UNIVERSITI PUTRA MALAYSIA

LEARNING PRIMARY SCIENCE IN A WEB-BASED LEARNING ENVIRONMENT

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DEDICATION

To my loving husband, Abdullah, who has understandingly endured the countless days that this study has taken from our relationship.

I further dedicate this thesis to my three children, Nurul Nadhirah, Nurul Afiqah, and Muhammad Akmal who have inspired me to keep going and hope this effort has also inspired them to keep striving for excellence.

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Learning primary science includes the acquisition of science process skills. Studies have shown that integrated science process skills should be taught through some form of specific training. This study adopts the use of Web-based learning environment in learning science process skills. The purpose of this study was to unravel the learning processes that occurred in the learning of science, particularly the skill of controlling variables, in a Web-based learning environment.

The study employed an exploratory qualitative case study which involved nineteen Grade Five children. The participants were selected using the purposive sampling technique. During the study, children explored the specially designed Web-based instructional material known as 'Science Process Skills in Scientific Exploration', in short SPicE.

The primary data collection techniques used in this study were interviews, children's conversations, observations, children's diary entries and entries from the on-line discussions. Data from interviews, conversations and observations were transcribed while relevant entries from children's diaries and on-line discussions were extracted. Data were analyzed using the constant comparative method of analysis.

The findings of the study suggest that there were three dimensions of learning, the cognitive, interpersonal and intrapersonal dimensions. These learning dimensions were intertwined among each other and were influenced by the design features of SPicE. Besides the acquisition of the intended skills, the findings also indicate that the children acquired other science process skills, manipulative skills as well as computer skills. There were four main factors that influence the acquisition of these skills; the programme, physical setting, the teacher and children's readiness.

Three major conclusions were drawn from this study. First, Web-based learning facilitates science learning. Second, besides the intended learning outcome, learners acquired other related skills such as manipulative skills and computer skills, in the Web-based learning environment. Lastly, skill acquisition in the Web-based learning environment is influenced by various external and internal factors.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan Ijazah Doktor Falsafah

PEMBELAJARAN SAINS SEKOLAH RENDAH DALAM PERSEKITARAN PEMBELAJARAN BERASASKAN JARINGAN

Oleh

ROHAIDA MOHD. SAAT

Mei 2003

Pengerusi: **Profesor Kamariah Abu Bakar, Ph.D.**

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Pembelajaran sains merangkumi penguasaan kemahiran proses sains. Kajian terdahulu menunjukkan bahawa kemahiran proses sains bersepadu perlu diajar secara terus dengan menggunakan latihan tertentu. Justeru, kajian ini menggunakan persekitaran pembelajaran berasaskan Jaringan dalam pembelajaran sains. Kajian ini bertujuan untuk mendalami proses pembelajaran sains, khususnya dalam penguasaan kemahiran mengawal pembolehubah dalam persekitaran pembelajaran yang berasaskan Jaringan.

Kajian kes ini menggunakan kaedah kualitatif yang bersifat tinjauan. Kajian ini melibatkan sembilan belas murid sekolah rendah dan mereka dipilih berdasarkan teknik persampelan bertujuan (purposive). Semasa kajian dijalankan, murid berinteraksi dengan satu bahan pembelajaran sains yang berasaskan Jaringan berjudul 'Kemahiran Proses Sains dalam Penerokaan Saintifik' atau dalam singkatan SPicE. Program ini direka khas untuk penguasaan kemahiran proses sains mengawal pembolehubah.

Data dikutip melalui temubual, perbualan murid, pemerhatian, diari murid dan perbincangan murid secara "Atas Talian" (on-line). Data dari temubual, perbualan dan pemerhatian ditranskripsikan manakala hanya data yang relevan diekstraksikan dari diari murid dan perbualan secara "Atas Talian". Analisis dilakukan dengan sentiasa membuat perbandingan antara data.

