THE LEVELS OF SCIENTIFIC UNDERSTANDING AND ATTITUDE TOWARDS SCIENCE AMONG PRIMARY SCHOOL SCIENCE TEACHERS IN THE KUCHING DISTRICT OF SARAWAK

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DEDICATION

To my Parents
The aim of this study was to ascertain the level of scientific understandings of primary school science teachers with regards to the concepts of speed, sound, condensation and germination. It also sought to determine whether any significant differences existed between the level of the teachers' scientific understandings across gender, ethnic groups, academic and professional qualifications, science-teaching experience and attitudes towards science.

The population of this study comprised all practising primary school science teachers in the district of Kuching, Sarawak. Seventy-three science teachers (24.7 percent of the target population) were sampled through a random sampling method. Data were collected through a questionnaire incorporating a likert-scale to measure the teachers' attitudes towards science and open-ended items to assess their scientific understandings in the selected science concepts.

Data was analysed using the Statistical Package for Social Science (SPSS) software. Part of the data obtained was also analysed qualitatively to identify existing misconceptions among the teachers studied.

Results of this study showed that there were no significant differences between the teachers' level of scientific understandings across gender, ethnic groups, academic and professional qualifications, science-teaching experience and attitudes towards science. There was only one exception, that was across gender in the concept of speed. Results showed that there was a significant difference between male and female respondents in this concept.

Demographic characteristics, namely gender, ethnic group, academic and professional qualifications and science-teaching experience did not have any significant relationship with the respondents' attitudes towards science.

This study gives some insights into the primary school science teacher's current level of scientific understandings. Knowledge of problem concept areas in the teacher's understanding will enable teacher educators and policy makers to design science teacher training programs that are more effective and relevant to the science teacher.
Tahap Pemahaman Saintifik dan Sikap terhadap Sains Dikalangan Guru-guru Sains Sekolah Rendah di Daerah Kuching, Sarawak

Kajian ini bertujuan untuk menentukan tahap pemahaman saintifik dikalangan guru-guru sains sekolah rendah berkenaan dengan konsep-konsep halaju, bunyi, kondensasi dan percambahan. Ia juga bertujuan untuk menentukan samaada terdapat perbezaan signifikan antara tahap pemahaman saintifik guru merentasi jantina, kumpulan etnik, kelayakan akademik dan ikhtisas, pengalaman mengajar matapelajaran sains dan sikap terhadap sains.

Populasi kajian merangkumi semua guru-guru sains yang berkhidmat di sekolah-sekolah rendah di daerah Kuching, Sarawak. Tujuh puluh tiga orang guru sains (24.7 peratus daripada populasi kajian) terlibat sebagai sampel melalui kaedah persampelan rawak. Data dikumpul melalui soal selidik yang melibatkan skala likert, untuk menentukan sikap guru terhadap sains, dan item-item terbuka untuk menentukan pemahaman saintifik mereka dalam konsep-konsep sains terpilih.

Data dianalisa menggunakan perisian Statistical Package for Social Science (SPSS). Sebahagian daripada data yang diperolehi juga dianalisa secara kualitatif untuk mengesan miskonsepsi yang wujud dikalangan guru-guru yang dikaji.

Keputusan kajian menunjukkan bahawa terdapat tiada perbezaan signifikan antara tahap pemahaman saintifik guru-guru merentasi jantina, kumpulan etnik, kelayakan akademik dan ikhtisas, pengalaman mengajar matapelajaran sains dan sikap terhadap sains. Hanya terdapat satu pengecualian, iaitu, merentasi jantina dalam konsep halaju. Keputusan kajian menunjukkan bahawa terdapat perbezaan signifikan antara responden lelaki dan perempuan berkaitan dengan konsep ini.

Ciri-ciri demografi, iaitu jantina, kumpulan etnik, kelayakan akademik dan ikhtisas dan pengalaman mengajar matapelajaran sains tidak menunjukkan sebarang perbezaan signifikan dengan sikap responden terhadap sains.

