Fifth International Conference on Science and Mathematics Education
CoSMEd 2013 Penang, Malaysia
11 – 14 November 2013

UNDERSTANDING STUDENTS' TECHNICAL SKILLS DURING TRANSITION FROM PRIMARY TO SECONDARY SCHOOL

HIDAYAH Mohd Fadzil
hidayahmohdfadzil@um.edu.my
Department of Mathematics and Science Education, Faculty of Education, University of Malaya

ROHAIDA Mohd Saat
rohaida@um.edu.my
Department of Mathematics and Science Education, Faculty of Education, University of Malaya

Abstract

Students lack exposure in 'hands-on' activities at primary school lead to insufficient manipulative skills and they may carry this problem with them to secondary school. Although most of the pupils are able to adapt to their new learning environment, some found transition difficult and problematic. Thus, to confront these issues, an in-depth study was proposed. This study resulted from a longitudinal study which employed a qualitative research paradigm. The research involved 10 primary school students (Year Six) and they were interviewed again in secondary school (Form One). Students' ability in handling thermometer, measuring cylinder, Bunsen burner and microscope were observed in order to get comprehensive insight of students' manipulative skills. From the data analysis, five (5) dimensions emerged to describe the students' manipulative skills which are: (1) technical skills, (2) operation of tasks, (3) management of time and workplace, (4) safety and precautionary measures, and (5) numeracy and technique of drawing specimen. However this paper only discuss on the aspect of technical skills.

Keywords: school transition, progression in science, science manipulative skills

Introduction

School transition is a process of moving from the familiar to the unknown environment which will be experienced by every student in their educational journey. During transition, students are shifting in the aspect of physical, emotional, social and intellectual and this process is influenced by the changes in environment. In this paper, transition refers to the moving processfrom primary to secondary school. Primary school in this context is definedas a period before the students end their Year Six journey at primary school. This period is referred as 'early transition'. Whereas secondary school is defined as a period after the students started their first year at secondary school. This period is referred as 'late transition'.

Students' interest in science and technology subjects may appear very early in primary schools. However, studies have shown a significance negative impact on

students' attitudes and attainment towards science learning during the phase of transitioning from primary to secondary school (e.g., Thurston,Topping, Christie, Karagiannidou, Murray&Tolmie, 2010). In science subject, this phenomenon can be exhibited by the decline in achievement and eroded interest in learning science subject (Galton, Gray& Ruddock, 2003).

Issues that arise during transition have been considered as a global phenomenon. Substantive progress has been achieved by developed countries in formulating and implementing specific programmes to ensure smooth progression during transition. In UK, Galtonet al.(2003) reported that decline in work rate and erosion of students interest stem from the high expectation on science prior to transition, the lack of curriculum continuity and non-harmonisation of teaching approaches. In New Zealand, Hawk and Hill (2004) reported that students found school transition very stressful and it gets worst along the process. Campbell (2002) found that American students reflected less positively on their experience in science learning because their expectation of learning science through practical approach were not fulfilled.

Undoubtedly, many benefits accrue from engaging students in science laboratory activities (Hofstein&Mamlok, 2007; Lunetta, Hofstein& Clough, 2007). One of the main aims of laboratory works is to develop skills in manipulating laboratory apparatus (Trowbridge, Bybee& Powell, 2000). Laboratories can be considered as the best place to learn manipulative skills and these skills are learned as part of formal instruction in science. However, teaching and learning of science at primary level was more on retention of knowledge where pupils have to involve themselves with too much writing and too little practical (Campbell, 2002; RohaidaMohd. Saat, 2010). Due to the lack of practical work in science during transition, students may have to deal with problems in obtaining specific skills in manipulating scientific apparatus and equipment in the laboratory.

Teaching and learning of science involve important component such as the mastery of scientific concept, inculcation of scientific attitudes and values and the mastery of scientific skills which include manipulative skills. However, manipulative skills are generally given the least amount of attention in the course of academic instruction though important aspect of learning can occur in this area (Trowbridge et al., 2000). In Malaysia, research in science manipulative skills is still limited and much can be done to improve students' laboratory skills. The development of students' manipulative skills in the context of during school transition is one of the settings that have not been given much interest in the field of science education. Thus the aim this particular study was to explore the students' manipulative skills during the period of transition by employing a qualitative research methodology.

