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Research Article:

Predictors of Student Engagement in Science Learning: The Role of Science Laboratory Learning Environment and Science Learning Motivation

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ABSTRACT

Student engagement is one of the indicators of a successful teaching and learning process. Many studies claim that student engagement is associated with the performance and achievement of students. In this study, the researchers aimed to determine the effects of science laboratory environments and science learning motivation towards student engagement in learning science among non-science students. 468 upper secondary non-science students in Sarawak were involved in this survey with the administration of three sets of questionnaires on science laboratory environment, science learning motivation and student engagement in science learning. Multiple regression was used to analyse the research questions. Both science laboratory learning environment (r = 0.523) and science learning motivation (r = 0.670) are found positively correlated to student engagement. The results also revealed that the science laboratory learning environment and science learning motivation are significant predictors of student engagement in learning science with R^2 = 0.463. Specifically, student cohesiveness, open-endedness, integration and material environment in the science laboratory learning environment and all the dimensions of motivation predict student engagement in science learning. The findings suggest that educators, especially science teachers, should utilise the laboratory effectively and keep students motivated to ensure their active engagement in science learning.

Keywords: Non-science students, science laboratory learning environment, science learning motivation, student engagement

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INTRODUCTION

Student engagement has been widely acknowledged as an important component in the field of education. Newmann et al. (1992, p. 5) define student engagement in academic work as "the student's psychological investment in and effort directed toward learning, understanding, and mastering the knowledge, skills, or crafts that academic work is intended to promote". Skinner and Pitzer (2012), on the other hand, describe student engagement as an action that is energised, directed, and prolonged, or the observable characteristics of students' real interactivity with academic works. Students are engaged when they are committed to their work, even though they face challenges and show an apparent delight in completing their tasks (Schlechty, 2001). A number of studies has reported that the student engagement exists as a predictor to quality of learning and students' outcomes (Carini et al., 2006; Kuh et al., 2007; Mahatmya et al., 2012). It tends to improve academic achievement as well as lower student dissatisfaction levels and dropout rates (Lei et al., 2018). In short, students may perform better with a higher level of achievement if they are engaged in learning.

In Malaysia, the low achievement in science is still an issue (Law et al., 2022). Based on the results from Programme for International Student Assessment (PISA) administered by Organisation for Economic Co-operation and Development (OECD) in 2018, Malaysian students managed to score averagely about 438. This was alarming as the stated score was still far from the mean score of 489 (OECD, 2019). To no avail, similar phenomenon occurred in 2019 as Malaysian students managed to score only 460 on average in science which was 40 points below the standard par of 500 in Trends during International Mathematics and Science Study (TIMSS) (Mullis et al., 2020). For this reason, it is necessary for researchers to look into the issue of student engagement in science learning, since student engagement appears to be the most vital factor in student learning and individual development (Hu & Kuh, 2002).

In addition, the 60:40 policy is yet to achieve its goal after half a century since its introduction in 1967. The policy has targeted 60% of students, especially at the upper secondary and higher education levels, to study science and technology and another 40% to pursue art streams (Sufean Hussin & Norliza Zakuan, 2009). Surprisingly, according to the current statistics, Datuk Prof Dr Noraini Idris, the chairperson of the National STEM Movement, reported only 19% of students studied science, technology, engineering and mathematics (STEM) subjects when they reached higher secondary schools (Faizatul Farhana Farush Khan, 2020). This signifies that only one in every five high secondary students is enrolled in the science stream in Malaysia. Evidently, Malaysian students prefer to enrol in non-science stream more and less engage in learning science. Previous research has also revealed a lack of interest in science among non-science students (Adu-Gyamfi, 2013). As non-science students constitute the majority of students, the study of engagement in science learning among these students is valuable and critical to our science education purposes.

