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The relationship between learning environment and psychological characteristics in higher education

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ABSTRACT

This study investigated the relationships between quality of learning environment (physical and psychosocial environment) and psychological characteristics (student self-efficacy and satisfaction) in statistic education. The target population is a total of 380 students from diploma level, Faculty of Computer Science and Mathematics, University Teknologi MARA. By using cluster sampling, 285 students were selected as sample. The study instruments were adapted from Smart classroom inventory SCI, Science Laboratory Environment Inventory PSLEI, College and Classroom Environment Inventory CCEI, Learning and Performance subscale from the Motivated Strategies for Learning Questionnaire MSLQ for College students, Test Of Science-Related Attitudes TOSRA and Self-Efficacy in Learning and Performance for College. The gathered data was mainly analysed using Smart Partial Least Square (SEM-PLS). The findings revealed that physical and psychosocial learning environment have significant and positive relationships with student satisfaction. In addition, the study confirmed that learning environment influence self-efficacy positively. Finally, the study's theoretical and practical implications as well as the directions for future research were provided and discussed.

Keywords:
Learning environment, physical environment, psychosocial environment, psychological characteristics, self-efficacy, satisfaction

1. Introduction

The study of environment has been conducted in various fields such as psychology, architecture, sociology, education and others. However in the educational field, studies about learning environment have not been done enough according to Zandvliet and Fraser [86]. Improving the quality of learning environment have a huge potential to increase positive effect on student's characteristics and behaviour. The learning environment refers to the physical and psychosocial aspect, and some researches also include pedagogical aspect which affects teaching and learning

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process, student's achievement and attitudes. Learning environment functioned as a major role in improving teaching and learning process and was identified as one of the vital determinants of students learning's succession. Learning environment also capable of nourishing the students to engage in the learning process. Moreover, Kember *et al*. [46] and Okurut [60] found that the quality of learning environment is also capable in motivate the student to learn. Fraser [29] has considered that providing a proper learning environment is one of the possible remedies to improve learning outcomes. Student learning outcomes are also proved to be incremented via a comfortable and enjoyable teaching and learning environment [5,42,50]. Khine [47] in his study identified the learning environment as a determinant of successful teaching and learning process. In 2001, Chang and Fisher [18] published a paper which they described a good quality of learning environment tend to increase students' achievement. Ten years earlier, McRobbie and Fraser [54] already demonstrated that students' positive perceptions on quality of learning environment revealed a consistent relationship with student outcomes. It may be noted that most of the studies revealed that students seem to learn better in high quality of learning environment.

This study is different from other studies in three aspects. First, the study focuses diploma level of education. In Malaysia situation, although numerous studies of education field have been conducted among students in primary, secondary schools, and undergraduate and even in the level of postgraduate, study focusing on diploma level was inadequate. Secondly, this study attempts to assess both physical and psychosocial learning environment set up in teaching and learning process that can give a direct effect to psychological characteristics. Thirdly, this study involves statistics education. If we were to look from education perspective, statistics courses or subjects, as compared to science and mathematics are lack of attention. This study focuses mainly on Regression analysis I subject because there are tremendous fundamental concepts of statistic in that particular subject such as the fundamental of correlation, parameter, the hypothesis testing, test statistic, error term and others. Once the students can master the knowledge and concept of regression analysis, it will be easier for them to learn other type of multivariate analysis because of the relatedness. Therefore, the present study aimed to investigate the relationship between learning environment and student's psychological characteristics in statistic education settings.

2. Literature Review

The discussion on learning environment construct begins with the concept of learning environment and learning environment models. For psychological characteristics, the discussion focus on the student's self-efficacy and satisfaction construct. The discussion begins with the concept of definition, the concept of the construct, and the importance of the construct.

2.1 The Concept of Learning Environment

Learning environment can be categorised into psychosocial learning environment and physical learning environment [29,48,87]. Physical learning environment refers to both physical construct such as learning space, tidiness, cleanliness, lighting and classroom size. On the other hand, psychological construct covered safety aspect, good relationship, and autonomy in expressing ideas, feeling and thought [2,80]. Generally, physical component includes all physical aspects such as classrooms, teaching materials and learning facilities while psychosocial learning environment related to the type of interaction between students, teachers and social environment where teaching and learning process is took place. Both physical and psychosocial constructs should complement each other in creating and shaping the overall quality of learning environment. With a great quality

of learning environment, the quality of learning process and outcomes will automatically improve either directly or indirectly.

2.2 The Theory Related to Learning Environment

There are numerous studies and models that highlighted the importance of learning environment in teaching and learning process. Among them are Lewin "Grand Truism", Walberg productivity model, model of conceptual systematic change and model representation schematics productivity education. In 1979, Moos [58] suggested a model which describing the determinants of classroom climate. The model shows the significant relations occurred between the classroom characteristics and the psychosocial environment of the classroom. Based to the model, the components of the learning environment in the classroom not only give a significant effect to the classroom climate directly, but also affect it indirectly via the organizational factors, teacher attribute, and student characteristics. Specifically, both the organizational factors and the teacher characteristics affect the classroom climate directly and affect indirectly via the aggregate student characteristics. Dorman [26] also mentioned that actions of educators took in teaching and learning process motivate, facilitate and encourage students to work more efficiently.

In earlier year, Lewin [49] have studied the problems associated with the individual's motivation and motivation within the group. Based on his research, Lewin recommended a formula that explained about human behaviour that is B = f (P, E). In the formula, 'B' described as human behaviour which are formed as a result of an individual's personality functions (P) and environment (E). The formula has identified that the environment and interaction with personality is an important factor in determining human behaviour. The graphical relationship among the variables shown as Figure 1.

