THE EFFECTIVENESS OF HANDS-ON/AUTHENTIC LEARNING ON ELEMENTARY SCHOOL STUDENTS' ACHIEVEMENT IN AND ATTITUDES TOWARDS SCIENCE

[1]Nik Azmah Nik Yusuff, [2]Norazimah Md Ali, [3]Norazilawati Abdullah, [4]Ong Eng Tek
[1, 3,4]Universiti Pendidikan Sultan Idris, Malaysia
35900 Tanjong Malim, Perak
[2]SK Kerling, Hulu Selangor

Abstract

This study is aimed at determining young students' achievement in the standard 5 science content, and attitudes towards science, after experiencing hands-on learning. Ten pupils from one elementary school in Selangor were purposively selected as participants. Observations and interviews were the methods used to collect data, and rubrics were specially designed as assessment tools. Data collected from observation were analysed descriptively while from interviews using NVivo 2.0. It is found that the attitudes of the pupils are positive towards science after experiencing hands-on learning, and they are able to link concepts taught through experiments to their daily life experience. Also, hands-on/authentic teaching and learning is found to be an effective pedagogy which increases pupils' achievement as well as improves their understanding of science concepts. The young students are found to be highly motivated, hence hands-on/authentic teaching and learning is recommended to be implemented by elementary school teachers in Malaysia.

Keywords *Hands-on/authentic Teaching and Learning, Achievement and Attitudes, Primary School Science.*

Abstrak

Kajian ini bertujuan untuk menentukan pencapaian dalam kandungan sains tahun 5 dan sikap murid berkenaan terhadap sains selepas menjalani pembelajaran secara amali. Sepuluh orang murid dari sebuah sekolah rendah di Selangor telah dipilih secara bertujuan untuk menjadi peserta kajian. Pemerhatian dan temu bual merupakan kaedah untuk mengutip data serta rubrik telah dibina khas untuk digunakan sebagai alat pentaksiran. Data yang dipungut melalui pemerhatian telah dianalisis secara deskriptif sementara daripada temu bual menggunakan NVivo 2.0. Dapatan kajian menunjukkan sikap murid adalah positif terhadap sains selepas mereka melalui proses pengajaran dan pembelajaran secara amali dan dapat mengaitkan konsep yang dipelajari secara eksperimen dengan pengalaman harian mereka. Juga, pengajaran dan pembelajaran secara amali/autentik merupakan suatu pedagogi berkesan yang meningkatkan pencapaian murid serta menambah baik kefahaman konsep sains mereka. Murid didapati bermotivasi sangat tinggi, lantaran itu pengajaran dan pembelajaran secara amali/autentik disarankan untuk dilaksanakan di sekolah rendah oleh guru sains di Malaysia.

Kata kunci *Pengajaran dan Pembelajaran secara amali/autentik, Pencapaian dan Sikap, Sains Sekolah Rendah.*

INTRODUCTION

Elementary or primary (as it is known in Malaysia) school stage is a formative phase in young students' development. What students experience and acquire during this stage lay the foundation for a successful secondary school stage. Malaysian education system has thrived to deliver competent citizens ever since her Independence in 1957. However, after 40 years of implementing the education system, the number of students choosing science in their upper secondary schools starts to decline and has since become of greater concern in this millennium. Supported by a growing body of recent research that showed most students develop their interest and attitudes towards school science before the age of 14, has turned primary school science teaching and learning into national agenda on how to improve the situation.

Researchers and practitioners have become increasingly interested in how early teen programs prepare young students for science. Due to a number of factors, including educators' low self-efficacy for teaching science and lack of educational resources many primary school classrooms do not offer high-quality science experiences for young students. Science teachers seldom use strategies other than basic recall as primary methods for teaching science to young students. Didactic teaching and one-way transfer of information from teachers to students are common scenarios where high-stake examinations influence the education school calendars and how science teachers approach their teaching of science. Hands-on teaching and learning, carrying out science experiments, or authentic teaching apparently perceived as good by teachers but they are apprehensive or reluctant to adopt them in their science classrooms.

However, as part of the international call for the scientific literacy of all citizens in society there is increasing support for a more authentic science education in schools, where the understanding of the nature of science and inquiry-based learning are important components of education (Atkin & Black, 2003; Tytler, 2007), efforts are being made in Malaysia to improve science education and has made it into a national priority to strengthen the nation's position in discovery and innovation.

Aspiration of educationists for an instructional shift in science teaching, moving away from teacher-centred, less effective instruction and toward the use of more effective instructional practices, including inquiry and exploration driven by student interests in the context of the real world (Anderson, 2002; NRC, 1996) have been a focus of reform in many nations including Malaysia. According to the National Science Education Standards (NSES), "learning science is something that students do, not something that is done to them" (p. 20). In an inquiry-based classroom, students should be engaged in inquiry through describing objects and events, posing questions, gathering data to construct explanations, conducting investigations, and considering alternative explanations. Students "actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills" (p.2). Science is for all students and is an active process grounded in how science contributes to culture (NRC, 1996).

Inquiry-based learning has been strongly encouraged by most science educators because students are provided with opportunities to ask questions, explore, plan, and most importantly, construct new knowledge and reflect on their learning (Chen & Howard, 2010; Shedletzky & Zion, 2005)

According to Hume and Coll (2010) international science curriculum have been redeveloped in the last two decades that increasingly advocates a "new look" inquiry-based approach to learning. The nature of the student-experienced curriculum where students are learning under a national curriculum that is intent on promoting students' knowledge and capabilities in authentic scientific inquiry, that is inquiry that properly reflects that practised by members of scientific communities.

