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Science Teaching Styles and Student Intrinsic Motivation: Validating a Structural Model

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ABSTRACT

This present study seeked to investigate the teaching styles adopted by the science teachers and their student intrinsic motivation in order to be persistence in learning the subject. Using the response from student experiences, the 5Es instructional model by Bybee (1996) has been adopted for the theoretical framework in the study. The purpose of the study was to validate the 5Es model and intrinsic motivation. 452 samples from selected secondary school students in Kuala Lumpur, Malaysia have been collected to provide the responses for self constructed questionnaires in the structural equation modeling analysis. The findings provide the implications toward empirical evidence of theory, teaching practice and appropriate interventions that can be addressed for future research.

Keywords: Science teaching, instructional technology, constructivist learning, instructional design model

INTRODUCTION

Direct instruction has been dominating science teaching for many years. Teachers put the emphasis on content knowledge which requires students to remember and recall facts. The lack of diversities in the teaching styles has led many students to withdraw from taking the subject in final year of secondary school and even in the university. Powell (2003) asserts on the overused of the direct teaching pedagogical approach which drives only selected students to sustain and succeed in learning. Further, teachers may find difficulties to implement constructivist approach where students active participation, discovery learning, project based learning are integrated in the teaching process. Despite constructivist approach contributes to effective teaching and learning and high motivation (Piaget, 1972), there is lack of evidence on the extent of this approach is materialized in schools.

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Previous researches have addressed teaching strategies of Engagement theory in ICT learning environment (Kearsley & Schneiderman, 1998) and learning styles accommodating multiple intelligence (Gardner, 1993). Kearsley and Schneiderman (1998) have focused on project based, problem based and collaboration approach in science teaching. However, it is difficult to distinctly assess both problem and project based learning as they relate to group and collaboration work. On the other hand, Gardner (1993) has used the sensory modality to look into visual-spatial intelligence which draws the attention of images and graphics and bodily kinesthetic intelligence facilitating physical manipulations and interactions. This leads to the integration of Information Communication Technology (ICT) in science teaching which can promote student learning through stimulations, graphics and multimedia presentation. Two other related intelligences are intrapersonal and interpersonal which the prior relates to interaction with others while the later emphasizes on self concept or meta-cognition. Thus, teaching strategies must address different learning styles which are dominated by different types of multiple intelligences. As a result, when students are provided with individualized learning, they are able to think critically and aware of their mental capabilities.

Other related researches of science education in the context of Malaysian have focused on the need to improve science teaching instruction (Kamisah Osman, Lilia Halim & Mohd Meerah, 2006); investigating teachers' experience in teaching mathematics and science in English (Lan & Tan, 2008) and inventory of science teachers needs (Zurub & Rubba, 1983); and in-service needs assessment of science teachers (Lilia Halim, Kamisah Osman & Mohd Meerah, 2006). However, these previous researches were lacking to promote models of teaching or empirically show the evidence of student intrinsic motivation and teacher style of teaching. Thus, this research utilized a self constructed instrument to measure 5E's model in the context of science teaching. The research has been designed quantitatively with a purpose to reveal the extent of 5Es' model is presently practiced in science teaching in Malaysian schools. Specifically, the findings were focused on the validation of the structural model and the estimation of the relationships of 5Es and student intrinsic motivation. This research has been guided with a theoretical framework from the instructional design model namely 5Es by Bybee (1997), intrinsic motivation and other related literatures of pedagogical approach in learning.

THEORETICAL FRAMEWORK

Bybee (1997) has introduced the 5Es model in a structured sequence and designed in practical manner that can be considered easy to implement the constructivist theory. This model is rooted from constructivist views forwarded by Piaget in 1960. The model also promotes experiential learning by engaging students in higher-order thinking learning activities. Despite Ergin, Kanli and Unsal (2008) have shown the evidence that 5Es model can directly promote curiosity and active learning, they have raised the issue of which event or attitude that can promote motivation is still remain unclear. However, Ritchie (2001); and McRobbie and Tobin (1995) indicate on the interaction involves will contribute students to think in critical, reflective and analytical way.