Research Methodology

This study is part of a larger study which explores and investigates the acquisition of students' manipulative skills during the transition from primary school (Year Six) to secondary school (Form One). This study examines the students' abilityin manipulative skills during transition. This has been understood by looking at the

students' ability in handling four types of laboratory apparatus which were the Bunsen burner, thermometer, measuring cylinder and microscope. The study tracked a number of 10 students through their transition from two different primary schools to two secondary schools in Gombak district.Participants were purposively selected with the help of primary science teachers. The main criteria in selecting participants in this study were they should be articulate and have the ability to express their opinion since verbal data during interview was the main data source. This longitudinal study utilised a qualitative research paradigm. The data were collected from individual observation of practical tasks, interviews and document analysis.Initially, a total number of 13 students participated in this studyat primary school. However three of the students had to withdraw to continue their educational journey at boarding school in Kedah, Pulau Pinang and Johor.

The first phase of this research was conducted at two primary schools. According to literature (e.g. Lunette et. al, 2007), observation technique is the most appropriate instruments to understand manipulative skills, where the students are needed to exhibit the skills to an assessor. Video recording have been used during execution of the task given. This was followed bya series of interviews to determine the challenges experienced by students duringthe transition period and their perception about the process of transition in science. The second phase of this study follows the same students along their transition to secondary school. Once again, students have to demonstrate their manipulative skills in using Bunsen burner, thermometer, measuring cylinders and microscope. Students were re-interviewed to explore their experience in secondary school.

All the video and audio recording were transcribed and analysed iteratively where the researcher repeated the process of data collection and analysis back and forth until the saturation of data has been reached. The different way in performing manipulative skills were scrutinized and the progression in using and handling the apparatus were among the important phenomenon to be understood. Each individual have their own technique in handling scientific apparatus and the dissimilarity and variation in manipulative skills were analysed in order to get a deeper understanding of the students' progression during transition.

Constant comparative data analysis technique (Glaser & Strauss, 1967) has been used to answer the research questions for this study which focus on the understanding of concepts in science manipulative skills during transition. It involved the process of coding, categorizing and development of themes from information that emerged from the collected data, which can best described the ways students experience transition in science learning. Refining the thematic framework involves logical and intuitive thinking in making sure that the research objectives are being addressed appropriately (Ritchie & Spencer, 1994).

FINDINGS

Two (2) main themes have emerged from the analysis of the data: (a) technical skills and (b) functional aspects of performing laboratory task or experiment, as represented in Figure 1.