Dapatan mencadangkan bahawa proses pembelajaran sains dalam persekitaran pembelajaran berasaskan Jaringan melibatkan tiga dimensi, iaitu dimensi kognitif, interpersonal dan intrapersonal. Ketiga-tiga dimensi pembelajaran ini berkait rapat antara satu sama lain dan dipengaruhi ciri reka bentuk SPicE. Selain daripada penguasaan kemahiran yang dirancangkan, dapatan juga menunjukkan bahawa murid menguasai kemahiran proses sains yang lain seperti kemahiran manipulatif dan juga kemahiran komputer. Dapatan juga mencadangkan bahawa terdapat empat faktor yang mempengaruhi penguasaan kemahiran; iaitu program SPicE, susun atur fizikal, guru dan kesediaan murid.

Tiga kesimpulan dapat dibuat daripada dapatan kajian ini. Pertama, pembelajaran berasaskan Jaringan dapat meningkatkan pembelajaran sains. Kedua, murid menguasai kemahiran lain dalam persekitaran pembelajaran berasaskan Jaringan. Akhir sekali, penguasaan kemahiran dalam persekitaran pembelajaran berasaskan Jaringan dipengaruhi beberapa faktor dalaman dan luaran.

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INTRODUCTION

Background to the Study

Science education has been a vital part in the school setting in many countries across the world. This is because science and technology is regarded as the prime mover of the economic development of a nation (Ministry of Science, Technology and Environment, 2000). Developed countries such as the United States of America, Germany, United Kingdom, Japan and Australia have introduced science as early as kindergarten or at primary level. The United Nations Educational, Scientific, and Cultural Organization (in short UNESCO), recommends that science be taught in primary schools, as the teaching and learning of science has direct influence on how children think logically about the everyday phenomena and how they solve daily problems (as cited in Ministry of Education Malaysia, 1993a). Such intellectual skills nurtured at an early age, will be a valuable asset to the children, as the learning of science fosters creative and innovative minds.

Tilgnes (1990) pointed out several benefits of learning science at an early age. The learning of science helps students to acquire the habit of questioning, the ability to evaluate premises and variables, the desire to search for patterns and meanings of a collection of data, and to approach logically the solution of problems. In short, students are able to acquire a systematic method of studying the things around them.

Another reason for introducing science at an early age is that children are known to possess universal qualities regardless of their individual genetic or cultural differences. They are curious, persistent, interpretive, energetic and adventurous (Kellough, Carin, Seefeldt, Barbour, and Souviney, 1996) which are analogous to the nature of science. In view of this, science is deemed suitable to be taught at an early age as the characteristics of children complement the nature of science.

In fact the teaching of science at an early age is widely practised in most countries in the world. Science education including science at elementary or primary level worldwide has undergone several changes and innovations, aimed at improving the quality of science education. In the mid 1950’s rigorous science curriculum reform took place in the United States of America, especially when the Soviet Union launched its earth orbiting satellite Sputnik in October 1957 (Bybee and DeBoer, 1994). The American government then became enthusiastically involved in improving the teaching of science. Among the innovations that have gained much attention is the inquiry approach in teaching science. As DeBoer (1991) stated, "If a single word had to be chosen to describe the goals of science educators during the 30-year period that began in the late 1950's, it would have to be INQUIRY" (p.206).

Inquiry was popularized by John Dewey back in the early 1900's, though it was commonly known as problem solving (Barr, 1994). Inquiry is synonymous to science since the nature of which Schwab (1962) argues is itself an inquiry process, where one finds the source and the cause of phenomena. Through this process, students are actively solving problems and discovering scientific knowledge. This marks the beginning of the process approach adopted in science education. The process approach focuses on many skills that human use to construct knowledge, to represent ideas, and to communicate information. The acquisition of these skills will enable students to solve problems better.

The Process Approach

Since the mid-1900's, there has been a growing support for the teaching of science processes as a part of school curriculum (Finley, 1983). In this respect, Gagne (1963) views science process skills as the foundation for scientific inquiry and knowledge is developed inductively from sensory experience. According to Gagne (1963), basic science process skills include observation, inference, classification, predicting, collecting and recording data, and measurement. These skills are simpler and provide a foundation for learning the integrated or more complex skills which includes controlling variables, interpreting data, defining operationally, formulating hypotheses, and experimentation.