Student engagement is seen to be changeable and adjustable, and greatly impacted by the learning environment (Shernoff, 2013; Christenson et al., 2012). The classroom learning environment, according to Wong and Fraser (1996), is a significant determinant of student learning. When it comes to learning science, laboratory work complements the study of theories and concepts. Among the reasons for laboratory work are: engaging students, translating theories into practice, confirming the concepts, developing technical and investigative skills (Parappilly et al., 2013). Also, laboratory work is able to encourage and increase students' interest in science and promote science as an engaging subject (Shana & Abulibdeh, 2020). Most of the literatures indicate that the science laboratory learning environment potentially improves students' attitudes towards science (Karpudewan & Chong, 2017; Kapici et al., 2020). This gradually changes students' attitudes positively towards learning science, thus increases student engagement in science-related tasks (Gibson, 2002). Hence, a positive science laboratory environment is absolutely necessary when doing practical work. However, comprehensive studies on the direct effect of the science laboratory learning environment on student engagement in science learning are ambiguous. Thus, the researchers aimed to study the causal effect of the science laboratory learning environment on student engagement.

Besides, student motivation is also an essential element of student engagement in learning. (Mai et al., 2015). Motivation is a necessary prerequisite for student engagement in the process of learning and is closely related to it (Ryan & Deci, 2009). Students who are intrinsically motivated show a lower level of anxiety, a higher level of achievement, a perception of competence, and higher engagement in learning (Wigfield & Wagner, 2005). Previous studies have also presented the relationship between learning motivation and student engagement (Saeed & Zyngier, 2012; Nayir, 2017; Wang et al., 2017). However, it is found that most of the studies discussed the relationship between the variables generally. The causal effect between the science learning motivation and student engagement remains unclear. As a result, in this study, the researchers aimed to examine learning motivation and student engagement with a focus on science learning among non-science students.

STUDENT ENGAGEMENT

Student engagement is described as the quality of students' efforts dedicated to academic activities that contribute to desired outcomes (Hu & Kuh, 2002). Researchers often have different views on student engagement (Appleton et al., 2008; Christenson et al., 2008). Although there are different definitions, there is a commonality that student engagement is a construct that consists of various dimensions that involve internal thoughts and feelings as well as external behaviours (Finn, 1989; Fredricks et al., 2005). The researchers agree that engagement is a meta-concept that encompasses multiple dimensions of school involvement or commitment to learning activities (Fredricks et al., 2004; Jimerson et al., 2003; Sinclair et al., 2003). For instance, Finn (1989) claims that student engagement involves emotional and behavioural factors, while Skinner and Belmont (1993) focus on the affective, behavioural, and cognitive components in the learning process. Morse et al. (2004), on the other hand, suggest four dimensions of student engagement, which are academic engagement (the length of time spent on assignments and the credits gained), cognitive engagement (students concentrate on academic tasks and work towards self-learning), behavioural engagement (involvement in the classroom and extracurricular activities), and psychological engagement (students feel identification with the school, experience membership in the school, and have a positive connection with peers).

To date, most research have divided student engagement into three dimensions, namely cognitive, behavioural, and emotional engagement (Fredricks et al., 2004; Wang & Eccles, 2012; Pilotti et al., 2017). Students' cognitive engagement relates to their investment in their own learning, identifying their own goals, and enjoying mental difficulties (Gunuc & Kuzu, 2014; Fredricks et al., 2004). Meanwhile, behavioural engagement is primarily founded on the concept of participation in academic and social activities, including self-regulation in learning. Lastly, emotional engagement includes responses in terms of attitudes, beliefs, and values toward teachers, course content, classmates, and friends (Bryson & Hand, 2007; Gunuc & Kuzu, 2014). In addition, emotions like belonging to institutions, loving school, and feeling like a part of the community are also included in the context of emotional engagement (Fredricks et al., 2004). The researchers in this study see student engagement as an action, as well as student participation and response to stimuli in the teaching and learning process. Student engagement might be generated due to an internal factor (personal determinants such as learning motivation and interest) and an external factor (learning environment, student demographics). Therefore in this context, student engagement refers to the cognitive, behavioural and emotional engagement of non-science students in science learning.

SCIENCE LABORATORY LEARNING ENVIRONMENT

A learning environment, according to Dunlop (2004, p.17), can be explained as the entire climate, culture, ambiance, or atmosphere in which learning occurs. In the context of teaching and learning science, a science laboratory is an important learning environment (Wrutheran et al., 2001; Che Nidzam Che Ahmad et al., 2010) to the extent that it provides interactive, comfortable, and student-centred classroom which promotes collaborative learning (Akinbobola and Afolabi, 2010). While carrying out hands-on activities in the science laboratory, students use scientific processes and materials to develop their own explanations of scientific events or phenomena. This gives the students a student-centred environment to interact and collaborate with others. Subsequently, students would have the opportunity to actively learn and collaborate with friends, which indirectly promotes student engagement when learning science.

