THE INTENSITY OF DISCORD IN SCIENCE LEARNING AMONG MALAYSIAN HIGH SCHOOL STUDENTS

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A person's beliefs about the processes of knowing and the nature of knowledge in science may influence the way in which the person approaches the task of learning in science. Meaningful science learning occurs when a student chooses to deal with the learning task by trying to understand the relationships among new information and other information. Many research studies have shown that meaningful learning in science appears to require that students' world views are commensurable with that of science they experience in classrooms. The conceptual ecology of the learner emphasizes the importance of the context in which learning takes place as well as the elements interacting in the learning environment. This paper will discuss the initial findings from a bigger study, which attempts to explore the presence of discord/ conflict faced by Malaysian students during science learning that may lead to the formation of multiple epistemologies concerning the source of knowledge. It has been argued that cultural and religious beliefs do have a subtle influence on knowledge acquisition that may either enhance or impede meaningful learning. The Rasch model was applied to investigate those hidden feelings/emotions that learners harbor in the course of science learning. Early findings indicate that different students hold varying levels of discord in items regarding controversial issues such as evolution and the impact of science and technology on mankind.

INTRODUCTION

Epistemological beliefs are beliefs concerning the nature of knowledge and its process of acquisition. A belief system held consciously or unconsciously, is critical in the learning process because cognitive behaviours take place within it and are shaped by it (Schommer, 1989; Snively, 1990; Zuzovsky, 1994; Roth & Roychoudhury, 1994). As a global construct belief has been elusive to empirical investigation and tend to be loosely perhaps incorrectly to mean the same as knowledge (Pajares, 1992). However, Nespor (1987) suggested that beliefs have a stronger affective and evaluative component than knowledge. Whatever has been subscribed to belief and more specifically, epistemological beliefs ultimately rest on the prevailing worldview of the individual.

A person's beliefs about the processes of knowing and the nature of knowledge in science may influence the way in which the person approaches the task of learning in science. Meaningful science learning occurs when a student chooses to deal with the learning task by trying to understand the relationships among new information and other information. Many research studies have shown that meaningful learning in science appears to require that students' worldviews are commensurable with that of science they experience in classrooms. Research studies have shown that students' scientific epistemologies may influence students' learning orientations (Tsai, 1998) and these beliefs guide students' metal-learning assumptions (Roth & Roychoudhury, 1994). Driver, Leach, Millar & Scot (1996) claims that there are good grounds for supposing that students can entertain epistemological questions and can express their reasoning in words. However, according to Osborne (1996), science teachers do not tend to address the important epistemological issues.

Constructivism argues that meaningful learning is the result of the integration of knowledge gained from new experiences into existing schemas. Constructivist principles are touted as providing learners the means to emancipate learning from rote thereby paving the way for more independent style of learning. However, Yerrick, Pederson, & Arnason (1998) warned that epistemological belief differences between students and teachers have to be addressed before any new approaches in instruction can be successfully carried out. It was proposed that students learn science when they see that the scientific explanation is superior to the untutored, commonsense beliefs they bring to the classroom (Cobern, 1993). The worldview theory further argues that this can only happen if and only if they share the same plausibility structure. In other words, students may find a scientific explanation to be rationally flawless but still do not accept it as legitimate (Cobern, 1993) if the worldview that they hold are incompatible with the accepted western scientific worldview. The majority of students are inclined to display learning orientations that were consistent with their epistemological beliefs (Edmonson & Novak, 1993; Roth & Lucas, 1997; Roth & Roychoudhury, 1994; Tsai, 1998).

The conceptual change model widely used, seeks to compare the differences about scientific concepts that learners hold from that agreed upon by the scientific community. Any mismatch between the two is termed misconceptions or alternative concepts so instruction is designed to teach for conceptual change. However, results from utilizing the early model were inconsistent (Gunstone, White, & Fensham, 1988) for learners were found to be highly resistant towards the acquisition of new concepts (Hewson, 1996; Akerson, Abd-El-Khalick, Lederman, 2000). Previous research concerning epistemological beliefs demonstrated that change in epistemological beliefs is gradual (Perry, 1968). Thus, the conceptual change model has embraced the notion of the *conceptual ecology* of the learner (Hewson, 1996) that emphasizes the importance of the context in which learning takes place as well as the elements interacting in the learning environment. In this matter the epistemological beliefs held by learners are deemed all too critical.

