STUDENTS' LEARNING STYLES AND THINKING STYLES IN SCIENCE PRACTICAL

Lee Tze Jiun & Nurzatulshima Kamarudin
Faculty of Educational Studies, University Putra Malaysia

Abstract
Science practical work is one of the ways to enhance students' scientific knowledge and conceptual understandings through practical skills. The quality of students' practical work in term of their ability to interpret, analyse and evaluate ideas and arguments is strongly dependent on the competency of a teacher who teaches science practical and also effectiveness of curriculum and instruction. In this concept paper will discuss overview of Social Learning Theory and Constructivist Theory that relevant to the need of learning science. The literature review will review about the important of learning style and thinking style that affect students' learning in science practical.
Keywords: science practical, learning style, thinking style

Introduction

Reintroducing the fourth times of policy of 60:40 Science: Arts students in Malaysia Education Blueprint 2013-2025, which was first introduced in 1967 by Malaysia Higher Education Planning Committee in order to produce quality science graduates to meet 2020 human capital targets. These future science students would equip with sustainable knowledge and skills, so that they can become a self-motivated learner, critical thinking person or a productive creative and knowledgeable worker. They also will help the country sustaining talent recruitment to achieve the Vision 2020 that introduced by Tun Dr. Mahathir as one of the high income nation in the world (RMK10E 2011-2015).

The 60:40 Science: Arts policy refers to the ratio of science students to art students that targeted by Ministry of Education, where about 60% of all upper secondary students enrolled in the science stream, and 40% students enrolled in the arts stream. According to Malaysia Education Blueprint 2013-2025, in 2012 recently, the Ministry of Science, Technology and Innovation (MOSTI) has targeted to increase the number of science-related training person from 120,000 to 1.2 million in their 2020 Human Capital Roadmap; 500,000 person will have Science and Engineering degrees out of the 1.2 million, which there is still 415,000 to go to achieve the mission (from 85,000 today). From the latest report of Quick Facts 2013 Malaysia Education Statistics Education Planning and Research Division, prepared by Ministry of Education Malaysia (Malaysia Education Statistics, 2012), we have 128,349 Form 4 Science students, and 122,329 Form 5 Science students, which made a total of 250,678 students who enrolled in Science stream. This figure is only about 21% of the MOSTI's target (1.2 million) in 2020 Human Capital Roadmap vision. Hence, there are some urgency approaches that needed to be done so that policy of 60:40 Science: Arts students can be realizable.

According to Malaysian Ministry of Education (MMOE), science is one of the core subjects for lower secondary education (form 1 to form 3) in Malaysia. After completion of lower secondary education, there are three main streams in upper secondary education (form 4 to form 5) that can be chosen by students, one of it is Academic Stream or usually called as Science and Arts Stream. Students can pursue either one of these two main streams. Those who interested in science can take Chemistry, Biology, Physics, Additional Mathematics and English for Science and Technology and all students who pursued in science stream must take at least two pure science subject at SPM either in Biology, Chemistry or Physics.

Science Practical

In the effort and determinations to increase the number of quality students in schools, Malaysia government has spent estimation RM 37,280,783,100 on educational expenditure, 16.01 percentage of total educational expenditure against total federal expenditure in 2012 (Malaysia Education Statistic, 2012). In the 2006-2010 Education Development Master Plan, the Ministry has spent more than RM20 billion on infrastructure development to utilised for the development of 400 new schools, including upgrading and maintenance of existing facilities such as science laboratory, computer laboratory, sufficient classrooms and others. The approach of upgrading science laboratories is one of the determinations that can be seen from our Malaysia Government to equip and support students in learning science (Malaysia Education Blueprint 2013-2025).

Recently, Education Ministry secretary-general Tan Sri Abdul Ghafar Mahmud has announced that Education Ministry will implement 15 recommendations part of 61 recommendations in the ministry to increase the number of science students. One of the recommendations is reintroduced practical science-centred examination at the Sijil Pelajaran Malaysia (SPM) level. In our current Malaysia Education system, our Examination Syndicate has come up with this school-based continuous form of examination, where is one of the ways to access students' laboratory competencies named PEKA (Practical Skills Assessment), which replacing the final traditional practical examination.