The study of science laboratory learning environment scholarly began in 90s. Fraser et al. (1993) developed the Science Laboratory Environment Inventory (SLEI) and validated it over a sample of 5,447 students in 269 classes from six countries (United States, Australia, England, Canada, Nigeria, and Israel). SLEI appears as one of the most widely used instruments to study the science laboratory environment based on students' perception. Past studies (Shernoff et al., 2014; Shernoff et al., 2016; Tas, 2016) presented the importance of learning environment on student engagement. However, there are still limited studies of the science laboratory learning environment on student engagement. Moreover, most of the literature discussed the association between the science laboratory learning environment and its affective learning outcomes, such as attitude and satisfaction (Wong & Fraser, 1996; Che Nidzam Che Ahmad et al., 2010; Gupta et al., 2015; Karpudewan & Chong, 2017) and cognitive domain (Aladejana & Aderibigbe, 2007) in learning science. Also, there have been limited studies on the impact of the science laboratory environment on behavioural outcomes, including student engagement. This generates the passion of researchers to fill up the gap. In this study, the science laboratory learning environment is seen from several dimensions as stated by Fraser et al. (1993). The dimensions in the science laboratory learning environment are student cohesiveness, open-endedness, integration, rule clarity, and material environment.

SCIENCE LEARNING MOTIVATION

Motivation is the guidance, impulses, and internal emotions or desires that drives an action (Brown, 1980). In the process of learning, motivation encompasses all means of initiating and maintaining learning behaviours and prerequisites for meaningful learning to take place (Palmer, 2009). Ainley (2012) also describes motivation as inner psychological elements and engagement as the nature and level of participation in an activity.

The self-determination theory by Ryan and Deci (2000) emphasis on vitalising students' inner states and hence is concerned primarily with motivation (Reeve, 2012). The self-determination theory focuses on one's inherent motivational drive for learning and growth and how it might be developed (Ryan & Deci, 2020). The motivation state may be adjusted by external factors, for example, classroom rules and environment (Saeed & Zyngier, 2012) and punishments or rewards such as praise from teachers (Peng, 2021). When the three basic psychological needs, according to Ryan and Deci (2000), namely autonomous support, feelings of competency and relatedness are met, the likelihood of healthy motivation and beneficial well-being increases. Students gradually become more motivated and actively engaged in the learning process.

In specific, science learning motivation means the motivation or inner drive of a student to learn science. Past studies discussed the relationship between learning motivation and student outcomes. There are three dimensions of motivation that have been researched consistently, namely learning goal orientation, task value, and self-efficacy (Velayutham et al., 2012). Bircan and Sungur (2016) presented a significant positive correlation between student motivation (self-efficacy and task-value) and cognitive engagement in science. Hsieh and Yu (2022) also reported that motivation had a significant relationship to practical STEM competence gained through the participation and engagement in science learning process. Besides, Wang et al. (2017) also concurred that an increase in student motivation is related to the increase of student engagement in behavioural, emotional, and agentic dimensions with practice learning. The sense of enjoyment students experience in the classroom is highly motivating and drives them to pursue different levels of learning enthusiastically (Martin, 2013). This, in turn, contributed to active engagement in learning progress. In this study, the researchers aimed to investigate the causal effect of science learning motivation on student engagement in the context of non-science students. This generates a meaningful finding for Malaysian science education since the majority of Malaysian students are from non-science streams.

RESEARCH FRAMEWORK

A number of learning theories in psychology that explain the process of development and learning. Social Cognitive Theory by Bandura (1986) is one of the most well-known among these. Social cognitive theory provides a framework for understanding, predicting and changing human behavior (Green & Peil, 2009). The theory describes the human learning as interrelations between personal, environmental and behavioural factors. Personal determinants include factors such as cognition (thoughts and perspective), self-efficacy, motives, beliefs and personality. The environmental component is the social context, which includes the relationships of people and their roles in them, for example in the classroom. The behaviour determinant is the observable actions or behavioural patterns such as self-regulation.