Schwab's idea on inquiry and Gagne's idea of science process skills have been embraced in projects such as SAPA (Science - A Process Approach) Project, Warwick Process Science, Science in Process (Woolnough, 1991). The developers of these projects believe that science is best taught as a procedure of inquiry that is a process of finding out, which involves the development of certain attitudes and skills. This enhances the development of specific thinking skills believed to be used by scientists in their work. This claim is supported by a study done by Davis (1979). Davis reported that SAPA students scored higher than students in the control groups on a subtest of Torrance Test of Creativity. In addition, these SAPA students were also found to produce more and a greater variety of ideas or questions. Bredderman (1982) reviewed more than 60 studies reported over a 15-year period which involved classrooms using process-oriented curricula. The results of these studies revealed a consistent pattern where children in the process-oriented classrooms outperformed the students in the control group, in all categories: creativity, attitudes, logic, and science content.

Although there is an increased popularity in the process approach in science curriculum, some science educators (Millar and Driver, 1987) have criticized this approach. Millar and Driver argue that there is no one scientific method as scientists work in a variety of ways. They also question whether science processes are situation specific or transferable, as people do generalize and transfer what they have learned from one situation to another. Some science educators (Ramsey and Howe, 1969; Millar and Driver, 1987) even believe that process skills such as hypothesis formation, are intuitive and cannot be taught, but many (Harlen, 1999; Pappelis and Pohlmann, 1980) signify the importance of science process skills. These skills are involved in scientific inquiry and discovery, where through these processes scientific knowledge is constructed.

Process skills are sometimes known as the basic problem solving skills, scientific method, scientific thinking, critical thinking, inquiry skills, and intellectual skills (Helgeson, 1994). Almekinders, Thijs and Lubben (1998) also referred to process skills as procedural understanding. According to them, the learning of science not only gives the understanding of the science content and methods of inquiry, but includes the understanding of methods and procedures of practical inquiry. Despite differences in the terms used, there is considerable agreement about what these terms mean. They are general descriptors of logical and rational thinking which are used in many areas of human endeavour. If used in some context in science, they are known as scientific process skills (Harlen, 1999; Millar and Driver, 1987). Therefore, science process skills are considered the vital skills needed in the learning of science since they involve the process of scientific inquiry. As cited by Harlen (1999),

> "...Learning with understanding in science involves testing the usefulness of possible explanatory ideas by using them to make predictions or to pose questions, collecting evidence to test the prediction or answer the questions and interpreting the results; in other words, using the science process skills" (p. 131).

Looking back at the importance of introducing science at the primary level and accepting the argument that science process skills are part and parcel of science education, one main question arises. Are the science process skills being taught at primary level the same as at the secondary level? Sometimes these skills seem to be hierarchical in nature. For example, before students can classify, they need to master the skill of observation. This is in line with SAPA project's argument, that the basic skills provide the basis for the learning of the more complex skills (Gagne, 1963). If this hierarchy exists, should the basic skills be more appropriately taught at primary level and the more complex skills be taught at secondary level?

Besides, these complex skills or integrated skills such as formulating hypotheses and controlling variables require one to operate at the Formal Operational Stage of Piaget's Stages of Cognitive Development Model (Inhelder and Piaget, 1958). In fact Brotherton and Preece (1995) found that there is a relationship between science process skills and Piagetian Reasoning Patterns. The integrated skills require a higher cognitive demand. Analysis of test items in the *Assessment of Performance Unit* (APU) by Adey and Harlen (1986), also found that these items on process skills have the same characteristics as the *Level of Demand in Piagetian Term*. The so-called complex science process skills require higher cognitive demands on the students.

However, many countries such as the United States, United Kingdom and Malaysia include these integrated skills in the primary science curriculum. Studies by Inhelder and Piaget (1958), Shayer, Kuchermann and Wylam (1976) and Palanisamy (1986) have shown that most primary school students are operating at the concrete operational stage. Some characteristics of students at this stage are that they able to think logically, able to perform mental operations