Kajian ini memberi sedikit-sebanyak pendedahan terhadap tahap pemahaman saintifik dikalangan guru-guru sains sekolah rendah pada masa kini. Maklumat tentang konsep-konsep hermasalah dalam pemahaman guru membolehkan mereka yang terlibat dalam latihan perguruan dan penggal-penggal polisi untuk merangkakan program-program latihan guru yang lebih efektif dan relevan terhadap seorang guru sains.
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1.0 Introduction

The formation of a technologically and scientifically literate Malaysian citizenry by the year 2020 has placed the learning of science high on the list of priorities of the education system of Malaysia. The achievement of this national goal necessitates the formation of a quality teaching force in the field of science. The preparation of knowledgeable and effective science teachers for all levels of education will be among the preliminary steps toward the realisation of this vision.

In December 1994, after a hiatus of over ten years, science was formally introduced in Malaysian primary schools as a subject on its own under the new Kurikulum Bersepadu Sekolah Rendah (KBSR) syllabus for the Year Four classes. Ten main aspects were stressed upon in the new primary school curriculum (Figure 1). Among these, several had direct bearing upon the new science syllabus, namely those pertaining to thinking skills, values, language, environmental studies and science and technology across the curriculum (Poh, 1997). If we look at the concept of science and technology across the curriculum (STRUM), Poh (1997) makes references to four elements:

(i) scientific knowledge;
(ii) scientific skills;
(iii) scientific attitude; and
(iv) the application of technology in the teaching-learning process.

This step toward integrating science into the overall primary school curriculum can be seen as a major deliberation on the part of the Education Ministry to emphasise the importance of science. The role of the primary school science teacher as the medium through which all the necessary skills and requisites of science as a way of life has been elevated by leaps and bounds.

Much literature written on the subject have stressed the importance of having a strong content knowledge base in addition to effective pedagogical skills in order to ensure efficient transfer of knowledge and the development of the proper and necessary attitude toward science (Smith, 1997; Ginns and Watters, 1995; Poh, 1997). This study will attempt to analyse the scientific understandings of science teachers in the Malaysian education system, particularly primary school science teachers implementing the new science syllabus under the current KBSR (Kurikulum Bersepadu Sekolah Rendah) curriculum.

1.1 Background of the Study

Recent studies by Devan et al. (1996), involving primary school children in several states of Peninsula Malaysia indicated a high level of misconceptions in basic
science concepts. Similar studies also show high levels of misconceptions in basic science concepts among pre-service science teachers (Teoh et al., 1996). These findings are disturbing in that they raise questions as to the competency of the teachers involved in the teaching of science, especially at the primary school level, which is often the first time a student is formally introduced to the study of science.

A uniform science curriculum in Malaysia only became officially entrenched in 1956 (Poh, 1997). Following that, various steps have been taken by the Education Ministry to increase the efficiency and effectiveness of science education in the country. In 1979, the national primary school curriculum was restructured, giving emphasis to three main aspects: communication, man and his environment, and self-development. Following this, a new field of study was introduced which incorporated elements of various heretofore separately taught elements, including science. This new subject, "Man and his Environment", was first introduced to students in Year Four in the year 1985 (Poh, 1997). However, in 1994, science was reintroduced to the curriculum. As a result, there was a need for teachers with a good understanding of science and the skill to impart the necessary knowledge to their students. Still, recent studies conducted by the Malaysian Science and Technology Information Center (MASTIC) in 1996 have revealed that Malaysians were generally of poor knowledge and interest in issues pertaining to science and technology. Ranking their findings with that of other countries, it was found that Malaysia ranked third last when it came to the level of understanding of basic science terms and concepts.

Currently, many science teachers in Malaysian primary schools are not science graduates (De Paul, 1996). Gooday and Wilson (1996) found that science teachers tend to focus more on topics they felt they have a strong understanding of. This would seem to indicate that primary school science teachers might not have sufficient schemata upon which to build knowledge, thus making the process of knowledge acquisition, for themselves and their students, less efficient. To produce scientifically literate students, and eventually, scientifically literate citizens, science teachers would also need to be scientifically literate with the ability to transfer this literacy to their students.