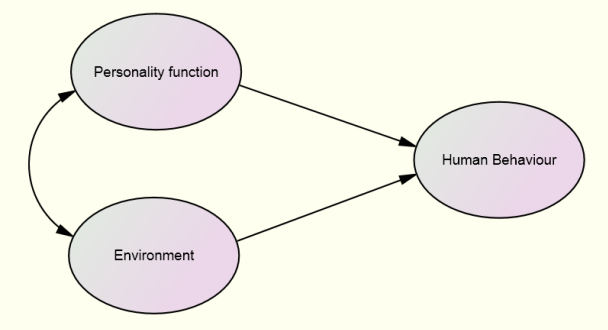

Fig. 1. Relationship between personality, environment and human behaviour by Lewin [49]

Study conducted by Walberg [79] produced another learning environment model called productivity model. The model highlighted about the important of the learning environment. In the model, Walberg has identified nine elements that affect the education productivity and those elements are correlated to each other. According to Walberg, nine of the elements are bind together to form three important factors that influence the production of learning. The factors are talent (ability, motivation, and level of development), teaching methods (quantity of instructions and quality of teaching) and environments (home, classroom, peer groups and media). These factors are mutually inclusive and give a direct influence on the learning production in terms of shaping the student's affective, cognitive and behaviour. As suggested by Walberg [79], educators need to explore those nine elements to create effective learning. The summary of relationship between the variables involved in the productivity model is shown in Figure 2.

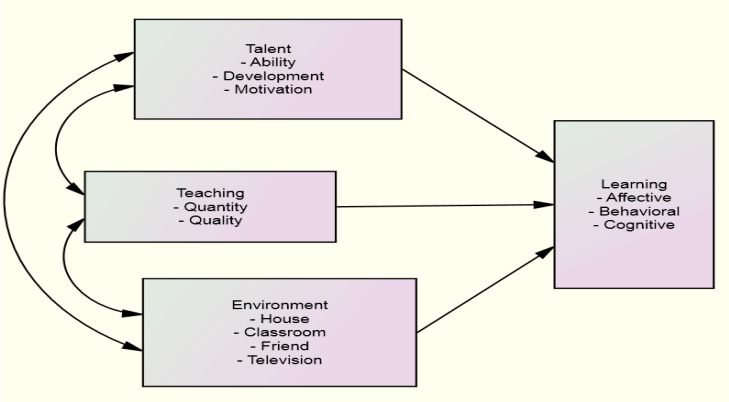

Fig. 2. The Productivity Model by Walberg [79]

A few years after the productivity model, Gardiner [32] comes out with a learning environment model that described the relationship between the physical, psychosocial and technology learning environment. According to Gardiner, there are three overlapping circles known as ecosfera, sociosfera and tecnosfera. Ecosphere associated with the physical environment, sociosphere associated with the outcome of individual interactions with others in their environment, while tecnosphere described as a technology learning environment. Gardiner mentioned that students are the most complex component in the system whereas they will be influenced by all those three type of environments. In 1999, Zandvliet [88] make a great attempted in the learning environment model development where he modified Gardiner Models, with the classroom physical environment as ecosphere, classroom psychosocial environment as sociosphere and implementation of new educational technologies represent tecnosphere component. The model shows the significant correlation existed between the physical environment, psychosocial environment and use of information technology. These variables also contributed to student development. The model suggested that by manipulating the environment, the productivity in education output can be improved. The model is as shown in Figure 3.

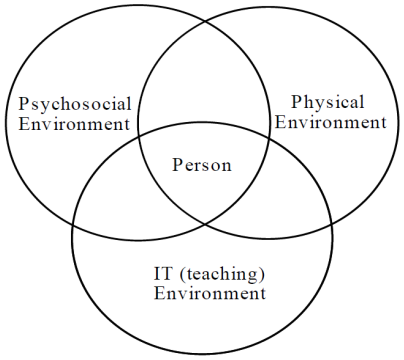

Fig. 3. The factors influencing student satisfaction by Zandvliet [88]

Altogether, various interesting models have highlighted the positive potential effects of learning environment toward development of a person. It can be summarized that, by increasing the quality

of the learning environment seems to be able to increase the efficiency of teaching and learning process. Learning environment also is one of the important factors that should be given advance attention because of its ability to improve cognitive, affective and behaviour of an individual.

2.3 Psychological Characteristic

The psychological characteristic refers to the behavioural characteristic of how individual express their feelings that cause different thinking skills process and way they learn [69,75,83]. This sub-section reviews the discussion on two major factors of psychological characteristic; student self-efficacy and satisfaction.

2.4 The Concept of Psychological Characteristic: Self-Efficacy

Self-efficacy is commonly defined as the individual belief in his/her own capabilities to accomplish a desired goal. In early year, self-efficacy is defined as a belief of individual's behavioral capability in achieving specific objectives [10]. In today century, the definition of self-efficacy exactly sharing the same meaning as before. According to Golightly [35], self-efficacy could simply be defined as a person's confidence in their ability to accomplish a task successfully. The definition is consistent with McGrew [53] in Model of Academic Competence & Motivation (MACM), where author interpret self-efficacy as reflection of a person self-assured in their potential to systemize, plan and maintain the performance in solving a problem or accomplishing a given task.

In education perspective, academic self-efficacy can be refers to a person's belief that they can successfully reach the designated level on an academic task or achieve a specific academic goal [8]. The similar definition given by Woolfolk [83] where academic self-efficacy is defined as students' readiness, keenness, intention, and endeavor to achieve learning objectives with eminent accomplishment. This type of psychological characteristic also refers to students' self-awareness proficiency in working and completing the goals [74]. When student fail to complete their tasks, high self-efficacy students will able to maintain their focus and put an extra effort to achieve the goal successfully. In simpler implication analogy, a person with a stronger self-efficacy means that a person likely to have more positive behavior to achieve their goal. Students with higher self-efficacy also shows a higher level of participation, positive behavior and attitude in mastering the learning outcome of the course. Self-efficacy is not an immutable construct. Self-efficacy can be developed, improved, and polished through many mechanisms. Bandura [9] explained that developments of self-efficacy in person are derived from four principal; 1) performance accomplishments, 2) vicarious experience, 3) verbal persuasion, and 4) physiological states. The Bandura's self-efficacy model is as Figure 4.