Bandura (1986) presented that human behaviour as a reciprocal interaction between the determinants and influencing each other. He added that individuals are agents who are actively involved in their personal development and own the ability to make things happen through their actions. When people with their own sets of thoughts, values, and experiences are exposed to different environments, their behaviour patterns are filtered and affect each other in a unique way. For instance, a student with low learning motivation (personal determinant) may not want to take part in a challenging learning activity (behavioural determinant). Receiving a poor score or responding improperly to teacher's question (behavioural determinant) on the other hand, may have a negative impact on a student's motivation and confidence (personal outcome).

The reciprocal interrelationships between the environmental and behaviour determinant illustrate that environmental determinant can affect one's behaviour and vice versa. When the teachers plan an interesting and engaging activity (environment determinant). this may promote the positive emotions, action and participation in learning (behavioural determinant). However, when a teacher approaches students in a threatening manner in order to persuade them to follow instructions, the students may respond with hostile behaviour to the unfavourable learning environment.

The purpose of this study was to determine the effects of the science laboratory learning environment and science learning motivation on student engagement in science learning. Researchers discovered a link between the variables in this study, which are the science laboratory learning environment, motivation, and student engagement, and the Social Cognitive Theory. The science laboratory learning environment is an environmental determinant for students. Student engagement is the behavioural outcome, whereas motivation is a cognitive and personal aspect of a student. Thus, a research framework was developed by mapping the variables with the determinants in social cognitive theory, as shown in Figure 1.

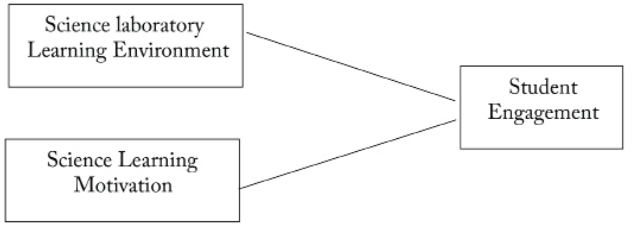

Figure 1: Research framework

RESEARCH QUESTIONS

The aim of the study is to investigate the effects of science laboratory learning environment and science learning motivation on student engagement in science learning among non-science students. This study hereby attempted to answer the following questions:

1. What are the effects of science laboratory learning environment and science learning motivation on student engagement in learning science?
2. What are the dimensions of the science laboratory learning environment that significantly predict student engagement in learning science?
3. What are the dimensions of science learning motivation that significantly predict student engagement in learning science?

METHODOLOGY

Samples

The population of the study consisted of the non-science students from secondary upper form schools in Sarawak. In Malaysia, the students will be enrolled into either science or art stream after their studies in Form 3. The research focuses on the non-science students, or the art stream students because they are the majority in our education system. Therefore, a total number of 468 samples (209 males and 259 females) were chosen from 20 public secondary schools in Sarawak to be involved in the study. Cluster and simple random sampling method were applied in selecting these samples. In other words, the science laboratory learning environments from 20 different schools was analysed in this study. The sample size was sufficient and suitable based on Krejcie and Morgan's (1970) recommendation.

Instruments

There were three questionnaires used in this study. SLEI is a widely used instrument to understand the perception of students on science laboratory learning environment (Fraser et al., 1993). SLEI contains 35 items, with five dimensions, namely student cohesiveness, open-endedness, integration, rule clarity, and material environment. The researchers used the Malay version of SLEI for the study, which was translated by Che Nidzam Che Ahmad et al. (2010). After the process of validity and reliability, 29 items were found suitable for the context of the current study.

This study also used a part of the questionnaire from the Students' Adaptive Learning Engagement in Science (SALES) by Velayutham et al. (2011). There are two domains in SALES which measure student motivation and self-regulation in science learning. Only the motivation domain was adopted by researchers to meet the objective of the study. The dimensions of science learning motivation tested were goal orientation, task value, and self-efficacy. The instrument was translated into by using back-to-back translation, as suggested by Brislin (1976) and Newmark (1988). The process of translation involved four language experts to ensure that the items were suitable in terms of structure and grammar.

