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THE EFFECTS OF CLASSROOM LEARNING ENVIRONMENT AND LABORATORY LEARNING ENVIRONMENT ON THE ATTITUDE TOWARDS LEARNING SCIENCE IN THE 21ST-CENTURY SCIENCE LESSONS

[1]Mageswary Karpudewan & [2]Chong Keat Meng
[1]*School of Educational Studies, Universiti Sains Malaysia, Malaysia*
[2]*SMK Methodist (ACS), Kampar, Perak, Malaysia*

[1]Corresponding author: kmageswary@usm.my

ABSTRACT

Purpose – Many students associate science with negative feelings and attitudes which discourage them from continuing with science. This is supported by findings indicating a positive correlation between attitude and achievement. The learning environment is an important construct that influences students' attitude. Following the claim that attitude is important and the learning environment is the determinant of learners' attitude, in this study, an attempt is made to investigate the effects of classroom learning environment and laboratory learning environment on students' attitude towards learning science.

Methodology – Survey research design was used to identify the students' perception of learning environment and attitude. A total of three sets of questionnaires on science laboratory, classroom learning and attitude towards learning science were administered to 272 (109 males and 163 females) lower secondary school students.

Purposive sampling approach was used to identify the samples. Multiple linear regression was used to answer the research questions.

Findings – The results show that attitude towards learning science is positively correlated with both classroom learning environment (r =.515) and science laboratory learning environment (r =.526). Both classroom learning environment and science laboratory learning environment are significant predictors of attitude. Cooperation, Equity and Investigation from the WIHIC and Integration, Material Environment and Students Cohesiveness from the SLEI are identified as significant predictors of attitude.

Significance – The findings obtained from this quantitative survey suggest the presence of causal effects among the learning domains. This finding suggests that teachers should seriously consider the causal effects of the domains when designing their teaching strategies to enable the development of 21st-century skills.

Keywords: 21st century learning, attitude towards learning science, lower secondary students, science laboratory and classroom learning environment.

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INTRODUCTION

The workplace in the 21st century very much emphasizes the ability of the workers to solve problems creatively besides having good communication and self-management skills (Osborne, 2013). In this context. education plays an important role. The education system needs to facilitate the transition process of producing a future workforce that is equipped with knowledge and skills to face the challenges of the 21st century. One of the challenges of the 21st century is the requirement for the workers to analyze, synthesize and evaluate any given situation. In other words, the 21st century reinforces the fact that higher-order thinking skills must be taught to the current students (future global workforce) (Osborne, 2013). However, in science education, contradicting trends have been noticed. In a research done in the United States, it was found that only 14% of the lessons have constructive criticism and include challenging ideas during teaching and learning of science and mathematics (Weiss et al., 2003). Similarly, Duschl (1990) asserted that science education is often presented as a 'final form' of knowledge.

In the Malaysian context, the current form of assessment which emphasizes on examinations does little to encourage our young minds to explore further because the teaching and learning of science are skewed towards memorization of facts. In the 21st century, students who do not possess functional and critical thinking skills will falter in the competitive work environment (Donovan et

al., 2014). This scenario does not go well with the aspiration of the country to attain the status of a fully developed nation by the year 2020. In cognizance of all the challenges facing us today, there is an urgent need to investigate the effects of the classroom learning environment and laboratory learning environment on students' attitude towards learning science following the notion that during science lessons, students spend most of their time in classrooms and laboratories. A more positive attitude towards learning science will be able to increase students' participation in science-related endeavors (Gibson, 2002).

A large number of studies on students' attitude towards science has been carried out since the 1980s (Freedman, 1997; Pell & Jarvis, 2003; Weinburgh, 1995; Zacharia& Barton, 2004). A decline in a positive attitude towards science is evident in the findings of Hofstein, Maoz, & Rishpon (1990) and Weinburgh (1995). Many students associate science with negative feelings and attitudes which discourage them from continuing to learn science. This is supported by findings indicating a positive correlation between attitude and achievement. Results from a research conducted by Schibeci and Riley (1986) show that attitude influences achievement. Other similar studies have also suggested that students with a positive attitude towards science will tend to score higher (Freedman, 1997; Oliver & Simpson, 1988;Weinburgh, 1995).