Authentic scientific inquiry is most simply described as the "doing of science" in a manner that mirrors the actual practice of scientific communities (Atkin & Black, 2003; Hume, 2009). This activity is not about getting "right answers" or using a single, unproblematic method, often cited as the "scientific method". Rather it is a social practice involving scientists investigating the natural world in diverse ways (Watson et al., 1999) where they interpret, negotiate and justify their inquiry approach in order to build believable and plausible explanations about how the physical world works (Haigh et al., 2005; Sandoval, 2005).

Beside the pedagogical aspect of teaching science is the concern over student interest in science education and to develop a positive attitude toward science regardless of individual differences (Arisoy, 2007; Azizoglu & Cetin, 2009). According to Osborne (2003, p.1050) attitude can be defined as "feelings, beliefs and values held about the enterprise of school science, school science and the impact of the science on society". Additionally, Newhouse (1990) emphasizes that attitude is a very important factor in influencing human behavior. Attitude is affected by personal opinion, and these opinions can be formed through personal life experiences and education. There is a relationship between science learning environment and students' attitude toward science (Riah & Fraser, 1997; Wahyudi & David, 2004; Telli,Çakiroglu & den Brok, 2006) and attitudes toward science involves the students' affective behaviours such as their preferences, acceptance, appreciation and commitment. Science achievement, student-student and student-teacher interaction and the classroom learning environment are factors and have an effect on the attitude toward science (Ali et al., 2013).

In Malaysia, the ministry of education has been revising the nation's education system from time to time, with the latest being the Malaysia Education Blueprint 2013 – 2025 (PPPM 2013 -2025). The new curriculum - Standard Curriculum of Primary Schools (KSSR) of teaching and learning is partnered with a new assessment method, School-Based Assessment (PBS). National standardized examinations have been the main focus of schools and parents alike, and since previous examinations focus on recall of content knowledge through the de-contextualised facts, didactic teaching method has been a norm among teachers, and accompanied by drills to prepare students to be examination-smart.

Transformation from exam-oriented teaching and learning to holistic teaching and learning through the implementation of the PPPM 2013-2025 is however facing great hurdles, as the previous Malaysia Education Blueprints have had. Nevertheless, if every quarter is willing to make a paradigm shift in the thinking about education of the future, the education plan is apparently a superb foundation for science learning. Reportedly, most primary science teachers have struggled to complete science syllabus in limited science time and therefore choose didactic teaching strategies that overemphasise basic recall. While internationally schools abroad are practising authentic scientific inquiry, Malaysian primary schools still lag behind even in performing hands-on science or doing science practical work. This paper is trying to expose to Malaysian primary science teachers how beneficial practical work, or hands-on science activities can be, and its effect in influencing young students' achievement in and attitude towards science, which are the intents of education. As well as how hands-on learning coupled with school-based assessment is carried out using teacher-designed authentic assessment tools to record young students' achievement in and attitudes towards science. This study can act as an exemplar of school-based assessment method.

THEORETICAL FRAMEWORK

Situated learning is used as the theoretical foundation for this study (Brown et al. 1989; Lave & Wenger, 1991; Resnick, 1987). The fundamental basis of situated learning theory is that knowledge should not be the transmission of de-contextualised facts from teachers to students. Rather, learning is a social process where knowledge is co-constructed within a learning environment mirroring the real world (Lave & Wenger, 1991). This framework provides an authentic approach for science instruction in which enhanced context, collaborative learning, questioning, and inquiry are included in a real-world situated approach to teaching important concepts (Resnick, 1987; Schroeder et al., 2007). This study that focuses on hands-on/authentic learning has involved the young students actively in the activities and allow for scientific communication to take place amongst them and with their teacher.

Newmann and Archbald (1992) suggest that assessment should focus on the achievement of authentic learning outcomes. The focus adopted for assessment has a substantial impact on the instructional process and the realisation of intended learning outcomes. Meaning that, assessment signals to teachers and students what is important in learning. Assessment tasks need to relate to and take account of actual teaching and learning processes. The situated learning theory posits that learning and performance are "situated", that is developed within a context, that the actual schema of the domain knowledge and processes are different from different contexts. Therefore, a performance demonstrated in one context may not be indicative of capability for performance in another context. In this case, it is necessary to assess within the relevant learning context (Cumming, J. J. & Maxwell, G. S., 1999). This study has made use of this situated learning theory whereby for every activity, a specific tool is developed to assess the young students' achievement and skills.

METHOD

The participants were purposively selected from one primary school in the state of Selangor. Ten year-five primary school students were involved in this study. They were 11 years old, six of them were girls and four were boys. The study was carried out during school hours. Each science period was 60 minutes, and there was one science class in a week. They work in small groups. For practical work, the young students carried out four separate science experiments in the school laboratory, and two science activities outside the laboratory. The practical work and activities were carried out hands-on/authentically. During and after each practical work or science activity, the young students were provided with work sheets containing relevant questions posed as a guide to elicit their understanding and did some writing work in their exercise books. In the process of teaching and learning between teacher and student, substantial discussion about the relatedness of the experiments or scientific activities to their everyday lives was established.