Basically, science teachers in school will assess the students' laboratory work while students are conducting their experiment based on few criteria: their science process skills, problem solving skills, manipulation skills, scientific skills and scientific attitudes. Students are request working in groups in doing their practical but each of them will be assessed independently at the end, score will be given to each of the student. At the end, teachers can evaluate students in terms of three stages that is the 'pre-lab', 'mid-lab' and 'post-lab' assessment. In pre-lab stage, teachers can determine whether the student has the ability to plan the experiment, state the objective of the experiment to name the variables, to state hypothesis, to list the apparatus, to describe the procedures of setting up an experiment and collecting data methods. For the mid-lab assessment stage, the teacher only can assess the student while he is doing the practical and collecting the data. Last stage the post-lab, can be assess when the student has finish his laboratory work and send in their results including calculation, analysis, interpretation and inference and drawing conclusion. Instead of just assessing their practical work, students' group work and interactions with his laboratory classmate also will be evaluated (Meerah *et al*., 2005).

Science practical that mostly conducted by students or researchers in laboratories is one of the way they perceive a real-world behavior that can be link to theory they have learned (Razali & Trevelyan, 2013). Despite of that, any evidence that obtained from the result of research through laboratory practicing can be used to communicate among countries by sharing their new perspective of science and comes out with better approaches (Kim, 2013). This supported by Knapp & Trainor (2013), who commented that practical solutions in science with accessible data-sharing, knowledge sharing networks and science-community partnerships in long term, can improve training in interdisciplinary research, change in the incentive structure of research institutions and have better lines of communication between funders, researchers and stakeholders. Hence, a good practical skill with one's theoretical knowledge in science would be the fundamental for producing reliable practical solutions that can be share among humans being.

Good science practical skill do not just happen naturally, students need to be educated with theoretical knowledge by teachers, then only they can have a well-planned, prepared and concluded experiment (CLEAPSS, 2009; Spektor-Levy, 2008). Mostly science practical skills or laboratory skills are based on hands-on learning, where students have a chance to gain reasoning and lab skills through experiences that can enhance students' concepts of science (Arnold *et al*., 2011) that link to the real world. Mismatch between education in traditional classroom and the real life context of practice (Brown *et al*., 2011) would wish to be avoided by researchers to reduce the impact of damages that can cause them. Imagine if an airline pilot only learn their theoretical flying an airplane in classrooms such as aircraft system, maneuvers, takeoffs and landings, and crew coordination, without actual or sufficient training methods or practices and the number of flight hours needed to master all these skills (Airline Pilots Association White Paper, 2009), would us dare to on board the flight? Obviously, practical is one of the major elements in educating students in science where students can learn it not only through kinesthetic learning style, but also through the combination experience of visual, sensing and audio learning styles.

Social Learning Theory

Social Learning Theory (SLT) focuses on how people learn that occurs within a social context and learns from one another (Bethards, 2013). SLT has been used to discuss social behavior such as criminology (Morris & Higgins, 2010), roots of aggression (Snethen & Puymbroeck, 2008) and others. According to Bandura (1977), human behavior is learned observationally through by observing others, conceive idea about how new behaviors are performed and served this new information as a guide of actions (Guney & Al, 2012).

Laboratory learning is one of the approaches that providing a learning environment for science students to practice their skills either learn by observing their teacher's demonstration or by sharing ideas among classmates on how to conduct an experiment. Through SLT, result from laboratory learning can provide students a conceptual model of understanding a development, maintenance or effectiveness of certain treatments such as in medical field (Page & Blanchette, 2009). Crittenden (2005) also suggested that speaking and listening behavior of the SLT covered classroom preparation (individual and/or group) and in-class experiences, which allow students to learn through observation and interactions, by exchanging their ideas and behaviors. Hence, SLT lead us to understand how people can learn from each other especially interactions between students and their peers, teachers and environment. At the end, teachers can develop an optimal learning environment that enhances student's communication with each other through discussion and feedback during or after a laboratory experiment.

Constructivist Theory

Experience of learning through knowledge, beliefs and skills are important for an individual in science learning. Constructivism is one of the theories that emphasizes on this experience of learning (Garbett, 2011), which pioneered by Jerome Bruner (1966). Makgato (2012) mentioned constructivism encourages active participation and variety of teaching methods such as problem-based learning, inquiry-based learning, project-based learning, case-based learning and discovery based learning. Learning through constructivism perspective, a learner learns new things or experiences and link with whatever they had known by construct their understanding through interactions either with physical or with social environment (Demirci, 2010).