The 5Es model relates to 5 phases which is cyclic in nature namely; Engagement, Exploration, Explanation, Elaboration and Evaluation. Engagement has become the main phase of any learning theories and instructional design which include Gagne nine events of instruction, intrinsic motivation by Brophy (1997) and Engagement theory (Kearsley and Sheneiderman, 1998). The most important phase namely engagement involves teachers to grab student attention and interest (Bybee, 1997) and capture children's imagination (Swanage & Lane, 1999). Engagement can lead to inquire and learn (Bybee, 1997), motivation (Gagne, 1995) as well as to be persistent in learning (Skinner & Belmont, 1998).

Bybee (1997) further includes Exploration or Expansion as to ensure students to develop concepts and skills by having common, practical experiences, It can be achieved through introducing scientific concepts in preceding steps that is easy for students to digest and comprehend the scientific theories. In the context of science teaching in schools, students are allowed to carry out experiments in groups, test hypotheses and explore their own ideas to relate with the topics. However, teachers are more inclined towards teaching for exams that laboratory work may not be an important learning activity at present. Exploration can also be referred to inquiry based learning activities. Inquiry based learning leads to critical thinking skills, positive attitudes and curiosity toward science and high achievement in science (Hall & McCudy, 1990)

Explanation is crucial in teaching which can be from the teacher or students participation to present their ideas, explanation of concepts or summarizing the topic they have learnt. However, Swanage and Lane (1999) further emphasize that the explanation must be clearly linked to earlier activities of engagement and exploration. Teachers must provide supportive environment by allowing students to explain and take part in teaching and learning. However, this activity may not be allowed when teachers are more inclined towards traditional teaching style.

Elaboration involves students to extend their knowledge of concepts to other contexts. Piaget (1972) refers one as intelligent when he or she is able to extend knowledge and apply to other context. Thus, students can elaborate by finding similarities in different context (Swanage & Lane, 1999) but with a condition that teachers provide problem solving environment (Boddy, Watson and Aubusson, (2003). These activities will promote students to be intrinsically motivated.

The last component namely evaluation involves formal assessment namely formative and summative. However, reflections can also be part of evaluation as constructivist theory includes evaluation as part of the learning component. Learning activities can include comparing, contrasting, provide values and carry out experiments on their own.

RESEARCH METHODOLOGY

This research has been designed quantitatively with a targeted population of secondary schools in Kuala Lumpur, Malaysia. 500 samples have been selected randomly from the science class (general science, biology, chemistry and physics) in five schools comprising students from all Forms (one, two, three, four and five). However, only 452 samples responded.

Instrument

A total of 46 questions with demographic information has been designed and constructed based on the 5E definitions by Bybee (1997) and other literatures related to intrinsic motivation. The reliability of the instrument has been tested for the Cronbach's alpha. The instrument was further validated through confirmatory factor analysis. A 5-Likert scale of strongly disagree to strongly agree have been used to identify students' experience on their science teaching styles and intrinsic motivation. The structural model has been tested to provide information of the model fitness that explains the relationships of 5Es and intrinsic motivation .

Hypotheses

Based on the 5Es instructional model and intrinsic motivation, the following hypotheses have been postulated. Fig.1 provides the hypothesized model.