Data were collected by means of observation using rubrics developed by the researchers in order to assess the young students' science content/achievement and their attitudes towards science. Other than direct observation as a mean to collect data, document analysis from exercise books and work sheets, and a semi-structured interview protocol developed by the researchers were carried out to gain data in this study. Therefore each activity carried out by the young students was assessed using an authentic-designed rubric specific to the context of teaching and learning to gauge their levels of science content knowledge or science achievement. After the hands-on teaching and learning, the young students were interviewed to gain insights into their opinions on their science experience, motivation, and interest. Data collected from recorded interviews were coded, put into relevant themes and analysed using NVivo version 2.0.

RESULTS

Results from this study will be presented in two sections: The first is from observations, and the second from interviews.

Section 1: Observation

The young students carried out four experimental activities. These were series electrical circuit, parallel electrical circuit, growth of fungus on bread, and temperature change in water.

(a) Series electrical circuit.
Achievement in content knowledge and skills were measured using a rubric designed specifically for assessing series electrical circuit (Table 1). While the young students were engaged with their work, the teacher went around scaffolding their learning, observed and wrote notes in the teacher's note book. The students' result was shown in Table 2. The students were graded between good and excellent for all four criteria, but they were better at listing the materials and apparatus and draw the circuit than construction, and functionality of the circuit.

Table 1 Rubric for assessing series electrical circuit

Name: ___________________________ Year: ___________ Date: ____________

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Need Guidance (1)	Score
Listing the materials and apparatus	Can list down all	Can list down most	Can list down a few	None	
Construction of the series circuit	Can construct the series circuit correctly	Most components are connected correctly	A few components are connected correctly	All components are connected wrongly	
Functionality	Both menthols light up with same brightness	Both menthols light up with different brightness	One menthol only light up	Both menthols do not light up	
Draw the series circuit	Can draw the series circuit correctly	Most components of the circuit are drawn correctly	A few components of the circuit are drawn correctly	All components of the circuit are drawn wrongly	
Total Score					

Table 2 Experiment on series electrical circuit

	Achievement								
	Excellent (4)		Good (3)		Satisfactory (2)		Need Guidance (1)		
Criteria	Number of students	%	Number of students	%	Number of students	%	Number of students	%	Mean
Listing the materials and apparatus	6	60	4	40	0	0	0	0	3.6
Construction of the series circuit	3	30	7	70	0	0	0	0	3.3
Functionality	2	20	8	80	0	0	0	0	3.2
Draw the series circuit	6	60	4	40	0	0	0	0	3.6

(b) Parallel electrical circuit
Achievement in content knowledge and skills were measured using a rubric designed specifically for assessing parallel electrical circuit (Table 3). The criteria were almost the same as in series electrical circuit. The students' result was shown in Table 4. The students were graded between satisfactory and excellent for all four criteria, but they were only better at listing the materials and apparatus (but not all were at excellent levels) and less at drawing the circuit, construction, and functionality of the circuit compared to the earlier series electrical circuit.

Table 3 Rubric for assessing parallel electrical circuit

Name: ____________________________ Year: _____________ Date: ____________

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Need Guidance (1)	Score
Listing the materials and apparatus	Can list down all	Can list down most	Can list down a few	None	
Construction of the parallel circuit	Can construct the parallel circuit correctly	Most components are connected correctly	A few components are connected correctly	All components are connected wrongly	

Functionality	Both menthols light up brightly with same brightness	Both menthols light up but with different brightness	One menthol only light up	Both menthols do not light up
Draw the parallel circuit	Can draw the series circuit correctly	Most components of the circuit are drawn correctly	A few components of the circuit are drawn correctly	All components of the circuit are drawn wrongly
Total Score				

Table 4 Experiment on parallel electrical circuit

	Achievement								
	Excellent (4)		Good (3)		Satisfactory (2)		Need Guidance (1)		
Criteria	Number of students	%	Number of students	%	Number of students	%	Number of students	%	Mean
Listing the materials and apparatus	6	60	4	40	0	0	0	0	3.6
Construction of the series circuit	2	20	7	70	1	10	0	0	3.1
Functionality	2	20	7	70	1	10	0	0	3.1
Draw the series circuit	3	30	6	60	1	10	0	0	3.2

(c) growth of fungus on bread

Achievement in content knowledge and skills were measured using a rubric designed specifically for assessing growth of fungus on bread (Table 5). Five criteria were observed for this experiment. Results were shown in Table 6. Attendance was perfect during the five-days observation by the students followed by listing the materials and apparatus. However, the mean was only 2.3 for drawing the growth of fungus.

Table 5 Rubric for assessing growth of fungus on bread

Name: ______________________________ Year: ______________ Date: _____________

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Need Guidance (1)	Score
Listing the materials and apparatus	Can list down all	Can list down most	Can list down a few	None	
Attendance	Attend and observe the bread everyday	Attend and observe the bread 3-4 days	Attend and observe the bread 1-2 days	No attendance	
Observe and draw the growth of fungus	Draw the changes in fungus growth clearly	Draw the changes in fungus growth quite clearly	Draw the changes in fungus growth not very clearly	Draw the changes in fungus growth wrongly	
Explain the changes in bread after 5 days	Explain the changes in bread after 5 days correctly	Explain the changes in bread after 5 days partly correct	Explain the changes in bread after 5 days barely correct	Explain the changes in bread after 5 days wrongly	
Conclusion	Making conclusion of the experiment correctly	Making conclusion of the experiment partly correct	Making conclusion of the experiment barely correct	Making conclusion of the experiment wrongly	
Total Score					