The advent of the year 2020 marks the culmination of Dr. Mahathir's vision of Malaysia's future. By the year 2020, as a fully developed nation, Malaysia is expected to have an excellent society, in terms of morals and ethics, religious and spiritual values, tolerance, innovation and progressiveness. She is to function as a contributor to the scientific and technological civilisation of the future. This requires quantum leaps in various aspects, from economics to education. Among strategies planned toward this end are ensuring all secondary school leavers are computer literate by the end of the 1997 school year. By the year 2005 at least 50 percent of students in local institutions of higher learning should be enrolled in fields of science, technology and engineering (Institute of Strategic and International Studies Malaysia, 1996).

It is clear that the Malaysian education system has been entrusted with a heavy responsibility and the role of science in education and science teachers in particular, is indeed great.
1.2 Statement of the Problem

The worrying levels of science understanding among Malaysians are a cause for concern. The decline in students' performance in science subjects (Azmah
Abidin, 1996) may later affect the country's goal of having 50 percent of those enrolled in domestic institutions of higher learning involved in the fields of science, technology and engineering in the coming century (Institute of Strategic and International Studies Malaysia, 1996). There is a need to identify the factors that may have led to this current state of affairs.

In light of this circumstance, it is pertinent that the science educators' attitudes and grasp of basic science concepts be fully understood in order to halt and eventually reverse this turn of events. Thus, it is within the area of interest of this study to investigate and analyse the scientific understandings of primary school science teachers in the local context, that is, in the District of Kuching, Sarawak.

Specifically, several research questions are posed. These are:

(i) What are the current levels of scientific understanding among primary school science teachers?

(ii) What are the attitudes of these teachers toward science?

(iii) Are their attitudes toward science influenced by
    (a) gender?
    (b) academic qualifications?
    (c) professional qualifications?
    (d) ethnic origins?
    (e) science-teaching experience?

(iv) Are their levels of scientific understanding influenced by
    (a) gender?
    (b) academic qualifications?
    (c) professional qualifications?
    (d) ethnic origins?
    (e) science-teaching experience?
    (f) attitudes toward science?

(v) Do these primary school science teachers hold any misconceptions with regards to selected science concepts?

(vi) If so, what are some of these misconceptions?

1.3 Purpose of the Study

The main aim of this study is to analyse the levels of cognition in the form of scientific understandings of primary school science teachers in the District of Kuching, Sarawak, with regards to selected demographic characteristics and attitudes toward science.
1.4 Objectives of the Study

Specifically, the objectives of this study are:

(i) To determine the demographic characteristics of science teachers in the primary schools in the Kuching District of Sarawak, who were involved in the study.

(ii) To determine the distribution of respondents according to their
(a) attitudes toward science; and
(b) levels of scientific understanding

(iii) To determine whether there are any significant differences in the attitudes toward science between
(a) male and female respondents;
(b) respondents of different ethnic groups;
(c) respondents of different academic qualifications;
(d) trained and untrained respondents; and
(e) less experienced and more experienced respondents

(iv) To determine whether there are any significant differences in the levels of scientific understanding among
(a) male and female respondents;
(b) respondents of different ethnic groups;
(c) respondents of different academic qualifications;
(d) trained and untrained respondents;
(e) less experienced and more experienced respondents; and
(f) respondents with positive attitudes toward science and those with negative attitudes toward science

(v) To identify specific misconceptions in the selected science concepts used in the study that occur among the respondents.

1.5 Conceptual Framework

This study aims to find out the primary school science teachers' level of scientific understanding and whether this is influenced by demographic factors and their attitude toward science. It also aims to identify specific misconceptions, if any, that are held by the teachers involved in the study.

The study is done in two stages. Two dependent variables are involved: the level of scientific understanding and the respondents' attitude toward science.

The first dependent variable studied is the respondents' attitude toward science. This study attempts to find if the respondents' attitude toward science is influenced by demographic factors, specifically gender, ethnic origin, academic qualifications, professional qualifications and teaching experience. Thus, at this
stage, the demographic factors are the independent variables and the attitude toward science is the dependent variable.