Saunders, Cavallo, & Abraham (1999) reported that in some instances students make a choice about how to learn the information imparted by the teacher. If he/she attempts to reconcile this information with existing knowledge but in doing so be in conflict with the teacher's he/she may isolate this new information and utilize rote approaches to learning. In so doing so the student has maintained parallel ways of knowing about a concept. Edmondson's (1989) finding that students simultaneously held conflicting epistemological positions suggest that students do not necessarily integrate the epistemological assumptions of their recent experiences into their previously held positions. Cobern (1993) typified this situation as saying that students practice cognitive apartheid. Students become so good at setting up different ways of knowing that can coexist with each other that the students themselves are not aware of their presence.

An imperative issue to consider at this juncture is about the sources of knowledge learners choose as a priority to accept or reject an explanation. Cobern (1993) asserts that no person including any scientist or science educator would use a single source of knowledge. The influence of culture weighs heavily on the kinds of epistemology that a learner holds. Haidar and Balfakih (1999) reported that their studies on United Arab Emirates high scholars held mixed views concerning the epistemology of science but can be classified into four main groups namely, those holding (1) religious views - 35%, (2) traditional views – 33% and (3) constructivist views – 22%. The religious views of science that materialized in a largely Islamic culture (UAE) have taken on a different face by Western students who related science to technology. Haidar and Balfakih (1999) suggested that science curriculum designers have to take students' religious beliefs into consideration and more so now since the notion of conceptual ecology of the learner has been acknowledged as critical. What all this seem to establish is that students who hold religious views may have gone through conflicting times when trying to test the legitimacy of certain knowledge claims provided for through the western scientific worldview.

The larger scope of this study is to establish whether these conflicts have in any way acted to impede the effective acquisition of science concepts that are part of a necessary ingredient in scientific reasoning. However, this paper intends only to answer the question, "Are these conflicts real or imagined and do they vary in their intensity?"

METHODOLOGY

A questionnaire has been developed to investigate into those hidden feelings or emotions that Malaysian Muslim learners harbour in the course of science learning. Having a similar Islamic background as those students from UAE, items were sourced from various studies, which flashed out feelings of conflict between religious beliefs and science from both Islamic and Christian cultures. The questionnaire started from an initial number of 35 items, which were promptly translated from the English language into Bahasa Malaysia, the language for the medium of instruction in Malaysia. This translated version was then back translated to see that meaning and essence were not lost.

The early copy of the questionnaire was prepared for responses to be recorded on a four-point Likert type response scale. Each item response was allocated 1, 2, 3 or 4 points for each of the response categories of 'strongly disagreem,' 'disagree,' 'agree' and 'strongly agree,' respectively. Pilot testing for the questionnaire was done on 200 students doing their pre-university science courses in a government run college. Analysis was carried out on data returned but only managed to analyze on 127 students' responses due to missing values in the others.

The responses of the 127 students to the 35 items have been analyzed using BIGSTEPS (a Rasch Measurement program for obtaining objective, fundamental measures from stochastic observations of ordered category responses) and FACTOR ANALYSIS, a data reduction module using SPSS for Windows Release 10.0.1.

The Rasch analysis (Partial Credit Model) was carried out to determine whether the 35 questionnaire items were working together to form a unidimensional scale of "intensity of discord in science learning" to measure which students revealed higher discord and lower discord in science learning.

The Model is given as

$$Pnij = \exp \sum_{k=n}^{j} (ßn - dik) \Big/ \sum_{x=0}^{m_i} \exp \sum_{k=0}^{x} (ßn - dik)$$

for, $j = 0, 1, 2, \ldots m_i$; and $\__{i0} = 0$ so that $\sum(\__n - \__{i0}) = 0$ and $\exp\sum(\__n - \__{ik}) = 1$ (Wright and Masters, 1982)

From the 35 items, eight items (ITEM64, ITEM67, ITEM68, ITEM73, ITEM81, ITEM82, ITEM87 and ITEM95) were discarded from the Rasch analysis because of the following reasons:

- Small point-biserials values (approaching zero)
- Large infit and outfit values (more than +3.0 Logits)

The list of the 27 items used to define the scale of "intensity of discord in science learning" is shown in Table 1. The items are listed not according to their appearance in the questionnaire but in the order of factors from that of defining lowest feelings of "intensity of discord in science learning" (Factor 5: ITEM66, ITEM86 and ITEM90) to that of defining highest feelings (Factor 2: ITEM91, ITEM65, ITEM70 and ITEM72).