Table 6 Experiment on growth of fungus on bread

	Achievement								
	Excellent (4)		Good (3)		Satisfactory (2)		Need Guidance (1)		
Criteria	Number of students	%	Number of students	%	Number of students	%	Number of students	%	Mean
Listing the materials and apparatus	6	60	4	40	0	0	0	0	3.6
Attendance	10	100	0	0	0	0	0	0	4.0

Observe and draw the growth of fungus	1	10	3	30	4	40	2	20	2.3
Explain the changes in bread after 5 days	4	40	4	40	1	10	1	10	3.1
Conclusion	3	30	5	50	2	20	0	0	3.1

(d) temperature change in water
Achievement in content knowledge and skills were measured using a rubric designed specifically for assessing temperature change in water (Table 7). There were four criteria measured for this experiment.

Table 7 Rubric for assessing temperature change in water

Name: ____________________________ Year: _____________ Date: ____________

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Need Guidance (1)	Score
Skills in using thermometers	Operate the thermometer correctly and cautiously	Operate the thermometer quite correctly	Operate the thermometer less correctly	Operate the thermometer wrongly	
Recording the temperature change	Recording the temperature change precisely	Recording the temperature change quite precisely	Recording the temperature change less precisely	Recording the temperature change wrongly	
Making prediction	Making prediction about the temperature change correctly	Making prediction about the temperature change quite correctly	Making prediction about the temperature change less correctly	Making prediction about the temperature change wrongly	
Making conclusion	Making conclusion of the experiment correctly	Making conclusion of the experiment quite correctly	Making conclusion of the experiment less correctly	Making conclusion of the experiment wrongly	
Total Score					

Results were shown in Table 8. It was shown that majority of the students were not at excellent level at using the thermometer or recording the temperature change. Making prediction or making conclusion also yielded the means of 3.3 or 3.2 respectively.

Table 8 Experiment on temperature change in water

	Achievement								
	Excellent (4)		Good (3)		Satisfactory (2)		Need Guidance (1)		
Criteria	Number of students	%	Number of students	%	Number of students	%	Number of students	%	Mean
Skills in using thermometers	2	20	6	60	2	20	0	0	3.0
Recording the temperature change	3	30	6	60	1	10	0	0	3.2
Making prediction	4	40	5	50	1	10	0	0	3.3
Making conclusion	2	20	8	80	0	0	0	0	3.2

(e) Attitude

Attitude of students was measured using a rubric designed specifically for assessing attitude (Table 9). There were six criteria measured for this.

Table 9 Rubric for assessing attitude

Name: ____________________________ Year: __________ Date: ___________

Criteria	Excellent (3)	Good (2)	Weak (1)	Score
Attendance	Attend to all activities	Attend to most activities	Attend to few activities	
Involvement	Involve in all the activities and spend a lot of time completing the work	Involve in almost all the activities and spend quite a lot of time completing the work	Do not get Involve in all the activities and spend little time completing the work	
Thinking of others	Showing respect and care to others at all times	Showing respect and care to others most times	Never show any respect and care to others at all times	
Sharing	Sharing ideas to complete tasks at all times	Sharing ideas to complete tasks most times	Never Share ideas to complete tasks at all times	
Making group decisions	Making group decisions after consulting all group members	Making group decisions after consulting almost all group members	Making group decisions without consulting any group members	

Overall tasks performance	Complete tasks without mistakes on time	Complete tasks with few mistakes on time	Incomplete tasks with many mistakes
Total Score			

Results were shown in Table 10. It showed that the students' interest was overwhelming indicated by full attendance, willing to share ideas and making efforts to complete tasks. However two young students were observed to be weak in involvement criterion because they were not involved in all the activities and one student did not show respect or care to others.

Table 10 Attitude

	Achievement						
	Excellent (4)		Good (3)		Weak (2)		
Criteria	Number of students	%	Number of students	%	Number of students	%	Mean
Attendance	10	100	0	0	0	0	4.0
Involvement	5	50	3	30	2	20	3.3
Thinking of others	6	60	3	30	1	10	3.5
Sharing	8	80	2	20	0	0	3.8
Making group decisions	7	70	3	30	0	0	3.7
Overall tasks performance	6	60	4	40	0	0	3.6

Section 2: Interviews

This analysis was specified into three themes: students' perception on science teachers. Students' motivation, and students' joy in learning science.

For the student's perception on science teachers, aspects discussed were: doing experiments, group work activities, the use of real objects and materials, and teaching aids.

a. Students' perception on science teachers

(i) Doing experiments

These were examples from their answers: "My science teacher often have us do experiments", "If possible, I like to carry out experiments in the lab for every science period", "To experiment with series circuits and parallel circuits in groups", and "I'm interested in science subject since Year 1 but I like this year the most because before this, we had very few experiments. This year my teacher let us do many experiments and science activities".

Explanation:
The young students like to carry out science experiments and science activities. They wish that they can do experiments every time there are science periods. Unfortunately they carry out very few experiments in schools except for this year.

(ii) Using real objects and materials and teaching aids.
Examples of the young students' answers: "Sometimes my science teacher use video to teach", "My teacher teaches using apparatus like batteries, battery holders, menthols, switch, and crocodile clips during practical classes. We watch and hold the apparatus with our hands", "Sometimes we do just exercises in science class. We don't do any activities", and "It doesn't interest me because I can't see what happen with my own eyes. Writing and listening only in class make me bored. I like to do experiments to find out how things happen and when we do experiments, we can hold the real science apparatus and materials".

