Table 1 (b) the research related to epistemology in education.

Table 1(b) Epistemology research in education

Research / Year	Type of epistemology	Level/ Instrument
Perry (1968)	Epistemology belief	Dualist, Multiplism, Relativism, Committed, Relativistic
Schommer (1990)	Epistemology belief	certain knowledge, simple knowledge, quick learning, and innate ability and omniscient authority
Redish et al., (1998)	Scientific epistemology	Physics Expectation (MPEX)
Halloun (2001)	Variation of scientific epistemology	Naive, Low Transition, High Transition, Sophisticated; View about Science Survey(VASS)
Hofer and Pintrich (2002),	Epistemological development	Nature of knowledge, nature of learning
Schraw et al., (2002)	Epistemology belief	Epistemological Beliefs Inventory

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Abd-El-Khalik Lederman, Bell, & Schwartz (2002)	Scientific epistemology	View of Nature of Science VNOS (A-E)
Kuhn dan Park(2005)	Epistemology view	Realist, Absolutist, Multiplist, Evaluativist
Adam., (2006)	Epistemology belief	The Colorado Learning Attitudes about Science Survey(CLASS)
Samarapungavan et al. (2006)	Combination of epistemology belief and scientific epistemology	Nominal , Ordinal
Stathopoulou and Vosniadou (2007)	Epistemology belief, commitment	Low Epistemological, Sophisticated LES, High Epistemological Sophisticated HES
Tsai (2007)	Scientific epistemology belief	Positivist, Mixed, Constructivist
Liang et al., (2009).	Scientific epistemology	Students Understanding of Science and Scientific Inquiry (SUSSI)

2.2 Values and Epistemology

What is the concern of the epistemology? Epistemology concerns the issue of value of knowledge and reveal how we can acquire knowledge. Thus, the theory of how we can acquire knowledge and eliminate beliefs that have been mistakenly believe to be knowledge, as well as help future investigations to better a further knowledge. With epistemology, it will lead to possess more knowledge implies how the beliefs is deficient. Epistemology help people to generate the reasoning of any scientific explanation as long as it is accompanied by a heuristic we can use to guide its application.

In epistemology, is an necessary underpinning for the development of intellectual values; with certain key intellectual skills. Kuhn (1991) stated that a relation between level of epistemological understanding and skills of argument. This skill is a foundation for the development of intellectual values, as well as certain key intellectual skills. The intellectual skill or intellectual value is one of the important element that can be stress for era of education transformation, as can be mention as 21st century education need. The intellectually engaged according to Kuhn et al. (2005) was more extended than passing interest such as motivation. In psychology area, motivation was labeled as “a problem for the 21st century” (Hidi & Harackiewicz, 2000). Due this challenge, Kuhn (2005) find that individuals find intellectual activities affectively reward (“enjoyable”) due to connection with external reinforces or due to intrinsic motivation that renders them pleasurable in their own right.

With element of Malaysia curriculum perspective that stress the elements of higher order thinking skills (HOTs) (Bloom taxonomy (1956); modified by Anderson, Krathwohl, *et al.*, (2001), will be comparable with intellectual activity and compatible with a construct such as “need for cognition” (Cacioppo, Petty, Feinstein, & Jarvis, 1996). With two elements of 21st century need (cognitive and motivation), it is a hope that the product (students) will be taught with higher-order

thinking skills as well as enjoyable of intellectual motivation with retention. As Anderson, Krathwohl *et al* (2001) state that *"Two of the most important educational goals are to promote retention and to promote transfer (which, when it occurs, indicates meaningful learning) ... retention requires that students remember what they have learned, whereas transfer requires students not only to remember but also to make sense of and be able to use what they have learned"*. How is developing epistemological understanding relevant to the valuing of intellectual activity? Hofer and Pintrich (1997) and Pintrich (2002) suggest that an individual's epistemological beliefs function as implicit theories that lead to personal goals and guide self-regulatory cognition and behavior.