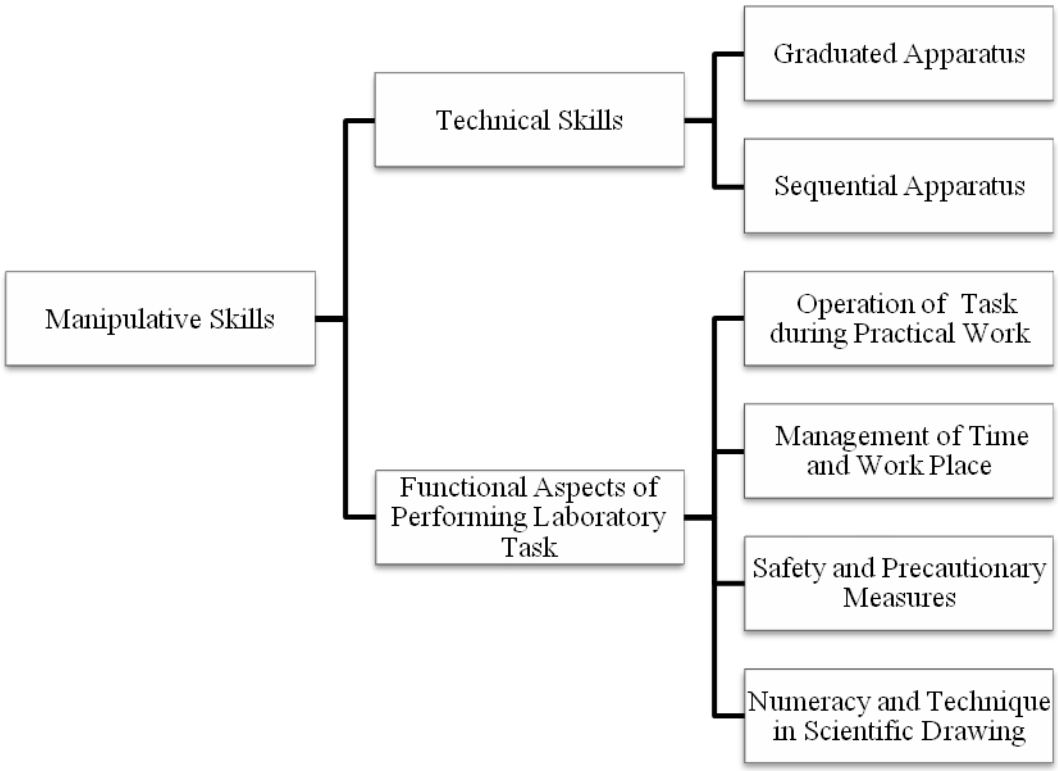

*Figure 1.*Themes and components of manipulative skills

Technical skills included knowledge and skills needed to properly manipulate and operate scientific apparatus during the execution of scientific task. In this study, technical skills have been divided into two main categories which were the technical skills in using graduated apparatus and sequential apparatus. On the other hand, functional aspects of performing laboratory task are specific procedures related to the operation of manipulative skills.Functional aspects included four components of manipulative skills, (a) operation of tasks during practical work, (b) management of time and workplace, (c) safety and precautionary measures, and (d) numeracy and technique in scientific drawing.

This paper only focuses on the aspect of technical skills in using and handling of graduated and sequential apparatus during transition from primary to secondary school. Graduated apparatus were apparatus which have lines or marking to indicate the measurement. In this particular study, measuring cylinder and thermometer were categorized as graduated apparatus. Sequential apparatus on the other hand were apparatus that needed the user to understand and acquire specific knowledge about the sequence of using it, in order to use the apparatus efficiently. Bunsen burner and microscope were categorized as sequential apparatus.Six

components of technical skills emerged from the analysis ofstudents individual execution of scientific tasks and interviews, as illustrated in Figure 2.

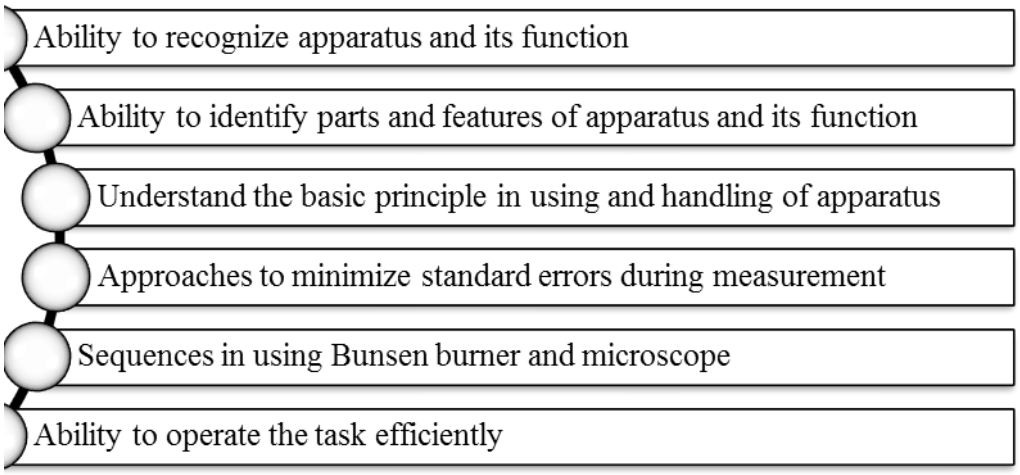

Figure 2. Components of technical skills

Ability to recognize apparatus and its function
Students' have shown a good ability in recognizing the apparatus during transition. Almost all of them gave the correct name of measuring cylinder, thermometer, Bunsen burner and microscope and its function. The following excerpts was taken from interview session with the primary school Student 4,

Researcher : Can you please tell me the name of this apparatus (showing a measuring cylinder to the student)?
Student 4 : Erm…Measuring cylinder.
Researcher : Do you know what is the function of this apparatus?
Student 4 : To measure the volume of water.
(Int. 1, S4a, Ln. 65-68)

However, finding from the observation showed that students encountered difficulties to practice the correct way of using apparatus according to its specific function. For instance studentsused beaker to measure the volume of liquid. Theoretically, beaker should only be used for ball park estimation of the volume of liquid.