Explanation:
The young students like to do experiments because they can hold the apparatus and materials themselves. They don't like just writing and doing exercises or listening about science all the time.

(iii) Working in groups
Examples of their answers were: "Sometimes we have group activities and make presentations", and "We work in groups to investigate series and parallel electrical circuits".

Explanation:
The young students like to work in groups when carrying out experiments, and do presentations.

b. Students' motivation

(i) Student's understanding
Among their answers were: "We can really see the apparatus and materials and not just looking or reading in the books. We can hold them with our hands, we can connect the wires to construct the circuits and see for ourselves the menthols light up. Make me understand", "I understand because I myself do it using real objects", "I really understand because I use the apparatus and do the experiments", and "I understand more if my teacher teaches by means of doing experiments because I myself see them".

Explanation:
The young students understand better the content area if the science teacher lets them do the experiments themselves using real apparatus and materials.

(ii) Working together in groups

Among answers given were: “When working individually, we get less ideas. But in groups, a lot of ideas can be contributed to help solve the tasks given. When working together in a group, work become easier and faster. It’s difficult to work all alone. We also can share knowledge among friends and it’s very beneficial”, “Discussing in groups is a good activity. My group size is suitable to hold discussion. I like my group because we work and help each other. Group activities are beneficial, allow everybody to contribute ideas, less energy needed, and the activities can be done faster and easier”, “I also like to do folios and l like group work as it makes the work easier. And if possible not much writing work”, and “I like to do activities in groups”.

Explanation:

The young students like to do activities as a group. They can share ideas to solve problems and they think working in groups can save energy and time.

(iii) New knowledge

Some of their answers were: “I learn something new about menthols, switches, and batteries”, and “I learn new things and do many science activities”.

Explanation:

The young students said they had learnt new things having done science activities using real objects and apparatus.

c. Students’ joy in learning science

(i) Doing Experiment

Some examples of the young students’ answers: “Because by doing experiment I can see how things happen. For example, I can see the difference between series and parallel circuits because I do the experiments and can see the brightness of the menthols”, and “Yes, I like doing experiments. We can see for ourselves any events, such as how menthols’ brightness differ in different circuits. Before this, I do not know even after reading books, now I know for sure”.

Explanation:

The young students liked doing experiments using real objects and apparatus. They can see real evidence by handling the experiments themselves.

(ii) Making folios

Examples of the young students’ answers were: “I like making folios and don’t feel burdened by it. In fact, I’m happy because I can search in internet and from books for materials, and I find new things that I don’t know before”, and “I like making folios”.

Explanation:
The young students liked making folios, and they found out about many things which they don't know before.

(iii) Doing field work
Some examples of their answers: "I like to learn outside the classroom if the topics is about plants and animals", "If possible, I want my teacher to take me out from the classroom, walking around school compound to observe plants and animals", and "If possible, less writing work, but looking out for plants and animals outside the classroom and do some investigation would be fun. I like it if I can watch and investigate about plants and animals".

Explanation:
The young students like it if they can learn about plants and animals by making observation in the real world.

DISCUSSION

Science achievement

Learning theories recognize that learning is dependent on complex interrelationships of cognitive, affective and socio-cultural factors (Resnick, 1989). Context also has significant effects on learning and performance (Wiggins, 1993; Anderson et al., 1996). The changing focus of assessment has led to two major theoretical considerations. The first relates to conceptions of validity. According to Maxwell (1997) this conceptions of validity should emphasize interpretations of quality and judgements of standards than with measurement-oriented or psychometric approaches based on a true score theory. The second relates to the need for learning and assessment of learning to be contextualized and meaningful for students. In resonance with the changing focus of assessment, rubrics were constructed for every experiments and they were found to be effective tools to assess the levels of knowledge and skill of the young students. Most of the students achieved the objectives of the lessons planned. Within the rigid time frame, where science periods are fixed in the school time table, all except a few were found to have acquired the expected knowledge and skills.

The concept of authentic assessment has been embraced enthusiastically by educationists and has led to different interpretations to the concepts. Four major interpretations of authentic achievement and authentic assessment relate to: performance assessment, situated assessment, problem-based assessment, and competence-based assessment (Cumming & Maxwell, 1999). Situated learning and situated assessment emerges from theories of learning which claim that learning occurs best, or perhaps only, within context (Campione & Brown, 1990; Cumming & Maxwell, 1999). These theories posit that the actual schema of the domain knowledge and processes are different for different contexts. Therefore, a performance demonstrated in one context may not be indicative of capability for performance in another context. However Anderson et al. (1996) discuss a continuum of theories of "situatedness". That is, theories related to situated learning range from those that posit possibilities of transfer of learning across contexts. From this study, almost all students could name the apparatus and materials in experiments, and construct the series and parallel electrical circuits and later drew the circuits, suggesting a transfer of learning across contexts. Our findings also indicated support to the idea that the actual knowledge, skills, and processes are different for different contexts. For examples, changes in bread caused by the fungus, drew what they saw, handled a thermometer correctly, and recorded the temperature change. Paralleled to our study that showed a positive achievement among the young students was the findings by Hacieminoglu, (2016) that there was a negative relation between students' achievement and a rote learning approach while it has a positive relation between students' achievement and self-efficacy as well as meaningful learning.