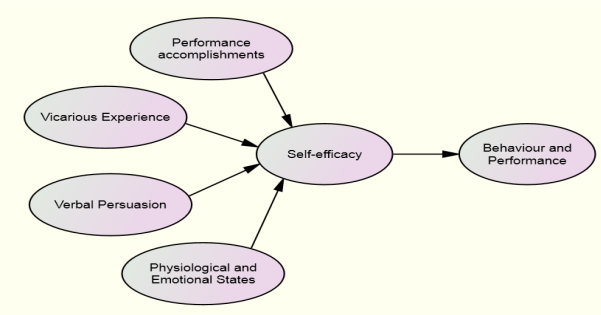

Fig. 4. Bandura Self-efficacy model [9]

In education point of view, self-efficacy is one of the variable needs to be given attention due to its capability affecting other constructs. In 1996, Pajares [62] already investigate about the influence of self-efficacy and revealed that self-efficacy able to increase student motivation, learning outcome and academic achievement. High self-efficacy seemed to influence academic achievement when student are highly affected by personal motivation such as goal setting and situational influences [66]. The dangerous thing about self-efficacy is generally low self-efficacy students are more likely to believe they cannot be successful. Therefore, they are lack of determination to succeed, low in terms of comprehensive effort and always avoid challenging tasks. Thus, students with poor self-efficacy have low desire and aspiration which in turn results in poor academic performances [11]. While, students with a strong efficacy are more motivated and like to challenge themselves with the tough task [52]. Therefore, this study was interested to assess the extent of learning environment influence student self-efficacy.

2.5 The Concept of Psychological Characteristic: Satisfaction

Student's satisfaction need to be viewed in two difference perspective, student as a customer to the company called universities and students as an 'output' of the universities. Student as a customer will be discussed by quality management perspective and student as an 'output' should be discussed by educational perspective. In quality field, Deming [24] stressed that customer is the utmost part of the production process. In fact, without someone to purchase the product or service, the company will not perform well in business. The same thing goes with the universities, without student, universities also cannot operated normally. Therefore, the ability to please the customer/student should become the top priority for the company/universities [24]. One of the quality expert, Juran [44] defines customer satisfaction as the result attained when the product or service provided correspond to the needs of its customers. The company is said to achieve the level of customer satisfaction when it meets or exceeds customer's expectation over the lifetime of its product or service. Oliver [61] stresses that since the satisfaction is defined based customers' perspective, satisfaction improvement projects must begin by studying what the customer/student wants and needs from a company/university.

Earlier researcher, Anderson [4] proposed that customer/student satisfaction is a function of expectation as well as product or service perception. When a discrepancy exists between the customers' expectations and their perceptions, dissatisfaction occurs. Customer satisfaction with the company can occur at different areas of relationship between the company and its customer including satisfaction with the product or service quality, on-going relationship, and performance of a product [77]. As for Fornell [28], he described customer satisfaction as an overall perceived evaluation related to the product or service after the consumption. If the perceived performance of the product or service exceeded the expected performance, then the customer is satisfied. Otherwise, the customer is not satisfied. The idea is supported by Spreng *et al*. [73] who stresses that customers are comparing the products' performance with their expectation. The same definition proposed by Zainudin Awang [85], where author contended that the feeling of satisfaction arises when the customers' perception of products' performance is greater than their prior expectations. If the actual performance exceeds their prior expectations, then they are satisfied. Vice versa, if the actual performance falls short of their prior expectation, then they are dissatisfied. He also suggests that customer/student satisfaction should be employed as a leading criterion in determining the service quality performance actually delivered by the company/university and experienced by its customers.

Coming back to higher education scenario of this study, student satisfaction can be defined as the subjective students perceptions of how well is the quality of learning environment, the support system and service provided by universities contribute to their academic success. According to Moore [55], a student is considered satisfied when they are successful in the learning and is pleased with their experience. Sweeney and Ingram [76] bring a similar definition where they defined student satisfaction as the perception of their enjoyment and accomplishment in learning. Both definitions focus on accomplishment and success in learning, pleasure and enjoyment with the learning experience. In year 2002, Thurmond *et al*. [56] in their study described student satisfaction as an outcomes reflection that occurs between students and instructor. While in more recent study conducted by Wu *et al*. [84], satisfaction is referred to the student attitude, feeling and hopes to receive a good quality system of learning environment. Based on the commonness in the definition by various researchers, it can be concluded that student satisfaction reflects student's appraisal of the quality in all educational program aspects [56].

The reason of this study interested to bring student satisfaction construct into the model is because of its potential impact on individual behaviour and cognitive development. Many researchers agreed with the positive effect of student satisfaction occurrence. Student satisfaction is claimed to be related to several outcome variables such as persistence [1], retention [23], course quality [57], and student success [45]. Booker and Rebman [15] agreed with the claim by bringing the evidence in his study that student satisfaction is significantly influence student's retention and decision. Sinclaire [71] reported that student satisfaction to be the most important key to continuing learning. Winberg and Hedman [82] in their study also mentioned that student satisfaction is helpful for ensuring students' academic success. Besides that, it has conclusively been shown that student satisfaction is an essential construct that influences the level of student motivation [22][25]. More recent study also bring out that high satisfaction leads the students to become more consistent in learning and become high motivate student [1]. In addition, according to American Psychological Association (1997), satisfaction is one of the major psychological factors that determine student success. Table 1 shows the recent supporting literature on the relationship between learning environment and psychological characteristics.