Besides, the study employed the instrument developed by Law et al. (2021) to measure student engagement in science learning. The instrument was designed based on three dimensions, mainly behavioural engagement, cognitive engagement, and emotional engagement. The content validity of the instrument was checked by four experts, which resulted in a Content Validity Index (CVI) of 0.885. The exploratory factor analysis revealed that all items had a factor loading value greater than 0.40. The example of the items are "I pay attention during the science class" (behavioural engagement), "When I get a poor grade in science, I will figure out the source of my weakness." (cognitive engagement) and "I feel like I'm part of this science class" (emotional engagement).

The items in three questionaires used the Likert Scale. The respondents were asked to rate on a scale from 1 to 5, where they agreed or disagreed with the items in the space provided. Prior to the actual research, the pilot test was conducted to ensure the validity and reliability of the instruments. The Cronbach's Alpha obtained for science laboratory learning environment, science learning motivation and student engagement are 0.822, 0.919 and 0.835, respectively. The reliability value of each dimension of the instruments and the distribution of items after the factor analysis are showed in the table below.

Table 1. The distribution of items and variables

Variables	Dimensions	Cronbach's Alpha	Number of items (after factor analysis)
Science Laboratory Learning Environment	Student cohesiveness	0.859	6
	Open-endedness	0.692	4
	Integration	0.896	7
	Rule clarity	0.846	6
	Material environment	0.771	6
Science Learning Motivation	Goal orientation	0.857	7
	Task value	0.871	8
	Self-efficacy	0.787	7

(Continue on next page)

Table 1 (continued)

Variables	Dimensions	Cronbach's Alpha	Number of items (after factor analysis)
Student Engagement	Behavioural engagement	0.816	6
	Cognitive engagement	0.810	5
	Emotional engagement	0.763	7

Data Analysis

Regression analysis is a widely used tool in educational research that can predict and indicate the relationship and strength of independent variable effects on a dependent variable (Sarstedt & Mooi, 2014). Since there were two independent variables analysed in this study, it is also known as multiple linear regression analysis. Multiple linear regression was run with the Statistical Packages for Social Science (SPSS) software version 21.0 to seek the effect of independent variables, the science laboratory learning environment, and science learning motivation on student engagement in learning science (the dependent variable). The assumptions of multiple linear regression (normality, linearity, and absence of multicollinearity) were addressed before conducting the analysis. The same method was applied to test the effects of the dimensions of the independent variables on student engagement.

Ethical Approval

Prior to data collection, the researcher obtained permission from Education Policy Planning and Research Division (Educational, Planning and Research Division, EPRD) at the Ministry of Education (MOE). The proposal, research methods, and instrument were reviewed and approved by the EPRD. Next, permission was also obtained from the Sarawak State Education Department and the school principals of the secondary schools selected to conduct the study. Apart from that, informed consent and voluntary participation are the ethical issues with which we should be concerned. Participants were thoroughly explained the purpose of the study, what would be asked of them, and how the data would be used administering the questionnaire (Fleming & Zegwaard, 2018). All participants took part in the survey voluntarily, were anonymous, and had the option to leave at any time.

RESULTS

Research Question 1

What are the effects of science laboratory learning environment and science learning motivation on student engagement in learning science?

Table 2. Relationship between science laboratory learning environment and science learning motivation and student engagement in learning science

Variables	1	2	3
1. Student Engagement	-	0.523	0.670
2. Science Laboratory Learning Environment		-	0.641
3. Science Learning Motivation			-

The correlation matrix between science laboratory learning environment, science learning motivation, and student engagement is displayed in Table 2. The results show that the science laboratory learning environment is positively correlated to student engagement in learning science with a coefficient of (r = 0.523). Science learning motivation (r = 0.670) is found to be the same, positively correlated to student engagement.

Table 3. Summary of multiple linear regression analysis for the effects of science laboratory learning environment and science learning motivation on student engagement in learning science

Model and predictor variables	B	Std Error	β	*t*	F (2,465)	R	R^2	Adj R^2
Model 1 (constant)	0.376	0.178		2.114	200.69	0.681	0.463	0.461
Science Laboratory Learning Environment	0.221	0.062	0.159	3.587				
Science Learning Motivation	0.586	0.046	0.568	12.832				

From Table 3, that the model of science laboratory learning environment and science learning motivation are strongly correlated to student engagement in learning science with a strong correlation coefficient (R = 0. 681). Significantly, the science laboratory learning environment and science learning motivation account for 46.3% of the variance (R^2 = 0.463)in student engagement, with F(2, 465) = 200.69, p = 0.000. The results also show that science laboratory learning environment (β = 0.159) and science learning motivation (β = 0.568) are significant predictors of student engagement in learning science.