Through situated and hands-on learning, those few who could not achieved the required skills were noted by the teacher, and will be given extra attention to in future science classes where similar experiments using same apparatus and materials such as thermometers, graph papers, connecting electrical wires, and measuring cylinders. The science teacher can precisely document the young students' progressive improvement in their science skills/science process skills over time. Those evidences can be used to enter discussion with the affected students to make them accountable to their own learning and to provide ground for them to try harder.

By implementing authentic teaching and learning and authentic assessment method, the science teacher armed with the rubrics or evidence, can evaluate which topic/activities deemed difficult for the young students to comprehend, or which science process skills need more practice. As in this case, the parallel electrical circuit is found to be more difficult than the series circuit. More students could not construct the parallel circuits to make them function or draw the circuits correctly.

The growth of fungus also was found to be a difficult topic for the young students because some of them could not explain the changes they observed on the bread as well as to draw correct conclusion. This is only natural because fungus such as the bread fungus is microscopic. With this evidence, the teacher should continue this topic by having students scrutinize the fungus under the microscope to see the structure of the fungus during different phases of its growth or life cycle in future science class or show slides or videos on the growth of the fungus. On the other hand, this topic is suitable for project-based learning, and according to Knezek et al., (2013) carefully designed project-based activities that encourage inquiry-based learning can be very effective at the middle school level.

The skill of using and reading the thermometers also was found to be difficult to some of the students. Thus the science teacher should emphasise on learning how to read the measurement on the thermometers, by holding a discussion session on this matter. Just as Gerde et al., (2013) suggest that using the scientific method to explore science with young students provides a systematic model for engaging them in observation, questioning, predicting, experimenting, summarizing, and sharing results. These processes encourage young students' use of language, literacy, and mathematics skills in authentic ways.

Recording readings also was found to be a skill that appear to be a problem to some. What the science teacher could do is to hold a discussion session on how to draw and read tables properly. Then plan future activities that require the use of tables to expose the young students more on the matter. When the young students acquire the skills of reading tables and graphs, they would be better able to make correct predictions. This supports statement by Verma et al., (2011) that such hands-on activities not only improve achievement but also develop communication, critical thinking and problem-solving.

Johnson et al., (2012) found in their longitudinal prospective cohort study science that authentic science teaching or inquiry and contextualized science instruction enhances long-term retention of learning. Their findings revealed that all students who experienced effective science teachers who engaged students in inquiry-based science outperformed students who had less effective teachers. Additionally, those who had more effective teachers over time performed increasingly better.

Another aspect from this finding is that some of the students lack confidence in their ability to draw what they observe in their experiments. What transpires here could probably because the young students think that drawing is the ability of the talented few. What the science teacher could do is to demonstrate to the students that scientific drawing is simple and precise, and not necessarily pretty as arts drawing and is everyone’s basic ability. Moebius-Clune et al., (2011) found that open inquiry showed significant student science-content learning. However suggest the need for more teacher-scaffolding in complex, open-ended assignments. Even in such “close inquiry” as in this study teacher-scaffolding is much needed.

Attitude

The quest for contextuality and meaningfulness arises from general awareness that learning and performance depend on context and motivation (Wiggins, 1993) while Murphy (2009) states that students are motivated to learn when their learning is hands-on and more personalized with the result that students perform real-world tasks. Alongside with motivation our Malaysian science curriculum disseminate virtues like interested in science activities, taking account of other people feeling, willing to share ideas and knowledge, and completing tasks as best they could. After considerably short period of studying hands-on science, it is found that the young students displayed tremendous interest in science learning. They attended class without fail and for example, observed the changes in bread caused by the growth of fungus every day. Most students get themselves involved in all the science activities and not just watching by. The young students learnt to respect other people’s opinions and ideas, and not just thinking about themselves and consulted everyone in the group before making decision pertaining to their group tasks. The young students were willing to share their knowledge, ideas, opinions, energy, skills, and learnt not to keep to themselves what could benefit their group inquiries. They were engaged in the activities from the beginning to the end, making sure they completed the tasks given to them.

Outcome from interviews indicated how they enjoyed doing experiments in which they could hold and handle apparatus and materials, in contrast to just looking at mere pictures or images. They could observe what happen to the brightness of the menthols for example, or the colour changes in bread. If they did a different way, results might be different. They learnt that making mistakes in connection of wires or handling apparatus or procedures is not mistakes but seen as part of the processes. They learnt to observe things around them because they were brought out of their class to check on plants and animals in the school compound. Field work allowed the young students to connect science with nature and exposed the reality of science as everything about our lives.

Making folios allowed the young students to realise that knowledge is vast and expansive. However the accumulated knowledge by previous researchers could be accessed through resources such as books and internet. The fact that they could build their knowledge and better understanding of science concepts or nature if they chose to find out on their own accord was indeed exhilarating. The fact that in schools science teachers do not plan science experiments or activities hands-on or allow authentic science teaching is cause for concern. The naturally inquisitive nature of young students to know about science will be tampered and ceased to bloom in their latter life. Classrooms could, and should, be reconstructed as 'communities of inquiry" in which seeing oneself as "one among others" is a key priority – the community of inquiry is the paradigm of an environment in which each participant exists as "one among others". It is bigger than any one of its members. The community of inquiry bears no extrinsic allegiances and loyalties, just those values and commitment as striving for truth and honesty, etc. that are defined, constructed or reconstructed by its members. All students that spend significant amounts of time in such environment, in which they develop a sense of who they are, affectively, cognitively, socially, and morally even as they get on with the business of learning, knowing and making sense of that which is presented to them. The students have a real chance to find themselves as learners and thrive to become authentic human beings (Splitter, 2009).