Factor analysis was carried out on the remaining 27 items to determine whether the scale of "intensity of discord in science learning" can be reduced to sub-scales. Calibrations of items obtained from the Rasch analysis for each of the subscales or factors was subsequently totaled up to find the means for each. The means for each subscale will then be used to determine the position of each subscale along the 'discord' scale. Initially nine factors were obtained but factor eight consisted of two items was appropriately removed for it contained one item (ITEM88), which is nicely conveyed the meaning as items in Factor 6, and another item (ITEM94) appeared in another factor (Factor 4). Naming the factors was done according to the spirit of the items captured in each factor (see Figure 1).

Table 1
List of 27 items used to define the scale of "intensity of discord in science learning"

ITEM91:	Deeply religious people do not do well in science.
ITEM65:	I am not curious about Nature.
ITEM70:	I sense neutrality in science classes, which makes me become indifferent to science teachings.
ITEM72:	I don't really think/care about laws/forces in the physical world.
ITEM85:	Science instruction and religion should be clearly delineated.
ITEM78:	Classroom science should clearly refrain from making any references about God.
ITEM88:	Science has eliminated the source of religious inspiration.
ITEM74:	Science has a violent and forceful image, which I find objectionable.
ITEM79:	I feel uncomfortable when science lessons refer to fossils and dinosaurs.
ITEM77:	I am uneasy about asking too many questions about Nature.
ITEM94:	Mankind has the right to dominate over natural events occurring in Nature.

ITEM69: I merely comply with my science teacher's explanation because the answers to the exam questions are dependent on them.

ITEM93: Scientific knowledge is more important than other kinds of knowledge.

ITEM75: Genetic sciences have reduced the process of fertilization to chance events.

ITEM71: Evolutionary theory being part of science has polluted the natural sciences.

ITEM80: The principles of evolution are logical but I still reject them because it is in conflict with my religious teachings.

ITEM76: My unease with science interferes with the development of clear understanding of science concepts.

ITEM92: Science inventions have increased tensions among people.

ITEM97: Traditional thinking and modern science are incompatible.

ITEM98: The development of science is considered value-free even towards mankind and I find this dangerous.

ITEM89: Science explains the concept of the making of a human being (fertilization) as a chance event. I consider this statement as degrading.

ITEM96: I feel that mankind is not able to overcome the problems created by scientific inventions.

ITEM83: Much of the anxiety in modern society is due to science.

ITEM84: Some scientific evidences are not clear and are ambiguous.

ITEM66: Afterlife is more important, not reasoning about why things happen in Nature.

ITEM86: Science values material evidence while religion values faith.

ITEM90: I place my trust more in faith than to science.

RESULTS AND DISCUSSION

The results of the Rasch analysis indicate that the 27 items could be used to define the scale of "intensity of discord in science learning." The results show that the Person Separation Reliability equaled 0.71 and the Item Separation Reliability equaled to 0.98. With Item Separation Index, equaled to 7.78, it indicates that the scale could be classified into eight separate subscales. The calibrations of the items extend from (–1.94) Logits to (+2.16) Logits, and the person measures from (–2.57) Logits to (+0.88) Logits with mean measure equaled to (–0.52) Logits.

The results of the factor analysis indicate that the scale of "intensity of discord in science learning" might be composed of eight sub-scales beginning with "conflict," followed by "confuse," "restless," "aversion," "compliance," "disapprove," "separation" and ending with "total rejection."

Figure 1 shows the map of 27 items classified according to eight factors and positioned according to their calibrations obtained from the Rasch analysis. Factor 5, which consists of three items (ITEM66, ITEM86, and ITEM90) describes the inner feelings of students with regard to differences in their perceptions toward science and religion, specifically on students' conflicting views between material evidence and faith.

