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The Relationship Between Achievement Goals and Scientific Achievement: The Mediating Role of Learning Approaches

Fonny Hutagalung[a], Hutkemri Zulnaidi[b], Wong Su Lee[c], Chew Fong Peng[d], Noor Aishah Rosli[e], [a,b,c,d,e]Faculty of Education, University Malaya, Malaysia, Email: [a]fonny@um.edu.my, [b]hutkemri@um.edu.my, [c]wongsulee@yahoo.com, [d]fpchew@um.edu.my, [e]noraishahr@um.edu.my

This research investigates the effects of achievement goals on academic motivation and the performance in science of upper secondary school students. Learning approaches and achievement goal orientations are among the academic motivation constructs. This research designed a quantitative correlation study to relate and model these factors of scientific achievement. A total of 350 students comprised the sample in the present study. SPSS and Smart PLS software were used to collect and analyse the data. Results indicate that learning approaches and goal orientation substantially affected students' achievement in science. Moreover, mediation roles were identified and results indicated that goal orientation considerably affected achievement in science via a deep approach. Thus, instructional strategies should be designed by teachers and educators through the incorporation of students' epistemological and motivational beliefs and various techniques in learning for effective science education.

Key words: *Achievement goals, learning approaches, motivation, science, student.*

Introduction

A sense of competition is observed in every education level and various degrees in the Malaysian context. This phenomenon can be attributed to grades, which typically comprise the determinants of entry into succeeding education levels, renowned programmes that are highly competitive or prestigious universities. Generally, students with the objective of obtaining high grades design their own academic activities to comply with exam requirements. They thereby

considerably disregard course objectives and scheduled learning endeavours that are not substantially aligned with those critical for earning good exam grades. Kvale (1980) determined that 'grade behaviour' modifies the self-image of high school students toward grade identification. Accordingly, their focus is adjusted towards rewards (i.e. extrinsic motivation) and adopts a surface approach to learning. This behaviour is contrary to educational objectives indicated in policy documents, including student independence, peer cooperation, self-development, intrinsic motivation and deep approaches to learning.

Contribution to Literature/Paper Originality

- The application of structural linear equation analysis to the proposed model clarified the recent research conducted in this area.
- A crucial aspect has been thoroughly considered in conducting research on epistemological beliefs.
- The current study integrates a multidimensional model of epistemological beliefs with other cognitive and affective models of learning.

Malaysia's vision to become a developed country by 2020 has highlighted the importance of science and technology as subjects for excellence. This is because these fields are often perceived as fundamental forces behind economic development in industrialised countries (Lee, 1989). Reports on science learning performance, specifically those that highlighted the lack of interest and declining abilities of students to turn in exceptional performance in science (Kong, 1993) have generated considerable concern for students' abilities to achieve their goals. These reports are further exacerbated by the fact that enrolment in the sciences, compared with the arts, is less than the expected 60% to 40% ratio in higher secondary school. Limited studies have examined the factors influencing science learning in Malaysia. Additionally, previous studies have also explored the difficulties arising from science's complex terminology, ideological or technological nature (Yusof, 1992), the inability to apply process skills (Ghafar, 1999) and the failure to classify, synthesise and evaluate information (MOE, 2001b). However, only a few studies have been conducted to investigate these strands of inquiry and evaluate the overall success of academic study. Previous research has supported the link between goal orientations and learning approaches (Elias, Ping & Abdullah, 2011).

The process of how these factors function as independent variables in a multiple regression setting should be determined. Despite the connections between epistemology and academic achievement, no research that examines the two variables in a multiple regression setting has been published. Therefore, the current study may extend scientific knowledge in the literature. This study tests the theoretical model to examine the links amongst the variables. Apart from testing such relationships, the theoretical model also addresses the issue of relative mediation goal orientation and learning approaches in predicting achievements in science.

This study provides the following assumptions: (1) Goal orientation and learning approaches are related to students' achievements in science. (2) A mediating role is provided by learning approaches between goal orientation and scientific achievement. Given the extensive and varying factors, the current study complements the related field of research with student-specific models for effective science learning. This study focuses on building a model to comprehend the aspects that influence the motivation of Malaysian students to learn science by identifying and profiling the development of good science students notwithstanding the implementation method of teaching science. This proposition is crucial because good science students are considered to exhibit a specific type of personal quality, thereby improving performance regardless of their teachers, schools and the method of teaching.

Researchers, educators and institutions are also interested in the predictive factors supporting the retention and academic success of students. Numerous studies have proven that such predictors of academic success as achievement, goal orientation and learning approaches are factors that contribute to success in academics (Kadioglu & Uzuntiryaki, 2014; Fadlelmula et al., 2015). The current research provides empirical evidence, adds to scientific knowledge and expands upon the literature. By examining various contributing variables to scientific achievement, understanding the process of how these variables influence students' performance will facilitate the identification of their aptitude for excellence in science. This research enables science teachers and education policy makers to provide suitable guidance, activities and other support necessary to further nurture students' science learning. Existing studies have proven that such predictors of academic success as epistemological beliefs, achievement goal orientation and learning strategies are factors that contribute to success in academics (Harackiewicz, Barron & Elliot, 1998). These salient predictor components may be combined within course designs to increase current below optimal retention and performance rates. The current study provides empirical evidence, adds to scientific knowledge and expands on the related literature.