Ability to identify parts and features of apparatus and its function
The finding showed that none of the students at primary and secondary school were aware of the different parts and features of the graduated and sequential apparatus. In using thermometer for example, the students can only acknowledge that thermometer contains mercury. During the interview session, only two Form One students were able to explain the function of the air hole of Bunsen burner. Howeverbased on my observation, none of them could show the correct technique of adjusting the air hole during the execution of task. This clearly showed that the

students had difficultiesin practising what they have learned theoretically in science classroom.Students' duringearly and late transition were incapable to identify parts of microscope and its function. From the interview conducted with the secondary school students, most of them admitted that they did not aware of the need to know the different parts of microscope, as illustrated in the following excerpt,

> Researcher: So why couldn't you recognize the important parts of microscope?
> Student 6: I think because I rarely used it…and I don't think it is important for me to memorize each part of microscope.
> (S6b, Ln.39-40)

Understand the basic principle in using and handling of apparatus

Most of the students exhibited inappropriate technique in using and handling of graduated and sequential apparatus during the period of transition. Basic principle in this context can be defined as fundamental rules that the students have to abide, to ensure the correct result can be obtained from execution of task. Inability to follow the rules may impede the students from obtaining accurate result for the experiment and can put their safety at risk. Students have to take adequate precautions to ensure reliable observations and results.

In using thermometer, most of the primary and secondary school students' showed common mistakes of holding the thermometer at the tip of the upper stem, immersed the wrong end of thermometer during measurement, let the thermometer bulb touched the bottom of the beaker while taking the temperature of the solution and have strong tendency to stir the solutions using thermometer even though they have been given glass rod. Howeverthe secondary school students have showed some progress in the using and handling of graduated apparatus. However the progression was unnoticeable when it comes to sequencing apparatus. Students demonstrated poor technique in using Bunsen burner and microscope following transition to Form One, as displayed in the following observation excerpts,

> He took the Bunsen burner and placed it under the tripod stand. He turned the gas knob without lighting the Bunsen burner.
> (Obs.3, Ep.2, S5b)

> She did not even use the coarse adjustment knob during this experiment, until her friend asked her to do it. She did as what her friend suggested.
> (Obs.4, Ep.2, S4b)

Approaches to minimize standard errors during measurement

This component explores the approach used by the students to minimize the standard error when using graduated apparatus. It was noticeable that most of the students were aware about the appropriate technique to be followed in order to

prevent parallax error. The awareness was also manifested during the interviews. They ensure that their eyes were parallel to the meniscus while taking the measurement. However, the students have shown different approaches to accomplish the criterion. For example, Student 3 lifted the measuring cylinder to her eye level while the basic principle of using measuring cylinder is to place the cylinder on a flat surface (refer to Figure 3). In some cases, the students' tilted their head while taking measurement, instead of lowering their head to get accurate reading (refer to Figure 4). Some of the students chose a different option to simplify the task, for instance Student 4, she "*checked on the volume of water by placing the measuring cylinder on the tripod stand" (Obs.1, Eps.2, S3a).* In using thermometer, among the common mistake made by the students was taking the thermometer outside the beaker and brought it close to their sight so the meniscus will be parallel with their eyes.

*Figure 3.*Student lifted the measuring cylinder during measurement

Figure 4. Student tilted his head when reading the meniscus

Correct sequences in using Bunsen burner and microscope

Students' technical skills of using Bunsen burner have shown some progression during late transition. However, none of the students practiced the correct technique of lighting the burner sequentially. Theywere not aware of the function of air hole and the correct technique of controlling the amount of gas, as illustrated in the following excerpt,

> He turned the gas valve carefully and lighted the burner. He adjusted the flame and slowly brings the burner under the tripod stand (students did not bother to manipulate the air hole before and after lighting the burner)
>
> (Obs1, Eps 2, S7a)

The inability to recognize the sequence of using the apparatus will affect the students' awareness on the suitable precautious measure they should practice when using Bunsen burner.Students at primary school also tend to turn the gas on before lighting up the Bunsen burner.