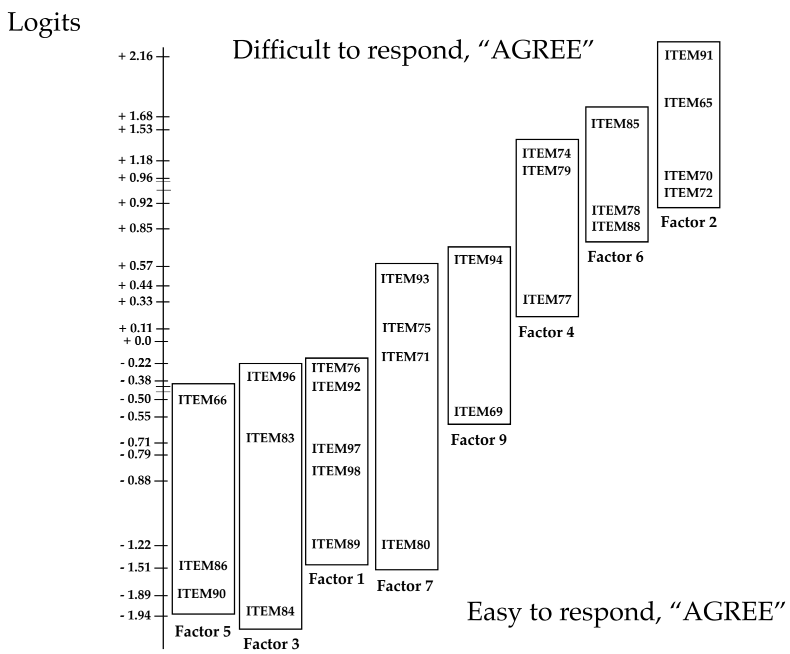

Figure 1: Map of 27 Items Defining Eight Factors

Factor 3 consisting of three items (ITEM96, ITEM83 and ITEM84) indicates the feelings of confusion among students about knowledge claims. This is based on students' perceptions towards the items "some scientific evidence are not clear and ambiguous," "much of the anxiety in modern society is due to science," and "mankind is not able to overcome the problems created by scientific inventions."

Factor 1, consisting of five items (ITEM76, ITEM92, ITEM97, ITEM98 and ITEM89) indicates the feelings of restlessness among students with regard to certain issues brought about by science like, "scientific inventions have increased tensions among people," the concept of chance in fertilization regarded as "degrading," the development of "value-free" science could endanger mankind, and incompatibility between traditional thought and modern science. The worries or restlessness about the issues might interfere students to enable them to develop clear understandings of science concepts.

Factor 7, consisting of four items (ITEM92, ITEM97, ITEM98 and ITEM89) describes students' feelings of dislike (aversion) toward science. This is shown through the students responses to the items like, scientific knowledge is more important than other kinds of knowledge," "genetic sciences have reduced the process of fertilization to chance events," and "evolutionary theory being part of science has polluted the natural sciences."

Factor 9, consisting only of two items (ITEM94 and ITEM69). The students' responses to these items indicate that the feelings of students toward science learning are something like of compliance instead of commitment. This can be viewed from the meaning of the items "I merely comply with my science teacher's explanation because the answers to the exam questions are dependent on them" and "Mankind has the right to dominate over natural events occurring in Nature."

Factor 4, consisting of three items (ITEM74, ITEM79 and ITEM77), elicits students' feelings of disapproval toward certain issues in science learning. The students feel that they are "uneasy about asking too many questions about nature," "uncomfortable when science lessons refer to fossils and dinosaurs," and "science has a violent and forceful image, which (they) find objectionable."

Factor 6, consisting of three items (ITEM85, ITEM78 and ITEM88). It indicates that the students feel that science and religion should be clearly differentiated. This is portrayed by items like "science has eliminated the source of religious inspiration," "classroom science should clearly refrain from making any references about God," and "science instruction and religion should be clearly delineated."

Lastly, Factor 2, which consists of four items (ITEM91, ITEM65, ITEM70 and ITEM72) describes students' feelings of rejection toward science learning. This is indicated by items like "don't really think/care about laws/forces in the physical world," "neutrality in science classes, which makes me become indifferent to science teachings," "not curious about Nature," and "religious people do not do well in science".