Table 1
The recent supporting literature

Relationship	Supporting literature
Learning environment positively affects psychological characteristic of students.	[16][89][26][59][63][14][90]

3. Methodology

This study also restrict to focus on Regression Analysis I subject which implies involvement of two programs from Faculty of computer science and mathematics (FSKM), namely; Diploma in Statistics (semester 4 and 5) and Diploma in Actuarial Science (semester 4 and 5).

3.1 Research Design

This study employed a cross-sectional design since taking measurements at one point in time was adequate. The study will mainly focus on quantitative method in order to achieve the study objectives.

3.2 Population and Sample

The target population for this study was the diploma students from Faculty of Computer Science and Mathematics at Universiti Teknologi MARA (UiTM) who had taken Regression Analysis I subject. UiTM has branch campuses in all states in the country. Science Computer & Mathematics courses are only offered at branches from eastern region (UiTM kelantan, UiTM Terengganu and UiTM Raub), northern region (UiTM Tapah, UiTM Kedah and UiTM Perlis) and southern region (UiTM Seremban 3 and UiTM Johor). The regions are divided in such a way in order to ensure homogeneity among campus within one region. For session Jun 2016 to Nov 2016, only UiTM Raub, UiTM Tapah and UiTM Seremban 3 contained a student who have been taken (semester 5) and are currently taking (semester 4) a Regression Analysis I subject. The details information about the population available for this study is as table 2 below;

Table 2
Target population

Campus	Total Student	Population (N)
Seremban 3	95	
Raub	94	380
Tapah	191	

3.3 Sampling and Data Collection

Since the target population was clustered together in different campuses geographically, cluster sampling was considered as the most appropriate sampling design for this study which resulted 2 campuses were selected. Randomly, UiTM Raub and UiTM Tapah were chosen for data collection whereas UiTM Seremban 3 was used for pilot study. The study obtained only the list of students from Diploma in Statistic and Diploma in Actuarial Science since those students were in the position to provide their opinion for items under the respective construct of the study. In other words, these students had experience in learning the Regression analysis subject. Therefore, 94 students from UiTM Raub and 191 students from UiTM Tapah with a total equal to 285 students became the respondent for quantitative study. This 285 sample was more than enough to fulfil the rule of thumbs set by Hair *et al*. [36] which is sample size should be at least 10 times the largest number of structural paths directed at a particular construct in the structural model.

3.4 Instrumentation

This study is intended to evaluate the perceived physical quality as well as the perceived psychosocial learning environment quality in teaching and learning process of Regression Analysis I subject from the perspective of diploma students. The study is also intended to assess the level of students' self-efficacy, and satisfaction with their experienced of learning the subject. Realizing that UiTM students consist of different demographic and socio-economic background, the study incorporated certain demographic variables in the questionnaire. The questionnaire consists of five sections. Section A will cover information on demographic variables while Section B, C, D,and E cover on physical learning environment, psychosocial learning environment, student self-efficacy, sand lastly student satisfaction variables respectively with 1 to 9 likert scale.

Table 3
The Summary of instruments used in questionnaire

Construct	Items	Source	Expert Validation
Physical learning enviroment	24	Adapted from; -Smart classroom inventory,SCI [12] -Science Laboratory Environment Inventory, PSLEI [19]	Prof. Madya Dr. Che Nidzam Che Ahmad (UPSI)
Psychosocial leaning environment	33	Adopted from College and Classroom Environment Inventory, CCEI [29]	Prof. Madya Dr. Che Nidzam Che Ahmad (UPSI)
Academic Self-efficacy	8	Adapted from Self-Efficacy in Learning and Performance for College [65]	Dr. Mazlina Mamat (UiTM)
Student's satisfaction	8	Adapted from Test Of Science-Related Attitudes, TOSRA [30]	Prof. Madya Dr. Che Nidzam Che Ahmad (UPSI)

Pre-test for the instrumentation validation was performed by field expertise from different university. Five former student of Diploma in Statistic also involved in instruments pre-test and they agreed that the items in questionnaire are understandable and not confusing. Then, prelimenary study was conducted to pilot the extent of how reliable is the items from inventory in measuring the intended latent construct. The study involved 30 student of Diploma in Acturial Science, UiTM Seremban 3. The result of pre-test and pilot test can be concluded that items in questionnaire are understandable to read and statistically all the construct give an acceptable reliability (above 0.7) values with items of factor loading greater than 0.6. Only three items were deleted due to low factor loading value. The result of pilot study was summarised in table 3 and the summary of final instruments is described as in table 4 below.

Table 4
Summary of preliminary results on reliability of instruments

Construct	Sub-construct	Cronbach alpha Value		No. of final items
		Before	After	
Physical Learning environment	Physical design	0.906	0.906	22
	Learning space	0.910	0.941	
	Technology	0.885	0.902	
	Indoor air, temperature and lighting quality	0.855	0.855	
Psychosocial Learning environment	Attitude toward students	0.946	0.946	32
	Autonomy-power sharing	0.747	0.879	
	Student-student relationships	0.921	0.921	
	Student interest-motivation	0.947	0.947	
	Class organization	0.917	0.917	
Self-efficacy	Academic self-efficacy	0.975	0.975	8
Satisfaction	Student satisfaction toward Regression Analysis subject	0.978	0.978	8

3.5 Techniques of Data Analysis

Data analysis covered data coding, data screening and choosing the most suitable data analysis strategy [21]. Data screening was performed to identify data entry errors and to examine the statistical assumptions of analysis which involve checking for missing data, outlier, and normality.

After screening the data, cleaning the data is necessary. Data cleaning include the process of removing errors and inconsistencies in the data [31]. The data will be analysed using Partial Least Square-Structural Equation Modelling (PLS-SEM).

4. Result and Findings

4.1 Response Rate

The population of this study was 380 respondents and based on cluster sampling, 285 respondents became a target sample. Out of the target sample, 277 respondent was succesfully participate in quantitative study wherease 183 students from UiTM Tapah and 94 students from UiTM Raub. The response rate for the study was 97.19% and this number are more than sufficient for further analysis.