The study carried out by Hacieminoglu (2016) provided an overview of students' attitude towards science and the predictive variables related to their attitude. The finding indicated that generally the students had not respectable level of positive attitude towards science. The author posits that the teachers' different application of science and technology curriculum and varying classroom environment might lead to negative feelings about science. Therefore, in tandem with that, teachers can learn science content in a variety of ways, including through readings, discussion, and "cookbook labs" (Bulunuz & Jarrett, 2010). However, knowledge of science vocabulary and principles is not sufficient for teaching science in the ways children learn best. Teaching through inquiry requires teachers who are knowledgeable about both content and inquiry methods.

However teachers feel less confident teaching science than any other subjects (Varelas et al., 2008) suggesting that they may be weak in both content and inquiry methods. Even if teachers are knowledgeable and skillful, they must be highly self-motivated to implement inquiry teaching because it requires time and materials, both of which are often at a premium. Declining interest in science and the need to encourage science, technology, engineering and mathematics (STEM) career aspirations and interests at an early age has been recorded by many researchers (Archer et al., 2010; Tai et al., 2006). But the concern about the decline should be fundamental enough for change. The nature of work that students perform in the classroom influences their perceptions of mathematics and science and what students value as important to their learning (Haitham, 2002; Rukavina et al., 2012) thus hands-on learning and inquiry-based problem solving help student to become motivated independent learners. Besides that, Knezek et al. (2013) found positive indications that engaging students in hands-on STEM activities promotes interest in STEM careers. Students' understanding of what scientists do, namely agreement that scientists can do many different jobs and that scientists can work on things that help the world.

CONCLUSION

Claims that school science is still far removed from real science and these classroom realities have implications for students' understanding of the nature of authentic scientific inquiry was supported by Hume and Coll (2010) who stated that over-emphasis on fair testing limits students exposure to the full range of methods that scientists use in practice. Unfortunately, authentic scientific inquiry or real science is a distant vocabulary in Malaysian primary science classrooms, because the more basic, that is, hands-on inquiry activities are scarce and under-utilised in these classrooms. However, the new Standard Curriculum of Primary Schools and the new School-Based Assessment set a stage for primary science teachers to practise effective situated science teaching and learning as modeled in this study. As it was found that the young students' science achievement and attitudes towards science were commendable after experiencing hands-on/authentic learning. Furthermore, the different rubrics for different science activities used for assessment could measure each skill more precisely. This study and its findings should be taken into consideration in a wider perspective by elementary or primary science teachers.

REFERENCES

Ali, M. M., Yager, R. E., Hacieminoglu, E., & Caliskan, I. (2013). Changes in student attitudes regarding science when taught by teachers without experiences with a model professional development program. *School Science and Mathematics, 113*(3), 109-119.

Anderson, R. D. (2002). Reforming science teaching: what research says about inquiry. *Journal of Science Teacher Education. 13,* 1-12.

Anderson, J. R., Reder, L. M. & Simon, H. A. (1996). Situated learning and education. *Educational Researcher, 25*(4), 5-11.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2010). "Doing" science versus "being" a scientist: examining 10/11-year-old school children's constructions of science through the lens of identity. *Science Education, 94*(4), 617-639.

Arisoy, N. (2007). Examining 8th grade students' perception of learning environment of science classrooms in relations to motivational beliefs and attitudes. Unpublished Theses in Middle east Technical University, Ankara, Turkey.

Atkin, J.M. & Black, P. (2003). *Inside science education reform: a history of curricular and policy change.* New York: Teachers College Press.

Azizoglu, n. & Cetin, G. (2009). The effect of learning style on middle school students' motivation and attitudes towards science, and the relationships among these variables. *Kastamonu Education Journal, 17*(1), 171-182.

Brown, J. S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*, 32-42.

Bulunuz, N. & Jarrett, O. S. (2010). The effects of hands-on learning stations on building American elementary teachers' understanding about earth and space science concepts. *Eurasia Journal of Mathematics, Science, and Technology Education, 6*(2), 85-99.

Campione, J. C. & Brown, A. I. (1990). *Guided learning and transfer: implications for approaches to assessment*, in Frederiksen, N., Glaser, R., Lesgold, A. &Shafto, M. G. (Eds) Diagnostic Monitoring of Skill and Knowledge Acquisition. Hillsdale, NJ, Lawrence Erlbaum Associates.

Chen, C. H. & Howard, B. (2010). Effect of live simulation on middle school students' attitudes and learning toward science. *Educational Technology & Society, 13*(1), 133-139.

Cumming, J. J. & Maxwell, G. S. (1999). Contextualising authentic assessment. *Assessment in Education, 6*(2), 177-194.

Gerde, H., Schachter, R. & Wasik, B. (2013). Using the scientific method to guide learning: an integrated approach to early childhood curriculum. *Early Childhood Education Journal, 41*(5), 315-323.

Hacieminoglu, E. (2016). Elementary school students' attitude toward science and related variables. *International Journal of Environmental & Science Education, 11*(2), 35-52.