Research, involving 1,180 students, 132 heads of science, 108 sixth formers and 84 staff from 12 schools, conducted by Woolnough (1991), shows that attitude towards science in schools is a major determining factor for continuing with science education. Attitude is also viewed as an essential determinant of STEM education (Suprapto, 2016). Therefore, the current downtrend of interest in pursuing science-related courses after secondary schooling which is happening in tandem with the declining positive attitude towards learning science can be reversed by implementing an effective teaching approach. This is because one of the most recent studies involving Bhutanese grade 10 and 12 students has suggested that students' attitude towards science improved by making science learning more interesting (Zangmo, Churngchow, Kaenin, & Mophan, 2016). Hence, using effective strategies to teach science is instrumental for maintaining a positive attitude of students towards learning science.

Attitude towards Learning Science

Attitude is defined as an individual's viewpoint of a person, thing or idea (Gall, Borg, & Gall, 2003). It constitutes three components: affective, cognitive and behavioral. Researchers have reached a consensus that attitude is a learned disposition to feel, think or behave positively or negatively towards an object. According to Koballa (1998), attitude is dynamic and not static which means it can be changed when there is intentional effort to do so. Hence, students are not born to like or dislike science; rather, they learn to like it or dislike it. The affective component refers to how one feels about the object, thus evoking either a favorable response or a negative response. When students perceive the object or learning favorably, they will tend to engage more in getting to know about the purpose or learning. The cognitive component comprises the person's beliefs and knowledge about the object, and the behavioral component is one's behavior acted out towards the object (Gall, Borg, & Gall, 2003; Salta & Tzougraki, 2004). In this study, the object that we are referring to is *science* that students learn in school. This science comprises a body of knowledge that explains the phenomena that we see in our daily surroundings. We intend to evaluate students' attitude towards learning science by assessing the three components (affective, cognitive and belief). An attitude inventory, TOSRA (Test of Science-Related Attitude) questionnaire has been developed in the past based on the three components of attitude to measure how students exhibit their attitude towards learning science (Fraser & McRobbie, 1995). For this study, TOSRA was used.

BACKGROUND OF THE STUDY

Classroom Learning Environment

Various studies in the past have pointed out that learning environment is a significant determinant of attitude towards learning (Fraser, 1998; Wolf & Fraser, 2008). Studies conducted in Indonesia (Margianti, Aldridge & Fraser, 2004) and Singapore (Fraser & Chionh, 2000) have provided further evidence, showing that the effects of learning environment on the learning outcomes of the students are significant. Also, students' perceptions of classroom environment are also related to attitude towards science (Fisher &

Waldrip, 1999). Research by Henderson, Fisher and Fraser (2000) that investigated the effects of science classroom environments on the learning attitude of science has generated similar results. In a study by Myers and Fouts (1992), using 699 students from 27 high schools in America, it has been found that the positive attitude towards science is associated with involvement, personal support, strong positive relationships with other students and teachers and the use of a variety of teaching strategies with teacher support and lesser teacher control. From the studies above, it could be surmised that classroom learning environment, which comprises interactions between teachers and students, students with students and the type of activities, has a profound influence on nurturing a positive attitude towards learning science. As such, through this study, an attempt is made to measure science classroom learning environment using *What Is Happening In this Class?* questionnaire. This questionnaire assesses the classroom learning environment through students' cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity.

Science Laboratory Learning Environment

Science students have the opportunities to learn science in physical settings other than the conventional classrooms. School science laboratories provide an environment whereby students can collaborate to investigate scientific phenomena and relationships (Hofstein & Lunetta,1982; Lunetta, 1998). They tend to be less formal, and this characteristic offers opportunities for students to have productive and cooperative interactions between students and the teacher. The laboratory learning environment is very much influenced by a few components, namely, the materials and apparatus as well as the physical setting of the laboratory. The dynamics between the expectations for learning, the interactions between students and teacher, and the nature of the laboratory activities will determine the kind of learning environment which can fosters a greater appreciation towards learning science. Given these, various studies on laboratory learning environment have been done to investigate the relationship between the laboratory learning environment and the attitude towards learning science, including studies to assess learning environments in senior science laboratories (Henderson, Fisher & Fraser, 1998) and studies to assess laboratory learning environments and practical tasks in

senior secondary science classes (Fisher, Harrison, Henderson, & Hofstein, 1998). All these studies have used the Science Laboratory Environment Inventory (SLEI) as a measuring instrument to gauge students' perception of the laboratory environment. Similarly, in this study, SLEI was employed to measure how Malaysian students view their science learning environment.