H1: engagement influences student intrinsic motivation

H2: exploration influences student intrinsic motivation

H3: explanation influences student intrinsic motivation

H4: elaboration influences student intrinsic motivation

H5: evaluation influences intrinsic motivation

H6: 5Es are five- factor model

ANALYSIS PROCEDURE

The Statistical Package for Social Science (SPSS) was used to compute the descriptive statistics and to perform reliability. Analysis of moment structures (AMOS) with Maximum likelihood estimation (MLE) was used to perform confirmatory factor analyses (CFA) and covariance structure analyses or structural equation model (SEM). A selection of variables were based on the CFA where only loadings of 0.5 and above were taken for final analysis of SEM. All violations have been addressed (error variances >0.8) with model fit indices were in the threshold point (RMSEA<0.08,CFI-comparative fit index>0.9,Tucker Lewis fit index- TLI>0.9, GFI-goodness fit index>0.9). However, p was ignored due to chi-square statistic is sensitive with the big sample size (>250) as guided by Kline (2001).

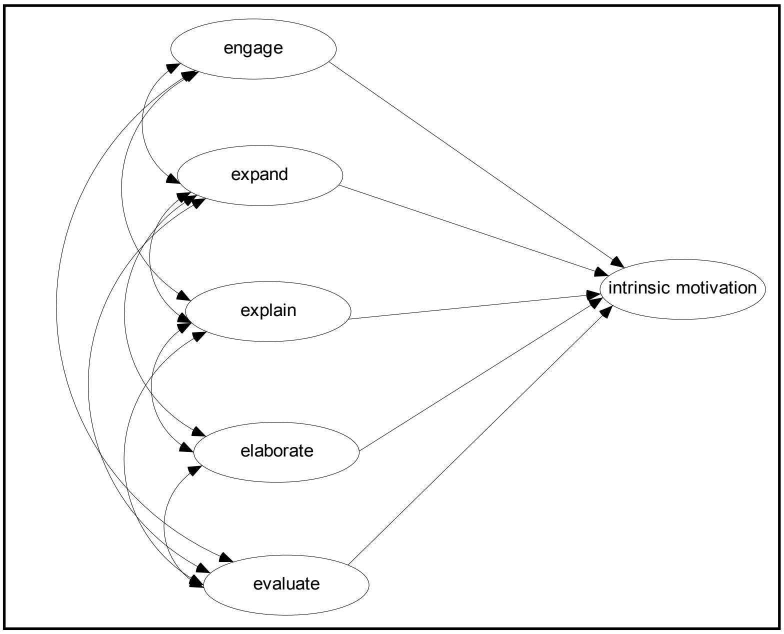

Fig.1: hypothesized model of teaching style and student intrinsic motivation

RESULTS

There were 452 (274 males and 178 females) respondents from the five selected schools. The breakdown of age group is revealed in Table 1. Majority of the respondents came from the age group of 14-16.

TABLE 1
Number of students based on age

Age	Frequency	Percentage
8-10	41	9.1
11-13	161	35.6
14-16	229	50.7
17-19	21	4.6
Total	452	100.0

The structural model was analyzed by addressing all paths to be significant at Critical ratio (CR) of more than 1.96. The paths which were not significant were deleted from the model. The item loadings of greater than 0.5 were selected. However, the researcher firstly addressed the model fit by finding the estimate model of fit indices values as outlined by Kline (1998) and Byrne (2001). The results show that the hypothesized model was to be rejected where two paths have contributed to non significant values (CR<1.96) and the model did not fit the data. Thus, the researcher further re-specified the model by deleting the non-significant paths.

The final findings have shown a fit model (RMSEA=0.60; CFI=0.919; TLI=0.906; GFI=0.901). (see Table 2 and Table 3). Only elaborate (β=0.403) and engage (β= 0.3903) influenced significantly on intrinsic motivation. The five- factor model of 5Es was significantly correlated to each other ranging from 0.338 to 0.738 indicating the factors were distinct and fulfill the divergent validity. Fig.2 provides the re-specified structural model.