4.2 Data Screening

Missing data is screening using SPSS, and AMOS software is used for outliers and normality assessment.

4.3 Missing values analysis

Based on Cavana *et al*. [17], missing data is one of the major concern in quantitative research due to its capability to effect results negatively. In classical method, missing data is impute using mean median or mode imputation. For this study, expecation maximazation (EM) was used which is more recent approach. By using expectation maximization (EM) method from SPSS, there are no missing data found.

4.4 Outliers assessment

There are many different methods of detecting outliers within a given research, among which include classifying data point based on observed (Mahalanobis) distance from the expected research [40]. Mahalanobis analysis can be conducted through SPSS in regression. Outliers' detection has its basis on whether D2 values are more than the chi square values (χ2) of the number of items used. The table of chi-square statistics was applied as the threshold value to determine the empirical optimal values. In this case, seventy (70) items were entered as variables, and so any individual with a Mahalanobis Distance score (D2) which is greater than (χ_(0.001,df:69)^2) = 111.055 would be considered a multivariate outlier and may be excluded from further analysis using this set of variables. Fourty one (41) outliers were detected but the study only exclude thirteen (13) serious outliers. After the deletion, the data were reduced to 264 responses for further analysis.

4.5 Normality assessment

PLS-SEM did not have normality assumption but normality still need to be checked to view the distribution of the data. As for the kurtosis, high value of kurtosis may influence the result of analysis because of the data need to have variability to make sure the partial least square methods is valid to apply. All skewness values were between -1 to 1 with kurtosis below 5. Hence, there are non-significant skewness and kurtosis for items which indicates normality and have a good variability.

4.6 The Descriptive Analysis of Respondent Demographic Profile

The descriptive analysis was used in order to examine the demographic profile of the respondents. Most of the respondents were mainly females which constituted 76.5 percent (202). 7.6 percent (20) of respondent age below 20 years old and 92.4 percent (244) were age 20 to 22 years old. The allocation of the respondents are 65.9 (174) percent from UiTM Tapah and 34.1 (90) percent from UiTM Raub and majority of the respondents 90.2 percent (238) were from semester 5 students. In term of study program, 44.3 percent (117) of respondent were from Diploma of Actuarial Science and 55.7 percent (147) were from Diploma in Statistic.

4.7 Structure of the Quantitative Analysis

PLS model were analysed and interpreted in two section. Firstly, the measurement model is tested to ensure its reliability and validity which included indicator reliability, internal consistency reliability, convergent validity, and discriminant validity are observed by conducting confirmatory factor analysis (CFA). Secondly, the structural model investigated hypotheses, R square (R^2,) effect size (f^2) and predictive relevance (q^2) of the model. Bootstrapping are employed to test the hypotheses.

The study model consists of seventy (70) reflective measurement items (manifest variable or indicator) for seven (7) variables comprising two (2) independent variables with nine (9) dimensions, and two (2) dependent variables. Physical learning environment had four dimension of first order construct (PD,LS,T and I), and psychosocial learning environment had five dimensions of the first order construct (ATS, APS, SSR, SIM and CO). Becker, Klein and Wetzels [13] have greatly discusses about hierarchical latent variable models in PLS-SEM. As they suggested, this study decided to use a Reflective-Formative Type model for higher order construct (HOC). There are three approach available to measure HOCs: the repeated indicator approach [51], the hybrid approach [81] and the two-stage approach [68]. Becker *et al*. [13] proved in their simulation study that repeated indicator approach and two stage approach are more appropriate with less biased result when dealing with reflective-formative higher order construct. Therefore for this study, the reflective-formative higher order construct is analyzed using repeated indicator approach by Mode B measurement.

4.8 Assessment of Measurement Model for the study

In order to evaluate the measurement model, reliability and validity tests were used. According to Sekaran and Bougie [70], reliability is to test how consistently a measuring instrument measures whatever concept it is measuring, while validity is a test of how well an instrument that is developed measures the particular concept it is intended to measure. In assessing the reflective measurement items, Hair *et al*., [39], recommend to achieved satisfaction in reliability (indicator reliability, and internal consistency reliability), convergent and discriminant validity.

4.9 Indicator and Internal Consistency Reliability

Reliability is the extent of how reliable is the said measurement model in measuring the intended latent construct. For indicator reliability, Hair *et al*., [39] and Valerie [78] suggested that indicator loadings (factor loadings) should be higher than 0.7. During the deletion stage, all of the outer loadings are above the minimum requirement of 0.7, with the exception of APS1 which is loading of 0.696, APS2 (FL=0.692), CO6 (FL=0.691) and PD6 (FL=0.637). PD2 (FL=0.724) also was removed to

improve the reliability of the construct. Therefore, these five items were deleted. The values of all the acceptable outer loading after deletion process is shown in table 4.

Another assessment need to put a consideration is the assessment of internal consistency reliability where it were asses through measuring the composite reliability (CR) and Cronbach alpha. Composite reliability values reflect the level to which construct indicators reveal the latent variables and they should be greater than 0.70. Cronbach's alpha coefficient was also developed in this study to examine the inter-item consistency of the measurement items. Based on Hair *et al*., [39]and Valerie [78], the Cronbach alpha (CA) and composite reliability (CR) should be higher than 0.7.

Based on the table 5, all the composite reliability values and the cronbach alpha values ranged from 0.850 to 0.980 which depicts the degree to which the construct indicators indicate the latent, and construct ranged which exceeded the recommended value of 0.7 [37]. All the cronbach's alpha (CA) and composite reliability (CR) exceeded the recommended value of 0.70, indicating that the measurement scale used in this study had high internal consistency [41,70].