![Conceptual Framework of Study]

Figure 2 Conceptual Framework of Study

The second dependent variable studied is the respondents' level of scientific understanding. This study attempts to find if the respondents' level of scientific understanding is influenced by several factors, specifically gender, ethnic origin, academic qualifications, professional qualifications, teaching experience and their attitude toward science. These factors serve as independent variables to the dependent variable of level of scientific understanding.

The suggested conceptual framework for the study is as shown in Figure 2.
1.6 Statement of Hypotheses

In relation to the objectives of this study and based on the conceptualised framework, the following hypotheses are formulated:

1.6.1 To determine differences in attitudes toward science

H1: There is no significant difference in attitudes toward science between male and female science teachers.
H2: There is no significant difference in attitudes toward science between trained and untrained science teachers.
H3: There is no significant difference in attitudes toward science between less experienced and more experienced science teachers.
H4: There is no significant difference in attitudes toward science between teachers of different ethnic groups.
H5: There is no significant difference in attitudes toward science between science teachers of different academic qualifications.

1.6.2 To determine differences in the levels of scientific understanding

1.6.2.1 Concept of Speed

H6: There is no significant difference in the levels of scientific understanding in the concept of speed between male and female teachers
H7: There is no significant difference in the levels of scientific understanding in the concept of speed between respondents of different ethnic groups.
H8: There is no significant difference in the levels of scientific understanding in the concept of speed between respondents of different academic qualifications.
H9: There is no significant difference in the levels of scientific understanding in the concept of speed between trained and untrained respondents.
H10: There is no significant difference in the levels of scientific understanding in the concept of speed between less-experienced and more experienced respondents.
H11: There is no significant difference in the levels of scientific understanding in the concept of speed between respondents with different attitudes towards science.

1.6.2.2 Concept of Sound

H12: There is no significant difference in the levels of scientific understanding in the concept of sound between male and female teachers
H13: There is no significant difference in the levels of scientific understanding in the concept of sound between respondents of different ethnic groups.

H14: There is no significant difference in the levels of scientific understanding in the concept of sound between respondents of different academic qualifications.

H15: There is no significant difference in the levels of scientific understanding in the concept of sound between trained and untrained respondents.

H16: There is no significant difference in the levels of scientific understanding in the concept of sound between less-experienced and more experienced respondents.

H17: There is no significant difference in the levels of scientific understanding in the concept of sound between respondents with different attitudes towards science.

1.6.2.3 Concept of Condensation

H18: There is no significant difference in the levels of scientific understanding in the concept of condensation between male and female teachers.

H19: There is no significant difference in the levels of scientific understanding in the concept of condensation between respondents of different ethnic groups.

H20: There is no significant difference in the levels of scientific understanding in the concept of condensation between respondents of different academic qualifications.

H21: There is no significant difference in the levels of scientific understanding in the concept of condensation between trained and untrained respondents.

H22: There is no significant difference in the levels of scientific understanding in the concept of condensation between less-experienced and more experienced respondents.

H23: There is no significant difference in the levels of scientific understanding in the concept of condensation between respondents with different attitudes towards science.

1.6.2.4 Concept of Germination

H24: There is no significant difference in the levels of scientific understanding in the concept of germination between male and female teachers.

H25: There is no significant difference in the levels of scientific understanding in the concept of germination between respondents of different ethnic groups.
H26: There is no significant difference in the levels of scientific understanding in the concept of germination between respondents of different academic qualifications.

H27: There is no significant difference in the levels of scientific understanding in the concept of germination between trained and untrained respondents.

H28: There is no significant difference in the levels of scientific understanding in the concept of germination between less-experienced and more experienced respondents.

H29: There is no significant difference in the levels of scientific understanding in the concept of germination between respondents with different attitudes towards science.

1.7 Definition of Terms

This section will attempt to define operationally several terms that will be used throughout this study.

1.7.1 Scientific understandings

The term 'scientific understandings' will refer to the individual's ability to understand science concepts. For the science teacher, scientific understandings would involve his/her grasp of the subject and its component concepts. It would also indirectly refer to his/her ability to translate this 'grasp' of scientific knowledge to the learner. Indirectly, these 'scientific understandings' will reflect the cognitive levels of the science teacher with regard to a particular scientific concept.