The constructivist theory of learning can be seen under the work of Piaget theory (1972), John Dewey (1997) and Lev Vygotsky (1978) (Makgato, 2012; Collins, 2008). Constructivism learners basically are active learners where they involved in interpretation of meaning, reflection of experience and reconstruct of the experience to become more knowing (Garbett, 2011) and these are important in science practical work, where students need to perform integrated science process skill which is one of the element science process skills. This integrated science process skills included skills for solving problem or doing science experiments, where needed students to evaluating information, controlling variables, operationalising variables, hypothesising and experimenting (Ong *et al*., 2011). Hence, constructivism theory able to lead students to learn something new through experience or 'hands-on' methods, from the combination of new and prior knowledge they had, students are able to construct a new meaning thus enhance their confidence level, creativity, communication skills, thinking skills and others (Figure 1; Collins, 2008; Altun *et al*., 2009; Sorathia & Servidio, 2012).

Learning Style in Science Practical

LeFever (2004) defined learning style as one of the ways to remove negative labels and restructure education to fit the way God made children. He mentioned all teachers should give every student a chance to show his or her learning styles preference (naturally) in their lessons, so that can help the students to improve their learning skills and succeed in future. Sheorey (2006) also said that learning styles are individual characteristics which a person is born with and which may be influenced by the person's environment and other cognitive or maturational factors. Learning styles are suggested by researchers to find out the extent of two interactions commonly among environmental, personality, academic achievement, motivation and others.

The Felder-Silverman model mentioned about four dimensions of learning styles and defined as follows:

Active-Reflective **:** how a leaner prefers to process information.
Sensing-Intuitive **:** how a learner prefers to take in information.
Visual-Verbal : how a learner prefers information to be presented.
Sequential-Global **:** how a learner prefers to arrange information.

In the finding of Patterson (2011) by using Felder-Silverman model, the researcher have found that students who performed the multimedia laboratory work were more on reflective, sensing, visual and sequential learning styles; while laboratory demonstrators were more on reflective, intuitive, visual and sequential learning styles. Patterson (2011) commented that students who do not match the learning styles of the laboratory demonstrators may not as adequately and properly prepared for their laboratory work which needed constant supervision and help from the laboratory demonstrators.

In the other way round, Koh & Chua (2012) tried to understand Mechanical Engineering students' learning style that can help an educator to design the course structure more effectively according to the different styles of students and able the students to learn faster and easier. The result showed that most of the engineering students prefer visual learning style and surprisingly kinaesthetic learning style was the lowest preference among them. This might due to their content of the syllabus which requires a lot of 'looking' such as the use of mind map, notes taking, visualisation of the concept in mind and information gathering through reading; and less of 'touching' such as laboratory works, prototype building, model construction, and information gathering through physical involvement. Through the analysis, it gives us some thoughts of whether educators' teaching styles should based on students' learning style, curricula subjects or their own preference teaching style to gain the benefits for science practical education.

Other than Felder-Silverman model, other learning styles model such as Kolb's Learning Style Inventory (1985) had also been done in investigation learning style regarding science practical. Ekici (2011) investigated perceptions of the students towards biology laboratory environment. The results showed that there was a positive and meaningful relationship between the perceptions with students' learning style by using Kolb (1985) model. Most of the students have Diverger learning style, which they are good in creativity and imaginative ability. Students who use this learning style tend to good at viewing situations from a number of different perspectives (William *et al*., 2013). Ekici (2011) emphasised that biology laboratory classroom environment is very important for the success of students in biology classes, which give students concrete learning environment and make a major contribution to the science field.

Thinking Style in Science Practical

Holyaok & Morrison (2006) defined thinking is the systematic transformation of mental representations of knowledge to characterize actual or possible states of the world, often in service of goals. Miller (2011) said that thinking can be involves in many aspects such as observing, remembering, recalling, reasoning, drawing inferences, reflecting, deciding, beliefs, opinions, judgements, wondering, imagining, inquiring, interpreting and evaluating, either in a concrete form or an abstract form (quality). Thinking style not matter in the way of which one better or worse but rather matter of differences, as well as generalized cognitive styles (Sternberg & Zhang, 2005). Abdi (2012) investigated the relationship between thinking styles inventory and critical thinking skills among 207 undergraduate students in higher education in Azad university of Kermanshah in Iran. The study claimed that students' thinking styles have the ability to predict their critical thinking styles and teacher's teaching styles should take into a consideration that can lead to the development of critical thinking styles.

In enhancing students' science thinking skills, Murphy *et al*. (2013) mentioned about co-teaching as a model for learning which can develop students' thinking skills and personal capabilities. Co-teaching is two or more teachers sharing responsibilities for planning, instruction and evaluation for students assigned to a classroom (Cushman, 2004). Because of two or more teachers teaching for a class, they may have different ways of thinking that can contribute to students' thinking skills. Murphy also mentioned that co-teachers encouraged children to think and shared their ideas when introducing science, to raise questions that can led to investigations, teachers showed interested in children's ideas, to be open-minded with no right or wrong answers and to help make abstract ideas concrete. With the co-teachers teach creatively inquiry-based science lessons with specific, this could enhance children's thinking skills and personal capabilities in science learning.