THE AIMS OF THE PRESENT STUDY

The purpose of this study is to investigate the effects of classroom learning environment and laboratory learning environment on students' attitude towards learning science. The results of this study can be used as a guideline to enhance the teaching practices in both classrooms and science laboratories. This research seeks to answer following questions:

1. What are the effects of classroom learning environment and laboratory learning environment on students' attitude towards learning science?
2. What are the classroom learning environment scales that significantly predict a positive attitude towards learning science?
3. What are the science laboratory learning environment scales that significantly predict a positive attitude towards learning science?

METHODOLOGY

Participants

The participants were 272 (109 males and 163 females) 15-year old students studying in public schools in Malaysia. The schools are located in the Northern region of Malaysia. These students will be sitting for the Form 3 Assessment at the end of the year. Based on the outcome of the assessment, students will be enrolled in either the arts or science streams in their fourth form. In this study, purposeful sampling method was employed. This is because at the end of the third form, students will ultimately decide their path, i.e. whether to follow a science-related career or otherwise.

Instrument

The questionnaires that were used in this study were adapted from What Is Happening in this Class? (Fraser, McRobbie, & Fisher, 1996), Science Learning Environment Inventory (Fraser, & McRobbie, 1995) and Test of Science-Related Attitudes (Fraser, 1981).

What Is Happening In This Class? (WIHIC) is a well-established and widely-used questionnaire in classroom environment research (Aldridge, Fraser & Fisher, 2000; Dorman, 2003). Since its inception, the WIHIC questionnaire has been applied in many studies to study about the learning environment in different countries, including Singapore (Fraser & Chionh, 2000), Korea (Kim, Fisher, & Fraser, 2000), Indonesia (Margianti, Aldridge & Fraser, 2004), and the United States (Allen & Fraser, 2007). The WIHIC questionnaire consists of seven scales, and each scale has 10 items. The scales in WIHIC includes students' cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity.

The Science Laboratory Environment Inventory (SLEI) has been ranked as one of the most commonly used instruments to assess students' perception of the science laboratory learning environment. It has been validated in a study involving over 5,447 students in 269 classes in the United States, Canada, England, Israel, Australia and Nigeria (Fraser, Giddings, & McRobbie, 1995). The original version of the SLEI had 35 items, presented in five different scales (students' cohesiveness, open-endedness, integration, rule clarity and material environment). Each construct in SLEI has seven items.

The instrument that has been proven to be reliable in assessing attitude towards science is the Test of Science-Related Attitudes (TOSRA) questionnaire. It was initially validated in Australia with a total of 1,337 students from 11 schools that varied socioeconomically (Fraser, 1981). The TOSRA questionnaire consists of seven scales. Each scale contains 10 items. The scales in TOSRA include the social implication of science, normality of scientists, attitude towards scientific inquiry, career interest in science, leisure interest in science, enjoyment of science lessons and adoption of scientific attitudes.

For this study, only positive items were used from all the questionnaires. Schriesheim and Hill (1981) previously concluded that reversed worded items have lowered questionnaires' validity. As such, to improve the validity of the instrument, only positive items were included in this study. The items were inserted with translations in the Malay language to increase respondents' understanding of the statements. A pilot test involving 50 students was conducted to validate the questionnaires. The results of the pilot test was that to prevent non-response of the students to the items, it would be better to remove the '*Neutral*' scale in the questionnaires. As such, students were only provided with four choices: Almost Never, Seldom, Often and Almost Often.

For the *WIHIC Questionnaire,* Cronbach's Alpha reliability value of 0.96 was obtained. The Cronbach's Alpha values for each construct ranged from 0.85 to 0.91as listed in Table 1. The highest alpha reliability value (0.91) was obtained for Investigation and the lowest (0.85) for Students' Cohesiveness. These values indicate that the items in the questionnaire are highly reliable (Nunnally, 1978). For content validity, five secondary science teachers with more than five years teaching experience were asked to check the content. All of them agreed that the questionnaire is suitable to be administered in Malaysia.