Table 5
Factor loading, composite reliability and Cronbach alpha value

Construct	Loading	Composite Reliability (CR)	Cronbach Alpha (CA)	Average Variance Extracted (AVE)
Physical Design		0.881	0.919	0.739
PD1	0.791			
PD3	0.868			
PD4	0.896			
PD5	0.879			
Learning Space		0.874	0.909	0.666
LS1	0.788			
LS2	0.799			
LS3	0.892			
LS4	0.799			
LS5	0.797			
Technology		0.903	0.926	0.675
T1	0.819			
T2	0.857			
T3	0.811			
T4	0.875			
T5	0.757			
T6	0.805			
Indoor air, temperature and lighting quality		0.849	0.891	0.62
I1	0.776			
I2	0.802			
I3	0.813			
I4	0.807			
I5	0.737			
Attitude towards Student		0.922	0.939	0.72
ATS1	0.802			
ATS2	0.846			
ATS3	0.883			
ATS4	0.885			
ATS5	0.828			
ATS6	0.845			

Autonomy power sharing		0.85	0.91	0.772
APS3	0.768			
APS4	0.938			
APS5	0.92			
Student-student relationship		0.908	0.927	0.646
SSR1	0.71			
SSR2	0.83			
SSR3	0.801			
SSR4	0.849			
SSR5	0.803			
SSR6	0.834			
SSR7	0.792			
Student interest and motivation		0.95	0.959	0.769
SIM1	0.809			
SIM2	0.875			
SIM3	0.899			
SIM4	0.897			
SIM5	0.877			
SIM6	0.893			
SIM7	0.885			
Class organization		0.931	0.946	0.746
CO1	0.816			
CO2	0.874			
CO3	0.898			
CO4	0.895			
CO5	0.891			
CO7	0.803			
Satisfaction		0.969	0.82	0.82
SA1	0.88			
SA2	0.924			
SA3	0.919			
SA4	0.925			
SA5	0.894			
SA6	0.913			
SA7	0.877			
SA8	0.912			
Academic self-efficacy		0.969	0.973	0.82
SE1	0.888			
SE2	0.906			
SE3	0.901			
SE4	0.899			
SE5	0.914			
SE6	0.901			
SE7	0.915			
SE8	0.922			

4.10 Convergent Validity

Convergent validity is asses using average variance extracted (AVE). Average variance extracted (AVE) measures the variance captured by the indicators relative to measurement error should be higher than 0.50 in orders to justify the use of the construct [39,78]. In this study, the AVEs ranged from 0.656 to 0.736, which were all within the suggested range.

Table 6
Summary of average variance extracted values

Construct	Average variance extracted (AVE)
Physical Design (PD)	0.739
Learning Space (LS)	0.666
Technology (T)	0.675
Indoor air, temeprature and lighting (I)	0.620
Attitude towards student (ATS)	0.72
Autonomy power sharing (APS)	0.772
Student-student relationship (SSR)	0.646
Student interest and motivation (SIM)	0.769
Class organization (CO)	0.746
Satisfaction (SA)	0.82
Self efficacy (SE)	0.82

4.11 Discriminant Validity

Discriminant validity is the extent to which a construct is different from other constructs. According to Hair *et al.*, [39], the discriminant validity stipulates that each latent constructs' AVE should be higher than the construct's highest squared correlation with other latent construct [27] and the indicator's loadings should be greater than all its cross loadings. Another way to asses' disrimant validity is by using heterotrait-monotrait ratio of correlations (HTMT) where HTMT below 0.9 means that the discriminent validity is establish.

Table 7
Discriminant validity

	APS	ATS	CO	I	LS	PD	SA	SE	SIM	SSR	T
APS	0.87										
ATS	0.61	0.84									
CO	0.62	0.69	0.86								
I	0.37	0.41	0.36	0.78							
LS	0.54	0.52	0.55	0.48	0.81						
PD	0.48	0.51	0.52	0.39	0.74	0.86					
SA	0.40	0.51	0.52	0.26	0.47	0.36	0.90				
SE	0.41	0.54	0.55	0.36	0.54	0.44	0.77	0.90			
SIM	0.62	0.69	0.81	0.31	0.55	0.51	0.57	0.54	0.87		
SSR	0.48	0.59	0.57	0.24	0.40	0.37	0.47	0.47	0.65	0.80	
T	0.49	0.52	0.56	0.42	0.71	0.70	0.47	0.54	0.54	0.47	0.822

In this study, discriminant validity of the measure was assessed through Fornell and Larcker's [27] criterion. All constructs had the values of AVE square root in diagonal were greater than the squared correlation with other constructs in off diagonal, showing that all constructs met the acceptable standard of discriminant validity [41]. The value of heterotrait-monotrait (HTMT) ratio of correlations for each construct also shows the value below 0.9 which indicate discriminant validity achieved.

In sum, all the constructs have achieved reliability and validity. The study involved higher order construct which are physical learning environment and psychosocial learning environment. Therefore, before proceed with structural modeling. The study asses the higher order construct in next section.

4.12 Assessment of formative higher order Construct

Empirical assessment of formative measurement models is not the same as with reflective measurement models. This is because the indicators theoretically represent independent causes of the constructs and thus do not necessarily highly correlated. As a result, internal consistency reliability, and convergent validity are not appropriate. Instead, focus should be give toward establishing the content validity of the construct's indicators. This study used reflective-formative type II model and employed repeated indicator approach mode B. For formative constructs, multicollinearity of indicators, indicators weights, significant of weights and significant of the indicators loading should be reports [13,36]. It is important to note that the role of weights and loadings are important for the assessment and they are obtained from the relations between higher order construct and lower order construct [13]. The study used repeated indicator approach, therefore weight and loading are now represented by the path coefficients between higher-order and lower order constructs and not by the manifest indicators that repeated at construct level.