Research Question 2

What are the dimensions of the science laboratory learning environment that significantly predict student engagement in learning science?

Table 4. Relationship between dimensions of science laboratory learning environment and student engagement in learning science

Variables	1	2	3	4	5	6
1. Student engagement	-	0.336	0.0106	0.503	0.331	0.278
2. Student cohesiveness		-	0.010	0.403	0.364	0.278
3. Open-endedness			-	0.004	0.015	0.025

(Continue on next page)

Table 4 (continued)

Variables	1	2	3	4	5	6
4. Integration				-	0.398	0.292
5. Rule clarity					-	0.744
6. Material environment						-

Table 4 shows that the most correlated dimension in SLEI with student engagement is integration (r = 0.503), while the other dimensions are only moderately correlated. The multiple regression analysis shows a significant regression F(5,462) = 39.571, $p < 0.000$, with a 30.0% variance in student engagement explained by the science laboratory learning environment (R^2 = 0.300). The findings also reveal that the presented integration (β = 0.414), student cohesiveness (β = 0.136), material environment (β = 0.116), and open-endedness (β = 0.101) dimensions are predictors of student engagement in learning science. The summary of the multiple linear regression analysis between the dimensions of the science laboratory learning environment and student engagement in science learning is shown in Table 5.

Table 5. Summary of multiple linear regression analysis for the effects of science laboratory learning environment dimensions on student engagement in learning science

Model & Predictor Variables	B	Std Error	β	t	F (5,462)	R	R^2	Adj R^2
Model 2 (constant)	1.051	0.175			39.571	0.548	0.300	0.292
Integration	0.358	0.038	0.414	9.524				
Student cohesiveness	0.107	0.034	0.136	3.137				
Material Environment	0.083	0.030	0.116	2.801				
Open-endedness	0.061	0.024	0.101	2.581				

Research Question 3

What are the dimensions of science learning motivation that significantly predict student engagement in learning science?

Table 6. Relationship between dimensions of science learning motivation and student engagement in learning science

Variables	1	2	3	4
1. Student Engagement	-	0.517	0.480	0.634
2. Goal Orientation		-	0.575	0.423
3. Task Value			-	0.457
4. Self-efficacy			.	-

From the analysis, all the dimensions of science learning motivation are positively correlated to student engagement in learning science. Self-efficacy (r = 0.634) is found to be most correlated to student engagement, followed by goal orientation (r = 0.517) and task value

(r = 0.480). The multiple regression model with motivational dimensions as predictors $F(3,464) = 146.46$, p.000, is found to contribute 48.6% of the variance in student engagement (R^2= 0.486). The results indicate that all the dimensions in science learning motivation, self-efficacy (β = 0.475), goal orientation (β = 0.547) and task value (β = 0.121) are predictors of student engagement in learning science. Table 7 shows the summary of the multiple linear regression analysis between the dimensions of science learning motivation and student engagement in science learning.

Table 7. Summary of multiple linear regression analysis for the effects of science learning motivation dimensions on student engagement in learning science

Model & Predictor Variables	B	Std Error	β	*t*	F (3,464)	R	R^2	Adj R^2
Model 3 (constant)	0.908	0.131			146.46	0.697	0.486	0.483
Self Efficacy	0.383	0.031	0.475	12.376				
Goal Orientation	0.198	0.033	0.247	5.921				
Task Value	0.108	0.038	0.121	2.839				

DISCUSSION

Student engagement is a robust predictor of learning outcomes, assessment performance, grade achievement, and completion of school (Carini et al., 2006; Appleton et al., 2008; Wang & Fredricks, 2014). Due to this, there is a growth of student engagement research over the last two decades. Student engagement is malleable, can be shaped and altered to different practices (Fredricks et al., 2004) and hence it is crucial to recognise its predictors.