Table 1

Mean and Cronbach's Alpha Values reported for the scales in WIHIC Questionnaire in the pilot test

Construct	**Mean**	**Cronbach's Alpha**
Students' Cohesiveness	3.10	.85
Teacher Support	2.67	.89
Involvement	2.62	.87
Investigation	2.56	.91
Task Orientation	3.00	.86
Cooperation	3.11	.89
Equity	2.85	.88

For the *SLEI Questionnaire,* Cronbach's Alpha reliability value of 0.88 was obtained. The Cronbach's Alpha values for each construct

ranged from 0.64 to 0.78 as listed in Table 2. Students' Cohesiveness has the highest alpha reliability value (a = .78), and Open-Endedness has the lowest (a = .64). For the *TOSRA Questionnaire,* Cronbach's Alpha reliability value of 0.95 was obtained. The Cronbach's Alpha values for each construct ranged from 0.47 to 0.93 as listed in Table 3. Enjoyment of Science Lesson has the highest alpha reliability value (a = .93), and Social Implication of Science has the lowest (a = .47).

Table 2

Mean and Cronbach's Alpha Values reported for the scales in SLEI Questionnaire in the pilot test

Construct	Mean	Cronbach's Alpha
Students' Cohesiveness	2.90	.78
Open-Endedness	2.40	.64
Integration	2.79	.68
Rule Clarity	2.94	.72
Material Environment	2.81	.66

Table 3

Mean and Cronbach's Alpha Values reported for the scales in TOSRA Questionnaire in the pilot test

Construct	Mean	Cronbach's Alpha
Social Implication of Science	2.72	.47
Normality of Scientists	2.55	.79
Attitude towards Scientific Inquiry	2.72	.84
Adoption of Scientific Attitudes	2.61	.70
Enjoyment of Science Lessons	2.49	.93
Leisure Interest in Science	2.46	.90
Career Interest in Science	2.53	.91

Data Analysis

Multiple linear regression was used to determine: a) the influence of the independent variables (Classroom Learning Environment

and Science Laboratory Learning Environment) on the dependent variable (Attitude towards learning science); b) the scales of WIHIC which significantly predict attitude; and c) the scales of SLEI which significantly predict attitude. The standard multiple linear regression or the stepwise method was chosen to evaluate the predictability afforded by the different predictors in the three categories of this study. The assumptions of multiple regression, namely linearity, homoscedasticity and absence of multicollinearity, were first assessed before conducting multiple regression. Linearity and homoscedasticity were assessed by examining the scatter plot. The absence of multicollinearity was assessed using Variance Inflation Factor (VIF).

RESULTS

Research question 1: What are the effects of classroom learning environment and laboratory learning environment on students' attitude towards learning science?

Table 4

Pearson Correlation Matrix between Attitude Towards Learning Science and Learning Environment

	1	2	3
1. Attitude Towards Learning Science	-	.515**	.526**
2. Classroom Learning Environment		-	.518**
3. Science Lab Learning Environment			-

***p < 0.01*

The correlation matrix between attitude and learning environment is presented in Table 4. The results show that attitude towards learning science is positively correlated with both classroom learning environment (r = .515) and science laboratory learning environment (r = .526). The model also shows that learning environment is strongly correlated with attitude towards learning science as indicated by a strong multiple correlation coefficient (R = 0.598). This shows that those who perceive the classroom learning

environment and laboratory learning environment more positively tend to have a better attitude towards learning science. The multiple regression model with both predictors produced an adjusted R^2 = .352, F (2, 269) = 74.72, $p < .001$, and accounts for 35.2% of the variance. The results indicate that classroom learning environment (β = .33) and science laboratory learning environment (β = .35) are significant predictors of attitude towards learning science. The summary of multiple regression analysis in presented in Table 5.

Table 5

Summary of multiple regression analysis for the effects of learning environment on the attitude towards learning science

Model & Predictor Variables	B	S E B	β	F (2,271)	R	R^2	Adj R^2
Model 1				74.72**	.60	.36	.35
(Constant)	1.09	.15	-				
Science Lab Learning Environment	.34	.05	.35***				
Classroom Learning Environment	.29	.05	.33***				

Research question 2: What are the classroom learning environment scales that significantly predict a positive attitude towards learning science?

Pearson correlation matrix between all the constructs in the WIHIC questionnaire and attitude towards learning science are presented in Table 6. The findings reflect that all the constructs are moderately correlated with attitude except for students' cohesiveness and teacher support. For both these constructs, the Pearson value is below .400. Correlations between the predictor variables are presented in Table 7. The model produced an above average multiple correlation coefficient, R = .531. This indicates that students who perceive classroom learning environment which incorporates cooperation among students, promoting equity among students and prioritizing investigation component during lessons, tend to have a more positive attitude towards learning science. The overall model is

significant, F (3, 268) = 35.16, p < .001, and accounts for 27.4% of the variance. The results indicate that cooperation (β = .215), equity (β = .219) and investigation (β = .195) are significant predictors of the students' attitude towards learning science.