At primary school the students' sequential skills were considered as insufficient. For instance Student 3has demonstrated an inadequate sequence of technical skills in using microscope. She did not show any ability in using the stage clips, mirror, condenser, diaphragm and coarse adjustment knob in sequence. She did not bother to use the lowest magnification power objective lens. The findings have showed that the students' sequential skills during transition from primary to secondary school were very basic. Much could be done to make the acquisition of manipulative skills more meaningful to the student.

Ability to operate the task efficiently

This component described the students ability to use the apparatus efficiently and confidently. It involved two criteria which were the mode of action in manipulating the apparatus and the level of guidance in performing technical skills. For example some of the students have shown an awkward and choppy movement when handling thermometer to measure the temperature of boiling water. In another instance, some of them were able to operate the thermometer in a smooth and appropriate manner.Thus, this criterion has been used as an indicator to understand the students' competency in technical skills.

The level of guidance in performing technical skills can be determined from the students' skills performance. It emphasizes on the teacher's role as an instructor in the science laboratory. Teacher is responsible in transferring technical skills to the students and to further enhanced the appropriate technique during transition to secondary school.

Conclusion

Manipulative skills can be explained by exploring students technical skills and functional aspects of performing laboratory task, which include the operation of tasks during practical work, management of time and workplace, safety and precautionary measures, and numeracy and technique in scientific drawing. In this paper, the components of technical skills during transition have been presented. Findings from this longitudinal study have revealed that primary school students developed a gap in relating the theory they have learnt in classroom with their actual skills and ability in performing experiment. The students have difficulties to

put theory into practise. The gap in technical skills did not seem to get narrower during the period of transition. The understanding of science was to be achieved in the first place not by reading about theories but by performing experiments and creating concepts at first hand in the laboratory. Students lack of exposure to 'hands-on' and 'minds-on' activities during transition could lead to students' lack acquisition of manipulative skills during this period. In order to confront these issues, bridging programmes in science should be initiated between primary school and secondary school. Students have to be given vast opportunities to explore the manipulative skills to facilitate the process of transition.

References

Campbell, B. (2002). Pupils' perceptions of science education at primary and secondary school. *Research in Science Education,3,* 125-130.

Galton, M. Gray, J. M., & Ruddock, J. (2003).*Transfer and transitions in the middle years of schooling (7-14).Continuities and discontinuities in Learning.* Cambridge: Queen's Printer.

Glaser, B. G., & Strauss, A. (1967).*The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine.

Hawk, K., & Hill, J. (2004, April).*Transition traumas, traps, turning points and triumphs: Putting student needs first*. Paper presented at The Way Forward for Secondary Education Conference, Wellington, New Zealand.

Hofstein, A., & Mamlok., R. (2007). The laboratory in science education: the state of the art. *Chemistry Education Research and Practice,8*(2), 105-107).

Lunetta, V. N., Hofstein, A., & Clough, M. (2007)**.**Learning and teaching in the school science laboratory: an analysis of research, theory, and practice. In N. Lederman & S. Abel (Eds.), *Handbook of research on science education* (pp. 393-441). Mahwah, NJ: Erlbaum.

Ritchie, J., & Spencer, E. (1994). Qualitative data analysis for applied policy research. In A. Bryman& R. G. Burgess (Eds.), *Analyzing qualitative data*.London, UK: Routledge.

Rohaida Mohd Saat. (2010). Issues in maintaining continuity and progression of students' science learning. In A. Hussain & N. Idris (Eds.), *Dimensions of education* (pp. 275-291). New Delhi, India: Gyan.

Thurston, A., Christie, D., Karagiannidou, E., Murray, P. Tolmie, A., & Topping, K. (2010). Enhancing outcomes in school science for pupils during transition from elementary school using cooperative learning. *Middle Grades Research Journal, 5*(1), 19-32.

Trowbridge, L. W., Bybee, R.W & Powell, J. C. (2000).*Teaching secondary school science*. Englewood Cliffs, NJ: Prentice Hall.

Author(s):
HIDAYAH Mohd Fadzil, Department of Mathematics and Science Education, Faculty of Education, University of Malaya
Email: hidayahmohdfadzil@um.edu.my
ROHAIDA Mohd Saat, Department of Mathematics and Science Education, Faculty of Education, University of Malaya
Email: rohaida@um.edu.my