In this research, four concepts are used to measure the respondents' scientific understandings, which are the concepts of speed, sound, condensation and germination. These selected basic science concepts are part of the concepts covered in the current Primary School science syllabus.

Several levels of scientific understandings are involved in this study, namely:

(i) Sound understanding

This refers to a scientific understanding that is scientifically accurate with regard to the concepts involved. Accurate usage of scientific terms in the appropriate contexts also fall under this level.

(ii) Partial understanding

This level of scientific understanding indicates an intrinsic understanding of the concept as a whole, but lacks the necessary contextual clues, such as accurate usage of scientific terms, that lend toward a fully rounded understanding.
(iii) No understanding

This final level indicates that the individual has no basis of understanding a specified science concept. There may be usage of scientific terms, but they are used in the wrong contexts. The terms used may or may not be accurate.

1.7.2 Attitudes toward Science/ Scientific attitude

References toward scientific attitude, for this study's purpose, are taken to indicate one's attitude toward, and perception of science, both as a subject and as a way of life. In this study, scientific attitude is categorised as highly positive, positive, negative and highly negative attitudes toward science.

1.7.3 Demographic characteristics

Several demographic characteristics are studied in this research: gender, ethnic origin, science-teaching experience, academic qualifications and professional qualifications.

Gender comprises two categories, namely male and female. The term ethnic origin is used to indicate the individual's race. Four categories are selected for this factor. The first three comprises the three most common ethnic groups in Malaysia, which are the Malays, Chinese and Indians. The fourth category is meant for the many indigenous groups found in the state of Sarawak.

Science-teaching experience refers to the number of years the respondent has taught science or science- based subjects, such as Alam dan Manusia.

Academic qualifications refer to the highest education level reached by the respondent. In this study, four levels are referred to, namely the Sijil Pelajaran Malaysia (or its equivalent) level, the Sijil Tinggi Persekolahan Malaysia (or its equivalent) level, the Diploma level and finally, the graduate level.

The respondents' professional qualifications refer to whether or not they have had formal training in teaching. Two categories are identified for this factor, which are, trained teachers who have had formal training and untrained teachers, who have had none.

1.7.4 Science teachers

For the purpose of this study, the above term refers to teachers in government or government-assisted primary schools that are currently teaching science in their respective schools. They may alternatively be referred to as primary school science teachers or respondents in this study.
1.7.5 Primary schools

In this study, the above term refers to government or government-assisted primary schools. These schools offer basic education for children of 7 to 13 years of age and consist of six levels, namely Year One to Year Six.

1.8 Significance of the Study

This study hopes to provide information as to the levels of cognition with regards to the scientific understandings of selected science concepts among primary school science teachers and the factors, if any, that affect this area. This study also hopes to identify, if any, misconceptions held by teachers regarding certain science concepts covered in the KBSR science syllabus. The information could be used in the development of a suitable curriculum for the purpose of training, either at the pre-service level or in-house level. It is also of interest, in that it would pinpoint certain areas of study or concepts that may prove particularly difficult to master and thus, effectively teach.

1.9 Scope and Delimitations of the Study

This study will directly refer to primary school science teachers in the district of Kuching, Sarawak. However, this may not be representative of all primary school science teachers in the country and should not be generalised to that extent.

The study will attempt to measure the attitudes of primary school science teachers using a likert scale questionnaire. Hence, the assumption will be made that the teachers involved are answering the questionnaire truthfully.

The scientific understandings of the respondents analysed are limited to the basic concepts covered in the current KBSR science curriculum. Specifically, the concepts of distance, speed, time, sound, condensation and germination. Thus, the scientific understandings studied are only within the contexts of these concepts.

The scope of this study is limited to those variables previously mentioned.