Table 6

Pearson Correlation Matrix between Attitude Towards Learning Science and WIHIC Scales

	1	2	3	4	5	6	7	8
1. Attitude TowardsLearning Science	-	.429**	.459**	.456**	.364**	.316**	.411**	.420**
2. Investigation		-	.551**	.525**	.470**	.531**	.698**	.449**
3. Cooperation			-	.623**	.601**	.451**	.540**	.695**
4. Equity				-	.555**	.618**	.611**	.610**
5. Students' Cohesiveness					-	.530**	.592**	.528**
6. Teacher Support						-	.598**	.485**
7. Involvement							-	.565**
8. Task Orientation								-

***p < 0.01*

Table 7

Summary of multiple regression analysis for the effects of classroom learning environment predictor variables (WIHIC) on the attitude towards learning science

Model & Predictor Variable	B	SE B	β	F (2,271)	R	R^2	Adj R^2
Model 2				35.16**	.53	.28	.27
(Constant)	1.62	.13	-				
Cooperation	.16	.05	.22**				
Equity	.15	.05	.22**				
Investigation	.13	.04	.20**				

Research question 3:

What are the science laboratory learning environment scales that significantly predict a positive attitude towards learning science?

In Table 8, Pearson correlation values between attitude towards learning science and each SLEI construct is presented. The results show that integration, students' cohesiveness and material environment are moderately correlated with attitude with Pearson correlation values between .457 to .432. However, the correlation between attitude and rule clarity is weak (r=.381), and the lowest correlation is observed between attitude and open-endedness (r=.288). Relationships between the predictor variables are presented in Table 9. Attitude towards learning science is positively and significantly correlated with all the scales in SLEI and shows an above average multiple correlation coefficient, R = .521. This indicates that those who perceive science laboratory environment to be well-equipped, promoting the integration of science knowledge with scientific experiments and conducive to interactions among students, tend to have a more positive attitude towards learning science. The multiple regression models with Integration, Material Environment, Students' Cohesiveness as the predictors produced an adjusted $R^2 = .264$, $F(3, 268) = 33.34$, $p < .001$, and accounts for 26.4% of the variance. This indicates that only three scales, Integration ($\beta = .25$), Material Environment ($\beta = .21$) and Students' Cohesiveness ($\beta = .15$) are significant predictors of students' attitude towards learning science.

Table 8

Pearson Correlation Matrix between Attitude Towards Learning Science and SLEI Scale

	1	2	3	4	5	6
1. Attitude Towards Learning Science	-	.457**	.432**	.436**	.288**	.381**
2. Integration		-	.622**	.538**	.401**	.604**
3. Students' Cohesiveness			-	.588**	.334**	.621**
4. Material Environment				-	.283**	.583**
5. Open-Endedness					-	.135*
6. Rule Clarity						-

*$p < .05$. **$p < .01$

Table 9

Summary of multiple regression analysis for the effects of science laboratory learning environment predictor variables (SLEI) on the attitude towards learning science

Model & Predictor Variable	B	SE B	β	F (2,271)	R	R^2	Adj R^2
Model 3				33.34**	.52	.27	.26
(Constant)	1.64	.13	-				
Integration	.17	.05	.25***				
Material Environment	.14	.04	.21**				
Students' Cohesiveness	.12	.06	.15*				

*Note: In tables, values are rounded to the second decimal, but in the text, the third decimal is used.*p < .05.**p < .01. ***p < .001*

DISCUSSION

Emphasis on higher order thinking skills is already in place in many countries, and 21st century learning requires students to be able to engage in analysis and interpretation of data, presenting arguments from the evidence gained and designing scientific investigations to discover solutions (Donovan et al., 2014). According to Partnership for 21st Century Skills (2011), creativity and innovation, critical thinking and problem solving and communication and collaboration are skills necessary to prepare students for the 21st century world.