Abrahams & Millar (2008) investigated the effectiveness of science practical work in secondary schools. The researcher tried to investigate effectiveness students in enabling to do what the teacher intended with the physical objects, effective in getting students to use the intended scientific ideas to guide their actions and reflect upon the data they collected. The researcher said 'doing with ideas' basically refers to the process of mental thinking about objects, materials, and phenomena in terms of theoretical entities or constructs that are not directly observable. In the researchers' view as well, getting students in understanding thinking is same meaning with 'doing with ideas', where thinking of the objects, materials and phenomena within a particular framework of ideas is always difficult as the ideas sometimes do not present themselves directly to their senses (eg. Student may think about the readings on a voltmeter as observables-the position of a pointer on a scale-rather than as measures of potential difference). This suggests that there are still some weaknesses need to be overcome in enhancing students' understanding of practical work procedural and come out with more effective and substantive instructional delivering methods in education science learning.

Conclusion

Science practical work is one of the ways to enhance students' scientific knowledge and conceptual understandings through practical skills, instead of just paper and pen test. Practical work in science is a 'hands-on' experience where students can be more understanding about our nature world and often challenge them to develop a new protocol or model for a better living world. The quality of students' practical work in term of their ability to interpret, analyse and evaluate ideas and arguments is strongly dependent on the competency of a teacher who teaches science practical and also effectiveness of curriculum and instruction. A good quality practical work can motivate students and stimulate their interest and enjoyment toward science subjects. Through Social Learning Theory (SLT) and Constructivism Theory, students should have more opportunities to learn science activities through communication between teachers or classmates, including writing, practise, use of diagrams, group discussions and role plays. At the end, teachers can develop an optimal learning environment that enhances student's learning science outcomes.

References

Abdi A. (2012). A Study on the Relationship of Thinking Styles of Students and Their Critical Thinking Skills. *Procedia - Social and Behavioral Sciences, 47*: 1719–1723.

Abidin M. J. Z., Rezaee A. A., Abdullah H. N. & Sigh K. K. B. (2011). Bibliography Learning Styles and Overall Academic Achievement in a Specific Educational System. *International Journal of Humanities and Social Science, 1(10)*: 143-152.

Abrahams I. & Millar R. (2008). Does Practical Work Really Work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education, 30 (14):* 1945–1969.

Air Line Pilots Association White Paper (2009). Producing a Professional Airline Pilot-Candidate Screening, Hiring, Training, and Mentoring. Air Line Pilots Association, International.N.W., Washington.

Altun E., Demirdag B., Feyzioglu B., Ates A. & Cobanoglu I. (2009). Developing an interactive virtual chemistry laboratory enriched with constructivist learning activities for secondary schools. *Procedia Social and Behavioral Sciences, 1:* 1895–1898.

Arnold P., Pfannkuch M., Wild C.J., Regan M. & Budgett S. (2011). Enhancing Students' Inferential Reasoning: From Hands-On To "Movies". *Journal of Statistics Education, 19 (2):* 1-32.

Collins S.R. (2008). Enhanced Student Learning Through Applied Constructivist Theory. *Transformative Dialogues: Teaching & Learning Journal, 2 (2):* 1-9.

Crittenden W. F. (2005). A social learning theory of cross-functional case education. *Journal of Business Research 58*: 960-966.

Cushman S. (2004). What is co-teaching? Villa Guide to Co Teaching, Chapter 1: 1-9. http://www.corwin.com/upm- data/6847_villa_ch_1.pdf&gt

Demirci C. (2012). Constructing a philosophy: prospective teachers' opinions about constructivism. *Procedia Social and Behavioral Sciences, 9*: 278–285.

Duggar J.W., Smith B.J. & Harrison J. ( ). International supply and demand for U. S. trained commercial airline pilots. Journal of Aviation Management and Education.

Ekici (2011). Analysis of variables that express perception of high school students towards the class environment of biology laboratories. *Procedia Social and Behavioral Sciences 15*: 1901–1905.

Felder, R. M. and Soloman, B. A. (2003). Index of Learning Styles Questionnaire, Available online at June (2003) in: http://www.ncsu.edu/felder-public/ILSdir/ilsweb.html

Garbett D. (2011). Constructivism Deconstructed in Science Teacher Education. *Australian Journal of Teacher Education, 36 (6)*: 36-49.