Before looking at the significant of the path, collinearity of the model constructs must be checked by calculating the variance inflation factor (VIF) values and it should be less than 5. The results of these analyses may be biased if collinearity is present [36]. In this study, multicollinearity does not exist for both physical learning environment and psychosocial learning environment higher order construct whereas the results for VIF were all less than 5 as suggested by Hair *et al*., [39]. Refer table 8 below;

Table 8
Variance inflation factor (VIF) results

Construct	Physical Learning Environment (PLE)	Psycosocial Learning Environment (PsyLE)
Physical Design (PD)	2.567	
Learning Space (LS)	2.814	
Technology (T)	2.378	
Indoor air, temeprature and lighting (I)	1.332	
Attitude towards student (ATS)		2.407
Autonomy power sharing (APS)		1.888
Student-student relationship (SSR)		1.894
Student interest and motivation (SIM)		3.724
Class organization (CO)		3.39

Table 9
Significance of path coefficient

Path	Path coefficient	T Statistics (|O/STDEV|)	P Values
APS → PsyLE	-0.015	0.142	0.444
ATS → PsyLE	0.337	2.603	0.005
CO → PsyLE	0.265	2.035	0.021
SIM → PsyLE	0.338	2.645	0.004
SSR → PsyLE	0.205	1.895	0.029
I → PLE	0.107	0.733	0.232
LS → PLE	0.533	3.572	0.000
PD → PLE	-0.116	0.880	0.189
T → PLE	0.567	4.217	0.000

After obtaining that the constructs did not have multicollinearity problems, the next step is the assessments of the path coefficient for the lower order construct to higher order. This step required bootstrapping procedure. The result of the significant of the path coefficient is shown in table 9.

Looking at the relative importance of the lower order construct in contributing to Psychosocial Learning environment (PsyLE) as higher order construct, student interest and motivation (SIM=0.338) is the most important, followed by attitude towards student (ATS=0.337) class organization (CO=0.265) and Student-student relationship (SSR=0.205). While autonomy power sharing (APS=-0.015) give insignificant contribution to psychosocial construct. Even so, autonomy power sharing is retained in the model. For Physical learning environment (PLE) construct, technology dimension (T=0.567) ia a primary contributor, followed by learning space (LS=0.533). In contrast, physical design (PD=-0.116) and indoor air, temperature and lighting quality dimension (I=0.107) were not significantly contributing to physical learning environment. These two lower order construct are still retained in the model.

4.13 The Structural Model Assessment

Once the measurement model have been confirmed as reliable and valid, the next step is to assess the structural model results. This involves examining the model's predictive capabilities and the relationships between constructs. Before assessing the structural model, collinearity for the structural model construct need to be examined. The reason is that the estimation of path coefficients in the structural model is based on ordinary least square (OLS) regressions of each endogenous latent variable on its corresponding predecessor constructs. Just as in a regular multiple regression, the path coefficient might be biased if the estimation involves significant levels of collinearity among the predictor constructs. After checking for collinearity, assessment continues with the level or the coefficient of determination R2 values, the f2 effect size, the predictive relevance and the significant of the path coefficient.

Table 10
VIF values for independent constructs

	SE	SA
Physical learning environment (PLE)	1.757	1.757
Psychosocial learning environment (PsyLE)	1.757	1.757

4.14 Assessment of effect size (f2) and coefficient of determination (R2)

The quality of the structural model can be assessed by R^2, values and effect sizes, and it also can be assessed by using blindfolding procedure to generate the cross validated communality and cross validated redundancy. Coefficient of determination revealed the percentage of variation in endogenous construct is explain by exogenous construct. While, the f2 effect size measures the change in R2 value when a specified exogenous construct is omitted from the model. Based on Chin [20], it is good to determine the effect sizes of specific latent variables' impact upon the dependent variables with the help of f^2 analysis which is complementary to R^2. In easier word, the effect size is asses to identify either the amount of R^2 is large enough to be meaningful. Using Smart PLS 3, the R^2 values and f^2 effect size was automatically provided.

According to Hair *et al*., [39] R^2 values of 0.75, 0.50 or 0.25 for endogenous latent variables in the structural model can be described as substantial, moderate or weak, respectively. The R2 values of satisfaction construct (0.420) and Self efficacy (0.476) are considered moderate. Based on Cohen (1988), the f^2 values of 0.02, 0.15 and 0.35, were used to interpret small, medium and large effects

sizes of the predictive variables, respectively. The result of effect size shows that Physical learning environment (PLE) has a small effect in producing the R2 for SA (0.059), and has close to medium effect to SE (0.142). While, psychosocial learning environment (PsyLE) has all moderate effect size on SE (0.170), and SA (0.208).

Table 11
R2 and f2 effect size of latent constructs result

	R^2	f^2 effect size	
		SE	SA
Self efficacy (SE)	0.476		
Satisfaction (SA)	0.420		
Physical learning environment (PLE)		0.142**	0.059*
Psychosocial learning environment (PsyLE)		0.170**	0.208**

4.15 Assessment of Predictive Relevance

Another criterion for the evaluation of the structural model is the predictive relevance Q^2, which is a measure that reflects how well observed values are reconstructed by the model and its parameter estimates [20]. Q^2 values are obtained using a blindfolding procedure [91].

Table 11
Prediction Relevance of the Model

Total	SSO	SSE	Q^2 (=1-SSE/SSO)
Satisfaction (SA)	2,112.00	1,437.61	0.319
Academic self-efficacy (SE)	2,112.00	1,352.52	0.360

Blindfolding procedure was performed to calculate the predictive relevance (Q2) of the model fit. As claimed by Hair *et al*., [39], the model will have predictive quality if the cross-redundancy value is more than zero or otherwise the predictive relevance of the model cannot be concluded. The results above show that the obtained cross validated redundancy values for satisfaction and self-efficacy were found to be 0.319 and 0.360, respectively. According to Hair *et al*., [39], a relative measure of predictive relevance Q^2 values of 0.02, 0.15 and 0.35 indicate that an exogenous construct has a small, medium or large predictive relevance. These results shows a range of Q^2 between 0.319 and 0.360 support the suggestion that the model has an adequate prediction quality.