TABLE 2
Standardized Regression Weights for direct path

Direct paths		Factors	Estimate
intrinsic motivation	←	elaborate	.403
intrinsic motivation	←	engage	.393

Further investigation of the items reveals that when teachers formulate activities which stimulate student involvement, encourages students to ask many questions and grabs their attention before starting the lesson (engage) have affected the way they feel towards science (intrinsic motivation). These include their effort to refer to the Internet even when teacher does not ask, work hard to get good results for this subject, happy with the teaching method used by teacher, enjoy learning science subject and look forward for the next class. On the other hand, when questions prompted after experiment are resolved through teacher elaboration, connects other related concepts to the real world, teacher allows students to build their own understanding and expands

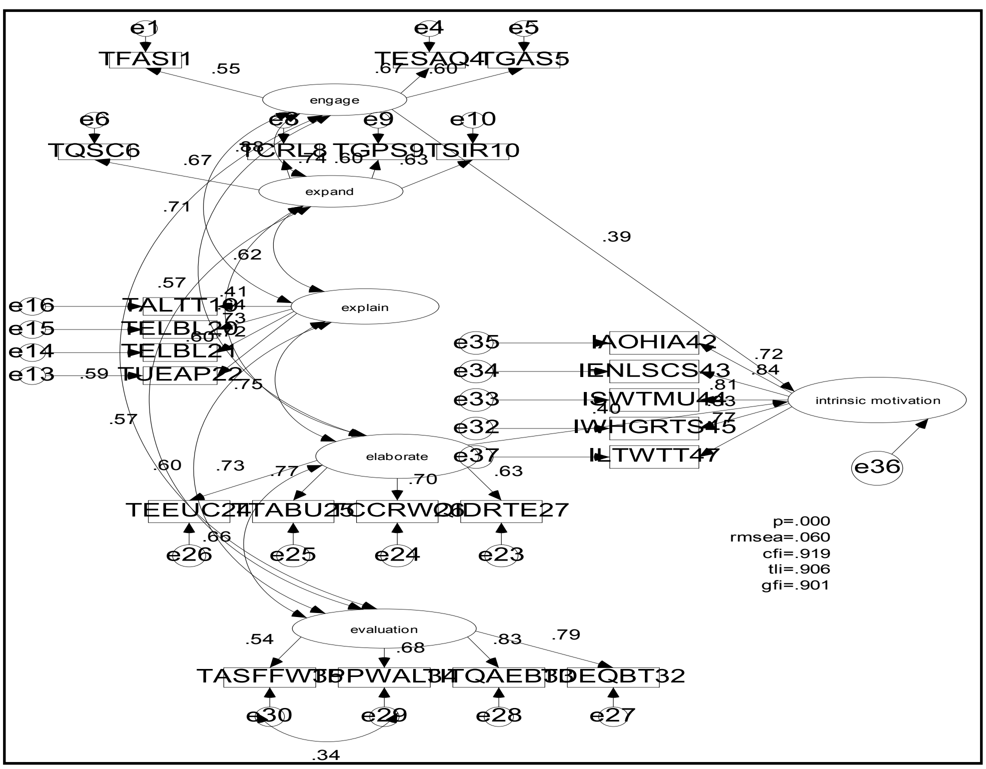

Fig.2: Re-specified model

TABLE 3
Standardized regression weight for items to factors

Factor loadings of items to factors			
formulate activities which stimulate our involvement	←	engage	.551
encourages students to ask many questions	←	engage	.671
grabs our attention before we start our lesson	←	engage	.601
involves us in defining and resolving the problem	←	expand	.671
relates the contents with the real life examples	←	expand	.744
gives problem to solve in groups	←	expand	.604
uses Internet resources to include in the teaching materials	←	expand	.634
add explanation after presentation of the student	←	explain	.719
explains further when we don't understand the concept	←	explain	.727
grabs our attention before we start our lesson	←	engage	.601
involves us in defining and resolving the problem	←	expand	.671
relates the contents with the real life examples	←	expand	.744
gives problem to solve in groups	←	expand	.604
uses Internet resources to include in the teaching materials	←	expand	.634
add explanation after presentation of the student	←	explain	.719
explains further when we don't understand the concept	←	explain	.727
explains on what to learn in the beginning of the lesson	←	explain	.643
uses appropriate language to teach	←	explain	.409
questions prompted after experiment are resolved through teacher elaboration	←	elaborate	.633
connects other related concepts to the real world	←	elaborate	.703
teaching allows me to build my own understanding	←	elaborate	.773
elaboration expands our understanding of the concept	←	elaborate	.729
designed exam questions based on teaching	←	evaluation	.788
includes test questions according to examination standard	←	evaluation	.833
provides practical work assessment in the laboratory	←	evaluation	.680
comes to students to check their work	←	evaluation	.542
refer to the Internet even when teacher does not ask	←	intrinsic motivation	.830
work hard to get good results for this subject	←	intrinsic motivation	.808
am happy with the teaching method used by teacher	←	intrinsic motivation	.842
enjoy learning science subject	←	intrinsic motivation	.723
look forward for the next class	←	intrinsic motivation	.769

their understanding of the concept, these will further impact on intrinsic motivation.

It can be concluded that explore, explain and evaluation were not prevalent and strong enough to influence student intrinsic motivation. This could be due to teacher's effort in making the class related to further application in different context (explore), evaluate students, and explaining did not promote further on students' effort to be persistence in learning. These results have shown that science teaching at selected secondary schools in in Kuala Lumpur are still lacking of constructivist approach.