2.3 Role of Epistemology in Science Education

Epistemology can lead a better approach of teaching such as inquiry. Scientific inquiry can lead the development of scientific knowledge (Schwartz, Lederman, & Crawford, 2004) during their methods and activities. By epistemological understanding and beliefs about the nature of knowledge and knowing by teacher influence strategy use (Schommer *et al.*, 1992), lead thinking critically, solving ill-structured problems, and making judgments about knowledge claims (King & Kitchener, 1994; D. Kuhn & Weinstock, 2002), cognitive processing (Kardash & Howell, 2000), motivation (Buehl & Alexander, 2005), can lead teacher to views on some issue in science that influence their curricular and pedagogical decisions, gain critical component of scientific literacy (Lederman, 1992), and conceptual change learning (Qian, 2002).

Transformation in Malaysia education, epistemology will be one of the method to increase the quality of teaching and students' aspiration. According to In Malaysia context, according to Nor Farahwahidah (2013), teaching science in Malaysia have the scientific attitude and culture of scientific inquiry but the degree of literacy science still lack. The implementation of epistemology could give a better explanation on the issues in science education by the extent to which students' development of scientific knowledge. Thus, research on epistemology gives a different perspective to understand the difficulties faced by students and teachers on the teaching and learning of science. Scientific literacy will be increased with the nature of classroom practice. Research noted that teachers' understanding of contemporary views about the nature of science, and their ability to translate these views will guarantee into effective classroom practice (Pete Sorensen *et al* 2012). Some research state that epistemology can influence teachers to achieve the goal of science education, behaviour (Kang, 2008) and teachers' instructional (Luft and Roehrig, 2007). Epistemology is a medium to evaluate teachers' scientific explicit attitude through their understanding about science and the process of science. Through epistemology, according to Huling (2014) the effective pedagogical practice can reside in personal epistemological beliefs.

General stance is that by having a sophisticated understanding of the way science knowledge is constructed, citizens will be better able to recognize pseudoscience claims, to distinguish good science from bad, and to have the ability to apply science within their everyday lives (Bell & Lederman, 2003). Knowledge construction according to Tsai (2007) is related to classroom practice. In his research, Tsai (2007) found that scientific epistemology belief (SEB) play critical role in inquiry-based science instruction and have previously suggested by (Abd-El-

Khalik, 2005). According to Tsai's dimension of his SEB (Positivist, Mixed, Constructivist), the theoretical positions of views of scientific knowledge aligned with either positivism or constructivism held a strong relationship with classroom practice.

Through epistemology, the influence and affect of instructional can be determined (Nor Farahwahidah, 2013). The idea of teachers' epistemological belief according to Yang, Chang and Hsu (2008) as 'teachers' views concerning constructivist instruction were consistent with their epistemological beliefs towards knowledge and learning'. In addition, teachers' epistemological beliefs was highlighted as an important influencing factor of classroom climate and instruction (Tsai, 2007), teaching aids (Yerushalmi et al, 2007) and students conceptual change (Kang, 2008).

Epistemology was reported related with the achievement and related with student performance. Schommer-Aikins et al. (2005) found that general epistemological beliefs and mathematical beliefs affect students' mathematical performance and overall academic achievement meanwhile Conley et al. (2004) found that low achieving children in science had less sophisticated beliefs in comparison to high achieving children. Stathopoulou and Vosniadou (2007) found students' epistemological beliefs about physics was a strong predictor of their understanding of physics, and that commonly students' epistemological beliefs are related to conceptual understanding about science. The importance of epistemology while teaching science make Luft and Roehrig (2007) suggested that some research epistemological are needed especially in formative stage began during teacher training.

7.0 Conclusion

Teachers' epistemological probably influence their conception about learning, and consequently, their preference for a certain way of teaching in terms of approaches and classroom management. Therefore, a fuller understanding of epistemological held would be of much value to educators..

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