4.16 Hypotheses Testing

The hypotheses of this study were tested by examining the path coefficients (β) through structural equation modelling using the PLS approach. The path coefficients generated by PLS provide an indication of the relationships and can be used similar to the traditional regression coefficients [34]. The bootstrapping technique was used to obtain the t-values of each coefficient [7,20]. The t-values of the parameter indicate the strength of the relationship the parameter represents; therefore the higher the t-value, the stronger the relationship [43]. Final structural model is shown in figure 5 and table 12 summarise the path coefficient for the model.

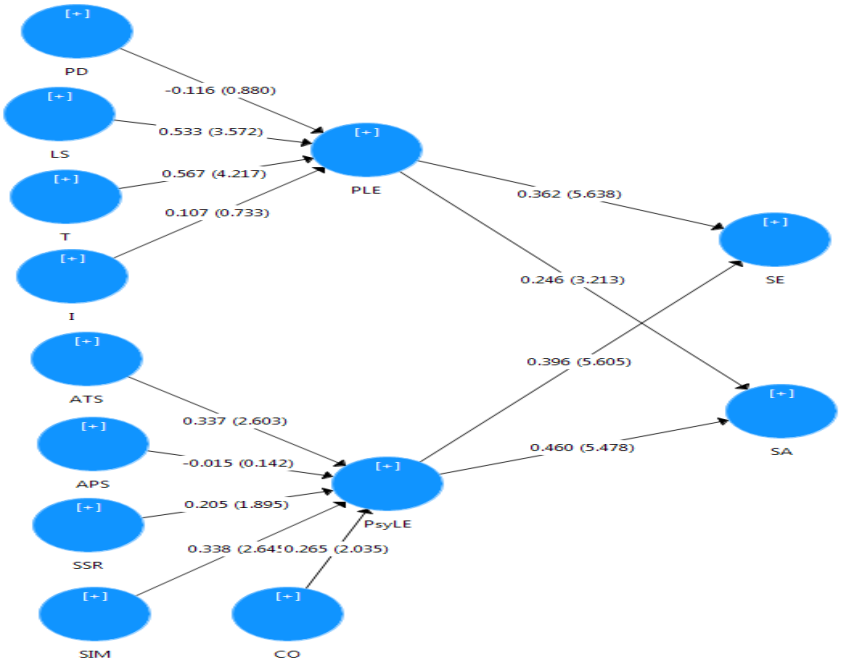

Fig. 5. Final structural model

Table 12
The path coefficient

Relationship	Path coefficient	T Statistics (|O/STDEV|)	P Values	Result
PLE → SA	0.25	3.213	0.001	Significant
PLE → SE	0.36	5.638	0.000	Significant
PsyLE →SA	0.46	5.478	0.000	Significant
PsyLE →SE	0.40	5.605	0.000	Significant

The results above showed that the physical learning environment construct has a significant direct relationship with satisfaction (ß = 0.25 p-value = 0.001) and self-efficacy (ß = 0.36 p-value = 0.000). On the other hand, the rsult also indicates that psychosocial learning environment has a significant influence on satisfaction ((ß = 0.46 p-value = 0.000) and self-efficacy (ß = 0.40 p-value = 0.000).

4. Conclusion

This study found that quality of learning environment has a significant and direct influence on students' psychological characteristic (satisfaction and self-efficacy). This result is consistent with Baetan, Dochy and Struyven [6] who study the effect of different learning environment. This result is also consistent with the findings of Budsankom *et al*., [16], Dorman [26], Nelson and Debacker [59], Patrick *et al*. [63], and Bong [14]. All of them support that learning environment positively affects psychological characteristic of student.

The study attempts to make several contributions. Firstly, the empirical findings of this study will help to clarify the impact of learning environment on the psychological characteristics development focusing on self-efficacy and satisfaction. Thus, by understanding the relationship, strategies could

be developed to enhance quality of the learning environment in universities. For policy makers, this result may assist in assessing and determining the appropriateness of the existing quality of learning environment that regulate good psychological characteristic of students. Secondly, by applying SEM-PLS, this study is able to demonstrate the simultaneous effects of these multiple variables to the firm performance. This study would be of benefit to academicians in enhancing their knowledge and thoughts relating to the variables under investigation within the Malaysian context. This study also contains reflective-formative model of higher order construct with repeated indicator approach mode B which also will give benefits to academician in studying SEM-PLS.

The study offers the same direction for future researches in this area. First, the respondents of this study consist of only the Bumiputera students in the country. Since this country consists of many ethnic groups, the study recommends future research to include all ethnic groups so that the comparison can be made between groups. And since different ethnic groups have distinct socio-economic background, the result might be interesting. Second, this study focused only on the Faculty of Computer Science and Mathematics, and hence the generalization might not be appropriate to other faculties. This study also only focuses on statistic education. Future researches should include more faculties in the university so that comparisons can be made between faculties. Since different faculties require different academic facilities, such as social sciences, pure sciences, and arts, the information obtained would be useful to the management of a university for their strategic planning. Third, this study was carried out in Universiti Teknologi Mara (UiTM) which is one of the twenty public universities in the country. The future research should include all public universities so that the comparisons can be made between public universities. More importantly, how the old universities perform compared to the newly established universities, as far as quality of learning environment is concerned. Last but not least, this study was done on the public university. The findings might not be generalizable on private universities even though both types of universities are in the same service industry. Today, the number of private universities has surpassed the number of public universities. Thus future researches should include both types of universities. The result might be interesting since these two types of universities have distinct characteristics such as the facilities, cost of study, and the source of financing

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