A significant contribution of the present study is it shows the effects of learning environment on attitude towards learning science. According to the Theory of Planned Behavior, attitude is one of the major components for determining the motivation of a person to act in a certain manner (Azjen, 1991). A positive attitude towards learning science will increase the chances of students engaging in higher order thinking skills while learning science. One major difference that sets this study apart from the past studies is that this study is a comparative study of classroom learning environment and laboratory learning environment. In Malaysian secondary schools, only science-related subjects have lessons conducted in science

laboratories. Therefore, it is of importance for this study to find out the impact of these different learning environments on attitude towards learning science.

From the results, it is found that science laboratory learning environment has a slight advantage over the classroom learning environment in promoting a positive attitude towards learning science. Creativity is integral to science and the science learning process as pointed out by Hodson and Reid (1988). Learning experiences in the laboratory, such as by conducting experiments and reflecting on outcomes, allow students to practice creativity in the classroom (Coxon, 2012). Hence, students become more interested and motivated to learn science because they have more opportunities and freedom to discover new knowledge in their own creative ways (Lee & Erdogan, 2007).This finding is of importance to the science educators in Malaysia's secondary schools as the government of Malaysia is trying to drive the young minds to embrace higher order thinking skills.

We also explored the specific scale items from the classroom learning environment and science laboratory learning environment which have the most influence in promoting a positive attitude towards learning science. The results from this study show that the scale items, *Cooperation*, *Equity* and *Investigation* from the WIHIC questionnaire are significant predictors. These findings are quite similar to the findings of a study conducted by Koul and Fisher on the relationships between the scales of WIHIC and attitude towards science. It is reported in their findings that *Investigation*, *Task Orientation* and *Equity* of the WIHIC questionnaire are positively and significantly related to students' attitude towards science (Koul & Fisher, 2005). For science laboratory learning environment, scale items *Integration*, *Material Environment* and *Students' Cohesiveness* are the significant predictors.

All these significant predictors fit the characteristics of 21st century learning which promotes active and innovative problem-solving skills as well as collaborative efforts in finding solutions. Each of the significant scales from the classroom learning environment (*Cooperation*, *Equity*, and *Investigation)* carries the elements of 21st century learning. For example, *Cooperation* describes the extent of cooperation that exists among students during classroom

activities. *Equity* refers to the degree of equal treatment given by the teachers to the different individuals in the classroom to express and develop themselves, while *Investigation* is linked to the emphasis on the scientific skills and inquiry learning which will be applied in problem-solving. Similarly, significant predictors from the science laboratory learning environment (*Integration*, *Material Environment* and *Students' Cohesiveness)* complement the skills set of the 21st century. *Integration* describes the extent to which laboratory activities are integrated into the theories obtained from the non-laboratory classes. *Material Environment* refers to the adequacy of the laboratory equipment and materials prepared for students to practice their hands-on investigation. *Students' Cohesiveness* measures the closeness of relationship among the students as they work collaboratively in the science laboratory experiments.

CONCLUSION

The present study investigates the effects of learning environments on the attitude to learning science in public schools. Both classroom learning environment and science laboratory learning environment are significant predictors of the attitude. Predictors that have been found to be significant, such as *Cooperation*, *Equity* and *Investigation* from the WIHIC questionnaire and *Integration*, *Material Environment*, and *Students' Cohesiveness* from the SLEI should be further investigated in future studies to enhance 21st century learning. As a follow-up to this study, it would be worthwhile for future researchers to consider giving more focus to the predictor, *Investigation,* due to its lowest position (mean - 2.56) in the classroom learning environment questionnaire.

A majority of the students who participated in this study expressed a need for changes in learning environments in public schools, especially in the science laboratory learning environment. This conclusion is drawn from the fact that all scales in the SLEI achieved a mean of less than 3. These deficiencies in laboratory learning environment might hinder the efforts of the government to incorporate 21st century learning in science which focuses on creative problem-solving and collaborative learning.

For the purpose of accelerating reforms in science teaching and learning in the 21st century, it may be of interest for future studies

to know to what extent such preparedness and priorities are shared by the existing and future science teachers, especially in terms of modifying the learning environments to suit the needs of the 21st century learners. The Malaysian government has placed much importance on the development of STEM in the country over the past decades, and the education setting in Malaysia is undergoing a major transformation with the introduction of Frog VLE, iThink, HOTS (Higher Order Thinking Skills) and many other exciting initiatives. With this in mind, coupled with the nation's aspiration to become fully developed by 2020, it is very crucial for Malaysia to embark on a new model of teaching and learning of science in the 21st century, incorporating an overhaul of the learning environments in public schools.

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