The current study makes a significant contribution by demonstrating the effects of the science laboratory learning environment and science learning motivation on student engagement. This differs previous studies from the current as it focuses on the learning environment and learning motivation specifically to the science subject and their roles in predicting student engagement. The results indicated that both the science laboratory learning environment and the science learning motivation variables are found to be predictors of student engagement among non-science students. The findings can be linked to the Bandura's (1986) Social Cognitive Theory. According to Bandura, there are interconnections between the environment, personal and behavioural determinant. Students' perceptions of the learning environment will direct the student engagement, which represented the behavioural determinant in this context. In teaching and learning science, the laboratory work is another emphasis to obtain the knowledge other than in a formal class. The setting of laboratory work enables students to do scientific investigation in small groups cooperatively (Hofstein et al., 2001). A productive laboratory learning environment is a student-centred classroom (Akinbobola & Afolabi, 2010). This means that students can be more active and will engage better in learning science when implementing laboratory work.

Besides, the findings also revealed another important contribution: the dimensions of the science laboratory learning environment affect student engagement. Integration, student cohesiveness, material environment, and open-endedness are the dimensions that predict student engagement in learning science. For instance, integration is a predictor to student engagement. When activities carried out were found relevant to their studies, students tended to participate more in the learning process. This is parallel to the finding of Struyf et al. (2019) who reported that the integrated STEM approach and the use of authentic real-world problems are effective in engaging students. When the laboratory environment is favourable, students can interact, change ideas, and help one another well and these develop the cohesiveness among the students (Fraser et al., 1993). The open-endedness nature of the practical activities provides more freedom in the tasks, also leads students to engage more actively in learning science. At the same time, the material environment such as the availability and condition of apparatus, including the facilities of science lab, also may influence student engagement. The good quality of equipment allows the laboratory work to be conducted smoothly, whereas poor conditions may demotivate students from carrying out activities.

A further difference between the current study and previous studies concerning student engagement was the demographic of the participants. Focusing on non-science students, the findings of this study provide a very important information to educators. Even though they are not enrolled in science stream for pure science learning, the laboratory work is still necessary in the process of learning science. Unfortunately, the total time for learning science subject is only 3.5 hours per week for non-science students. This is far different from those who are studying pure science subjects (biology, chemistry, physics) and technological subjects (computer science and engineering drawing). The time allocated is limited since science subject does not only involve the delivery of theories, but also investigation through laboratory work. The findings of the study highlight the importance of science laboratory learning environment in promoting student engagement, thereby an important factor in student learning (Hu & Kuh, 2002). Thus, the MOE should look into the issue in order to produce a competitive future generation in a sophisticated world of science and technology. The considerations should include the facilities and the conditions and availability of equipment in school labs to ensure the quality of laboratory work.

Furthermore, the findings indicate that science learning motivation has a slight advantage over the science laboratory learning environment in promoting student engagement in learning science. The result is parallel with the previous studies which show that learning motivation has significantly affected student engagement (Wang et al., 2017; Nayir, 2017). Also, all the dimensions of science learning motivation are predictors to the student engagement. As the description of Brown (1980), motivation is the guidance, impulses, and internal emotions or desires that drive an action, which means engagement in this context. The major differences between the study with the previous studies are the science subject and sample involved. The outcomes of the study still show that motivation plays an important role in non-science students taking part in learning science, behaviourally, cognitively and emotionally.

In addition, the findings support the motivation theories such as self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000). According to Ryan and Deci (2000), the desire to fulfil needs and wants is the basic motive of human behaviours. Therefore, the higher desire in an individual to achieve a target in learning (for example, science achievement), the more motivated and active he or she is in the matter. When the goal orientation is clear, for example, to show competence in science subjects, students have higher science learning motivation and show active engagement in science learning. Science teachers should guide students to clarify objectives or suggest suitable goals for each student. Having appropriate targets may build student self-efficacy. Thus, students who show confidence in their abilities are more motivated to overcome difficult science concepts, focus on tasks for longer, and control their learning (Usher & Pajares, 2008; Velayutham & Aldridge, 2013). For those reasons, in the teaching and learning of science, from time-to-time teachers should give proper encouragement and more guidance to non-science students. In doing so, SDT addresses how students' inner resources interact with classroom conditions to result in varying levels of students' engagement.