1.10 Summary

This study supports the importance of the primary science educator to have good scientific understanding in the basic science concepts. It seeks to find the current levels of scientific understanding existing among primary school teachers and their distribution. It also seeks to find out the attitudes of these teachers towards science. Five objectives and twenty-nine research hypotheses are put forward. Six research questions are to be answered. However, the scope of this study is small and pertains only to the population in that area.
CHAPTER TWO
REVIEW OF LITERATURE

2.0 Introduction

The aim of this study is to analyse the understanding of primary school science teachers in specific basic science concepts, with regards to the levels of their scientific understanding and the possible contributing factors to the teacher’s current level of scientific understanding.

The basis of this study is thus the nature of the science educator’s understanding of elementary science concepts, which is related to the science educator’s cognition and concept development. Thus, these areas will be the mainstay of the following review of literature.

2.1 Science

As a background to this chapter, the nature of science will be briefly outlined. Then, the review will briefly touch on the aspect of teaching and learning in science.

2.1.1. A Brief Outline of Science and its Nature

Carin (1993) broadly defines science as an activity of questioning and exploring the universe and finding its hidden order. The scientist seeks conceptual models that can help to explain natural phenomena and provide accurate predictions based on data. He realises that current models are tentative and are subject to change as new facts are discovered. Carin (1993) ventures that science is a process whereby 'models of reality' are constructed.

According to Collette and Chioppetta (1994), science can be thought of as a broad-based, multi-dimensional human enterprise. It can be viewed as a way of thinking in the pursuit of understanding nature, as a way of investigating claims about phenomena and lastly, as a body of knowledge that has resulted from inquiry. They summarise science as a human activity that can be characterised by the thinking that occurs in the minds of people who participate in it.

Germann (1994) also shares this view. He states that "science is a human endeavour in which knowledge about the universe and its parts is sought, organised, constructed, and reconstructed through scientific methods. This inquiry is a systematic and creative application of scientific methods to seek answers and solve problems" (pg. 749).

Science has two main characteristics, according to Rigden (1983):

1. Its empirical character, referring to aspects that can be directly observed or experienced.
2. Its analytical nature, referring to dissatisfaction with mere observations and the need to look between the lines and seek hidden meanings, underlying patterns and propose explanatory schemes to bring coherence to these observations.

Poh (1997) lists the six different characteristics of science. Firstly, science is amoral. It should not be classed as "good" or "bad". Secondly, science is creative in that it can be used to develop new ideas and solve problems. Next, science is said to be progressive as it involves the latest and best explanations about natural phenomena. Fourthly, science is parsimonious. It is simple to understand as the scientist explains natural phenomena in a language that is clear and concise. Science can also be tested and tried. A new discovery should be able to withstand the same testing to achieve the same results. Finally, science is comprehensive. Scientific concepts, laws and theories are interlinked and may be applied in all branches of science.

2.1.2 The Teaching and Learning of Science

In education, these facets of science are ideally incorporated in the science curriculum. Elementary school science, for example, focuses on developing the individual's scientific knowledge (sometimes known as the products of science), scientific processes and scientific attitudes (Carin, 1993). The Primary School Science Curriculum for Malaysian schools (Poh, 1997) stresses the aspects of (a) experiential learning of knowledge that is relevant to the student's daily life, (b) inquiry approach, (c) investigation and problem solving, (d) the development of scientific and thinking skills, (e) the application of scientific principles, and (f) intrinsic cultivation of values.

Carin (1993) cites four comprehensive goals of elementary science education, as drawn up by the National Center for Improving Science Education, which are:

1. Elementary science programs should nurture and sustain children's natural curiosity about the world.
2. Elementary science programs should develop skills for investigating the natural world, solving problems and making decisions.
3. Elementary science programs should develop children's knowledge base in science and technology.
4. Elementary science programs should strive to develop children's understanding of and attitudes about the nature, limits and possibilities of science and technology.

Much has been said about teaching. A study by Kember (1997) attempted to review conceptions of teaching among university academics. Thirteen independent studies, which were all qualitative in nature, were discussed. Kember (1997) proposes that conceptions of teaching be categorised into two broad orientations: teacher-centred/content-oriented and student-centred/learning oriented. Each orientation can then be divided into two subordinate conceptions, with a transitional conception linking them (Figure 3).