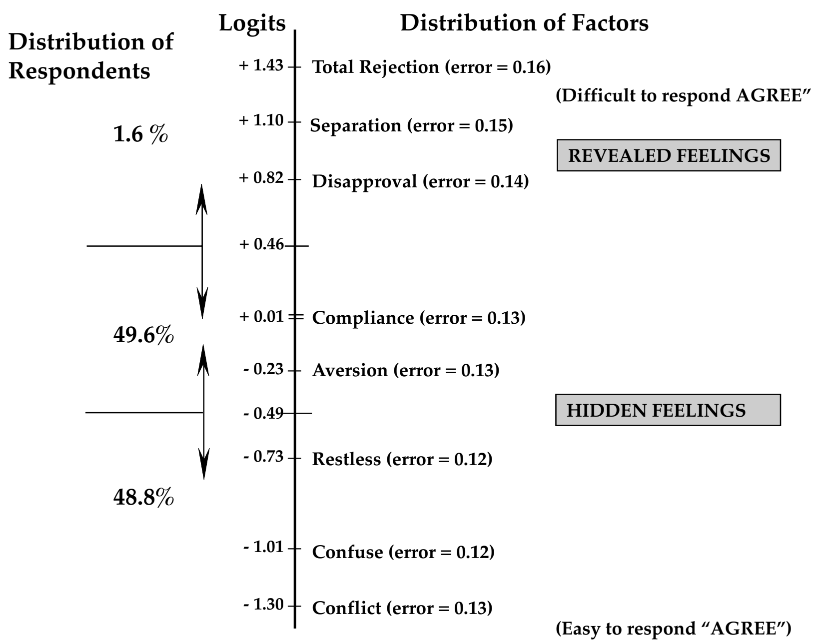

Figure 2: Scale of Intensity of Discord in Science Learning

Figure 2 is a summary of Figure 1. Each factor has been named according to the meanings of items that are constituted in them. The calibration and error of each factor are computed from the calibrations and errors of items obtained from the Rasch analysis. Looking at the distribution of the factors along a single continuum, it seems that they can be grouped into three distinct groups. This is calculated based on the error accompanied with each factor. Thus the scale of "intensity of discord in science learning" can be categorized into 3 distinct levels, "lower" (less than -0.49 Logits), "middle (or average)" (between -0.49 Logits and +0.46 Logits) , and "higher" (more than +0.46 Logits) level.

Although, based on the Person Separation index, which equaled to 1.56 Logits, it seems that the distribution of students could be grouped into two distinct groups (Wright & Masters, 1982). However, in this case, the students can be classified as those in "lower level of discord in science learning," "average or normal level of discord in science learning," and "higher level of discord in science learning," according to the grouping of the factors.

Students (48.8%) at "lower level of discord in science learning" develop only "hidden feelings" about mismatch between science and religion. They might feel that there is "conflicting views between science and religion," and these feelings would make them feel confused and restless.

Students (49.6%) at "normal or average level of discord in science learning" might comply with the science learning because of the importance of science in school education. However, these students might have developed a feeling of dislike towards science.

Students (1.6%) at "higher level of discord in science learning" might have developed an open-stance regarding their feelings about science and religion. They might openly observe that they objected to science learning.

CONCLUSION

The results indicate that the feelings of conflict harboured by students in the course of science learning are present and real. Feelings of conflict or discord appears to be present in varying degrees for the different students even though the students are largely composed of having come from similar academic background. Judging from the positions of the subscales on the discord scale, the majority of the students were at the lower end (48.8%) of the scale ('CONFLICT,' 'CONFUSE' and 'RESTLESSNESS') and the middle (49.6%), of the scale ('AVERSION' and 'COMPLIANCE'), while a minority (1.6%) occupied the top end of the scale ('DISAPPROVAL,' SEPARATION,' AND 'TOTAL REJECTION'). The existence of "*hidden feelings of discord*" among students toward religion and science learning could derive from misconception about knowledge and truth. And this could have resulted from the approaches in the teaching of religion and science. Nevertheless, these invisible barriers to learning science were effectively made possible using the Rasch measurement model to analyze the items and the reliability values obtained made the questionnaire robust enough to generate reliable (Item Separation Reliability = 0.98) and valid statistical data (as indicated by the logical ordering of items and factors) from the same kind of treatment in a much wider study.

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