DISCUSSION AND RECOMMENDATIONS

The findings of this study are parallel with Boddy, Watson and Aubusson, (2003); and Swanage, and Lane (1999) where engaging students and elaboration on the science concepts will trigger students to be intrinsically motivated in learning. Teachers were successful in engaging students to learn, grab their attention and interest. The students were also able to be actively involved in extending their knowledge to other context as well to have freedom to solve problems given.

However, the other three strategies namely explain, explore and evaluation were not prevalent. Students were more inclined towards active participation where they can carry out experiments, test hypotheses and explore their own ideas to relate with the topics in the exploration or expansion. This is supported by the results of high loadings in the factor of *exploration*. However, it is not strong enough to promote them to enjoy, be persistence in learning and to show interest in the science classroom. Further, evaluation was not a strong factor for students to get interested in science learning. They are bonded with exams that diminish their enjoyment in learning (Deci, Koestner & Ryan, 1999). Evaluation in problem and project based learning involves ill structured problems where students can solve problems and teachers monitor their students' thinking (Torp & Sage,2002). This kind of assessment may not exist in the structured, centralized and exam oriented curriculum. In the explanation, only the teacher i nvolved in the process which included, "*add explanation after presentation of the student, explains further when we don't understand the concept, explains on what to learn in the beginning of the lesson*". The items which involved students to summarize, explain, demonstrates were not detected in the analysis. This has proven that the selected schools in Malaysia still adopt teacher centered rather than student centered learning in science.

This research has shown the selected schools in Kuala Lumpur have adopted the 5Es instructional strategies. However, more effort is needed in inculcating further on the effective exploration, explanation and evaluation teaching strategies to the students. Teachers must involve students to be active in participating to explore scientific concepts further in real world context. Thus, students must be able to plan, develop and execute the laboratory work. Teacher must be able to play the role as a facilitator by assisting students in the experiments. On the hand, students must also involve in explaining rather than waiting for teachers to provide explanation. Teaching towards exam has further rooted in Malaysian curriculum thus diminishes student interest in science teaching. Teachers must be able to address the issue by making classroom more interesting enjoyable.

Despite the findings have shown a model of 5Es influencing student intrinsic motivation, further investigation needs to be carried out to other schools at different counterpart. The findings may be different when samples are from residential or Smart schools. The instrument has been constructed based on the definitions by Bybee (1996). Further bigger sampling with modifications of the instrument is necessary in validating the instrument so other researchers can utilize and adopt.

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