Haitham, M. A. (2002). Attitudes of undergraduate majors in elementary education toward mathematics through a hands-on manipulative approach. *Perceptual and Motor Skills, 94*(1), 55-58.

Haigh, M., France, B. & Forret, M. (2005). Is 'doing science' in New Zealand classrooms an expression of scientific inquiry*? International Journal of Science Education. 27*(2), 215-226.

Hume, A. (2009). Authentic scientific inquiry and school science. *Teaching Science: The Journal of the Australian Science Teachers Association, 55*(2). 35-41.

Hume, A. & Coll, R. (2010). Authentic student inquiry: the mismatch between the intended curriculum and the student-experienced curriculum. *Research in Science & Technological Education. 28*(1), 43-62.

Johnson, C. C., Zhang, D. & Kahle, J. B. (2012). Effective science instruction: impact on high-stakes assessment performance*. Resarch in Middle Level Education Online. 35*(9). 1-12.

Knezek, G., Christensen, R., Tyler-Wood, T. & Periathiruvadi, S. (2013). Impact on environmental power monitoring activities on middle school perceptions of STEM. *Science Education International. 24*(1), 98-123.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Maxwell, G. S. (1997). Teacher judgement of achievement standards in performance assessments, in Adar,D. & Kandarakis, H. M. (Eds) Proceedings of the Annual Conference of the International Association for Educational Assessment, Montreal, Canada, 12-17 June 1995. Montreal, IAEA, Faculty of Science Education, University of Montreal.

Moebius-Clune, B. N., Elsevier, I. K., Crawford, B. A., Trautmann, N. M., Schindelbeck, R. R. & van Es, H. M. (2011). Moving authentic soil research into high school classrooms: student engagement and learning. Journal of Natural Resources *& Life Sciences Education, 40*(1), 102-113.

Murphy, S. H. (2009). Real authentic learning. *Principal Leadership: Middle level Edition, 9*(6), 6-8.

National Research Council (1996). *National science education standards.* Washington, DC: National Academy Press.

Newhouse, N. (1990). Implication of attitudes and behavior research for environmental conservation. *The Journal of Environmental education, 22*(1), 26-32.

Newmann, F. M. & Archbald, D. A. (1992). The nature of authentic academic achievement, in Berlak, H., Newmann, F. M., Adams, E., Archbald, D. A., Burgess, T., Raven, J. & Romberg, T. A., *Toward a new science of educational testing and assessment*. Albany, NY, State University of New York Press.

Osborne, J. (2003). Attitudes towards science: a review of the literature and its implications, *International Journal of Science Education, 25*(9), 1049-1079.

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher, 16*, 13-20

Resnick, L. B. (1989). Introduction, in Resnick, L. B. (Ed.) *Knowing, learning and instruction: essays in honor of Robert Glazer.* Hillsdale, NJ, Lawrence Erlbaum Associates.

Riah, H. & Fraser, B. J. (1997). *Chemistry learning environment in Brunei Darussalam's secondary schools*. In D. I., Fisher & T. Rickards (Eds.), Science, Mathematics and Technology Education and National development: Proceedings of the Vietnam Conference (pp.108-120). Hanoi; Vietnam.

Rukavina, S., Zuvic-Butorac, M., Ledic, J., Milotic, B. & Jurdana-Sepic, R. (2012). Developing positive attitude towards science and mathematics through motivational classroom experiences. *Science Education International, 23*(1), 6-19.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education, 89*(4), 634-656.

Schroeder, C. M., Scott, T. P., Tolson, H., Huang, T. Y. & lee, Y. H. (2007). A meta-analysis of national research: effects of teaching strategies on students achievement in science in USA. *Jounal of research in Science Teaching, 44,* 1436-1460.

Shedletzky, E. & Zion, M. (2005). The essence of open inquiry teaching. *Science Education International, 16*(1), 23-38.

Splitter, L. J. (2009). Authenticity and construction in education. *Stud Philos Educ 28*, 135-151 DOI 10.1007/s11217-008-9105-3

Tai, R. H., Liu, C. Q., Maltese, A. V. & Fan, X. (2006). Planning early for careers in science. *Science, 312*(5779), 1143-1144, doi: 10.1126/science.1128690.

Telli, S., Cakiroglu, J., & den Brok, P. (2006). *Turkish secondary education students' perceptions of their classroom learning environment and their attitude towards Biology.* In D.L. Fisher & M. S. Khine (Eds.), Contemporary approaches to research on learning environments: world views (pp. 517-542).

Tytler, R. (2007). Re-imagining science education: engaging students in science for Australia's future (2007). *Australian Education Review*. http://research.acer.edu.au/aer/3

Varelas, M., Plotnick, R., Wink, D., Fan, Q. & Harris, Y. (2008). Inquiry and connections in integrated science content courses for elementary education majors. *Journal of College Science Teaching, 37*(5), 40-45.

Verma, A. K., Dickerson, D. & McKinney, S. (2011). Engaging students in STEM careers with project-based learning – marine tech project. *Technology & Engineering Teacher, 71*(1), 25-31.

Wahyudi, W. & David, F. T. (2004). The status of science classroom learning environments in Indonesian lower secondary schools. *Learning Environment Research, 7*, 43-63.

Watson, R., Goldsworthy, A. & Wood-Robinson, V. (1999). What is not fair with investigations? *School Science Review. 80*(292), 101-106.

Wiggins, G. P. (1993) *Assessning student performance*. San Francisco, CA, Jossey-Bass.