Gueny A. & Al S. (2012). Effective learning environments in relation to different learning theories. *Procedia - Social and Behavioral Sciences , 46*: 2334 – 2338.

Holyoak K.J. & Morrison R.G. (2005). The Cambridge handbook of thinking and reasoning.Cambridge University Press: USA.

Kim H.G (2013). Formative Research on the Primo Vascular Systemand Acceptance by the Korean Scientific Community: The Gap Between Creative Basic Science andPractical Convergence Technology. Journal of Acupuncture and Meridian Studies,

Knapp C.N. & Trainor S.F. (2013). Adapting science to a warming world. Global Environmental Change, 23: 1296–1306.

Koh Y.Y & Chua Y. L. (2012). The Study of Learning Styles among Mechanical Engineering Students from Different Institutions in Malaysia. *Procedia - Social and Behavioral Sciences, 56*: 636 – 642.

Lefever M. (2004). Learning styles: Reaching everyone God gave you to teach. Dave and New Jackson: Colorado, USA.

Makgato M. (2012). Identifying constructivist methodologies and pedagogic content knowledge in the teaching and learning of technology. *Procedia - Social and Behavioral Sciences,47*: 1398 – 1402.

Malaysia Education Blueprint (2012).Preliminary report Malaysia Education Blueprint 2013-2025.

Malaysia Education Statistics 2012 (2012). Educational Planning and Research Division Ministry of Education Malaysia.

Meerah S.M., Osman K. & Halim L. (2005). The science practical assessment tool: Measuring science process skills while doing science. http://www.recsam.edu.my/cosmed/cosmed05/AbstractsFullPapers2005/files%5Csubtheme1%5CSMM.pdf

Miller M. A. & Stoeckel P. R. (2011). Client Education-Theory and practice. Jones and Bartlett Publishers. USA.

Morris R.G. & Higgins G.E. (2010). Criminological theory in the digital age: The case of social learning theory and digital piracy. Journal of Criminal Justice, 38: 470–480.

Murphy C., Bianchi L., McCullaghc J. & Kerr K. (2013). Scaling up higher order thinking skills and persona capabilities in primary science: Theory-into policy-into-practice. *Thinking Skills and Creativity, 10*: 173–188.

Ong E.T., Wong Y.T., Yassin S.M., Baharom S. & Yahaya A. (2011). The development and validation of an all-encompassing Malaysian-Based Science Process Skills Test for secondary schools. *Journal of Science and Mathematics Education in Southeast Asia, 34 (2):* 203-236.

Page L. O. & Blanchette J. A. (2009). Social Learning Theory: Toward a Unified Approach of Pediatric Procedural Pain. *International Journal of Behavioral Consultation and Therapy, 5(1)*: 124-141.

Patterson D.A. (2011). Impact of a multimedia laboratory manual: Investigating the influence of student learning styles on laboratory preparation and performance over one semester. *Education for chemical engineers, 6*: e10–e30.

Quick Facts 2013 Malaysia Education Statistic (2013). Educational Data Sector Educational Planning and Research Division Ministry of Education Malaysia.

Razali Z.B. & Trevelyan (2013). An Evaluation of Students' Practical Intelligence and Ability to Diagnose Equipment Faults. *Procedia - Social and Behavioral Sciences, 56*: 42 – 51.

Reid J.M. (1987). The learning style preference of ESL students. *TESOL Quarterly, 21 (1)*:87-110.

Sheorey R. (2006). Learning and teaching English in India. Sage Publication Inc: New Delhi.

Snethen G. & Puymbroeck M.V. (2008). Girls and physical aggression: Causes, trends, and intervention guided by Social Learning Theory. *Aggression and Violent Behavior, 13*: 346–354.

Sorathia K. & Servidio R. (2012). Learning and Experience: Teaching Tangible Interaction & Edutainment. *Procedia - Social and Behavioral Sciences 64:* 265 – 274.

Sternberg R. & Zhang L. F. (2005). Styles of thinking as a basic of differentiated instruction. *Theory Into Practice*, *44*(3): 245-253. Steward W.J. (1983) (abstract). Meeting learning styles through the computer. *Journal of Educational Technology Systems, 11*: 291-296.

Thyer B. A. (2008). Comprehensive Handbook of Social Work and Social Welfare, Human Behavior in the social environement. Vol 2.New Jersey, Canada.

Williams B., Brown T. & Winship C. (2013). Learning style preferences of undergraduate paramedic students: A pilot study. *Journal of Nursing Education and Practice, 3 (1),* 51-59.