Aside from goal orientation, task value is another dimension to predict student engagement. Task value shows an important role in students' achievement-related decisions and their performance (Eccles & Wigfield, 2002). Students are willing to spend time on assignments and give commitment during science learning inside or outside the classroom if they perceive the task or learning to be meaningful and valuable, as well as if they derive enjoyment from the task. In contrast, students will disengage from learning science if they cannot find the value of it, for instance, anxiety, fear of failure, too much efforts needed to succeed, lost opportunities that result from making one choice. Hence, the students might withdraw their engagement if they find learning science is unrelated and not relevant to them. Knowing this, it is important for the science teachers to instil the value of science to non-science students instead of keep emphasising the outcomes and test scores. Science should be taught by giving awareness about its importance in daily life, society, development of a country as well as the environment conservation. Hence, science teachers have to meticulously design science lessons by including related content, laboratory work, and valuable tasks, in order to keep the motivation of these non-science students to engage in learning science.

IMPLICATIONS AND LIMITATIONS OF STUDY

There are several implications generated from this study. Theoretically, Social Cognitive Theory (1986) was adapted in the context of the study science learning in high school. This study proposed a more comprehensive framework for explaining the effects of the science laboratory learning environment (environment determinant) and science learning motivation (personal determinant) on the engagement (behavioural determinant) of non-science students in learning science. Empirical findings shows both science laboratory learning environment and science learning motivation are significant predictors of student engagement with the significant R^2 value. This study provides a significant contribution as both variables are found to be predictive of non-science students' engagement in science learning. Also, dimensions of integration, student cohesiveness, open-endedness, material environment in science laboratory, learning environment, goal orientation, task value and self-efficacy in science learning motivation predict student engagement.

Another significant contribution of this study is its focus on non-science students, as there is still lack of studies with these students, especially in Asia Pacific region. The findings of the study are beneficial to the MOE, curricular designers as well as science educators. The MOE may take the duration of science lessons for non-science students into consideration, as it seems like it might be a factor inhibiting the laboratory work conducted in schools (Adu-Gyamfi, 2013). The science curriculum should place more emphasis on the science laboratory work since it provides a more student-centred environment than the conventional teaching style, which enhances student engagement. The curricular experts may provide the appropriate laboratory activities and manuals to help the science teachers in designing, planning, and preparing the practical work more creatively for each level of students. The study also reminds us that, in addition to providing knowledge and facilitating learning, teachers are also important motivators for our students. Reasonable challenges, rewards, encouragement, and praise, as well as the classroom environment, required teachers' efforts to have a positive impact and motivate students to maintain their engagement in learning science (Peng, 2021; Saeed & Zyngier, 2012).

Besides, there are some limitations to this study. The current study employed a cross-sectional design with a quantitative method. This provides less information, as the analysis was based on the data collected from the survey. It would be meaningful to conduct qualitative studies to better understand the situation of non-science students in Malaysia, including the reasons why they prefer and remain in the arts stream. Secondly, the participants involved are non-science students, and hence the result could explain the circumstances that happened to non-science students only. It is also recommended to examine the stability of science learning motivation and student engagement over time. The sample may also include science students to give a better inference on Malaysian students' TIMSS and PISA achievement. Lastly, the engagement variable in this study was analysed as a whole. Therefore, there is less evidence to show the causal effect of the science laboratory learning environment and science learning motivation on each dimension of student engagement. The researchers hereby suggest that the future study examine student engagement separately, in order to provide more comprehensive information about the students' cognitive, behavioural and emotional engagement.

CONCLUSION

By knowing the factors affecting student engagement in learning science, stakeholders can look into the influence of laboratory learning environment on science learning motivation, especially in teaching non-science students. Apart from designing a favourable laboratory work environment, science teachers must be more creative in their teaching by using appropriate digital tools and practising teaching and learning outside of the classroom through projects or activities. The same thing should be done for students of all ages to promote motivation and engagement in learning science. Also, society and parents need to give full support and encouragement to their children since they are young to venture into STEM. Our children should be encouraged to explore the fields of science and technology more proactively, to maintain our competitiveness on the international market in the future, especially at the age of Industrial Revolution 4.0 (IR 4.0).

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