Previous academic exposure in learning approaches

Only a few previous studies have supported and opposed the relationship between learning strategies and academic success (Gardner, 1993; Honey & Mumford, 1982; Kolb, 1984). The current study uses Duff's (2004) three-factor instrument called Revised Approaches to Studying Inventory (RASI). RASI is composed of deep, surface and strategic approaches to learning. Elaborate processing and critical thinking skills are used in deep processing, in which a full understanding of what is learned is sought. The development of repetitive or rote memory to recall facts is involved in surface processor learning. Lastly, strategic processors are organised and approach learning uses strategies including the manner of reviewing previous exams to study for upcoming ones (Duff, 2004). Learning strategies are extensively investigated to improve the comprehension of their influence on asynchronous learners' academic success.

Offir, Bezalel and Barth (2007) indicated that deep processing contributes to an increase in cognitive processing levels. Conversely, diminished cognitive surface processing (e.g. understanding and reciting information) levels do not increase learning and critical thinking skill levels. The aforementioned study recommended the refinement of deep learning processing in asynchronous learning by providing higher-order questions to students to improve their information comprehension and assessment abilities. Their findings have suggested that deep processing should be used by learners to handle high-cognitive demand learning tasks and surface processing for low-cognitive demand learning activities. For example, deep processing may be used by learners for essay-type tests or surface learning for multiple-choice questions requiring rote memorisation (Entwistle & Tait, 1995). Generally, learners are predisposed to be either deep or surface processors, although they adjust their strategies in learning to execute the techniques required by assessments or learning tasks (Offir et al., 2007). Numerous studies have agreed that learners adopt an integrative learning process, which enables them to utilise the learning strategies that are appropriate and mandated by the learning activity or examination (Coutinho & Neuman, 2008). Students are reasonably assumed to possibly turn in an improved performance on examinations with an aligned learning approach used in coursework and examinations. Such an approach may be a surface approach to coursework with surface approach-oriented tests. Moreover, congruency between coursework and exam type may be critical and affect students' performance in tests in various academic disciplines and teaching approaches. Moreover, success in academics requires higher-order and critical thinking skills, which will be discussed in the succeeding section.

A survey was conducted by Clayton, Blumberg and Auld (2010) to investigate the influence of achievement goals, self-efficacy and learning strategies on the choices of learners of online, hybrid or traditional learning environments. Their survey determined the reasons for students' preference of learning environment, their motivation orientation and learning strategies. The survey findings indicated that the majority of the students prefer a learning environment provided by classrooms. The students are convinced that their style of learning enables them to engage in the learning process. A significant difference in motivational beliefs and learning strategies was determined through discriminate analyses. Moreover, the students had a mastery of goal orientation that is related to the exertion of adequate efforts to learn, thereby resulting in success in academics.

Learning approaches are based on Entwistle and Tait's (1995) Approaches to Studying Inventory. Prior studies on learning approaches primarily focused on two types: surface and deep processing (Dupeyrat & Mariné, 2005). These studies describe the qualitative differences of students' information processing in learning. Deep processors utilise elaborative processing or critical thinking skills. Thus, a deep approach to learning may be adopted by students to comprehend what authors intend to express and link such a meaning to their previous knowledge and personal experiences (Phan, 2006). Students adopting a deep approach aim to

understand, engage with, operate in and value a subject. Moreover, they endeavour to actively seek understanding of the material or subject, dynamically interact with the content and utilise evidence, inquiry and evaluation. They also broadly view the subject and effortlessly relate ideas to one another. Interest is the source of motivation for the majority of these students. Therefore, they simply connect novel ideas to prior knowledge and concepts to everyday experience. Lastly, students have the tendency to read and study outside the requirements of courses.

Students may also adopt surface learning approaches that emphasise study to merely reproduce information that does not involve additional analysis. Repetitive or rote memorisation is developed by surface processors to recall facts. RASI indicates that strategic processors utilise every available resource for studying. Moreover, students who consider a surface approach do not tend to exhibit interest in an understanding of the subject. By contrast, they tend to take only the needed steps to obtain the mark, grade or qualification. Students who adopt a surface approach will attempt to be able to repeat what they have learned. Thus, these students simply memorise information that is necessary for assessments and use rote learning. They constantly have a limited perspective of subjects, focus on the particulars and are unable to differentiate principles from examples. Additionally, students have the tendency to faithfully follow the course requirements and are motivated by the fear of failure.

Goal orientation

Goal orientation theory and achievement goals are defined as the terminal points that direct individuals' effort (Barkur, 2013). Research was conducted in an Indian medical school to identify the correlation between academic goal orientation and the performance of Malaysian students. The results indicated a strong positive correlation amongst performance approaches, performance avoidance and work avoidance orientations. Amongst the four goal orientations, only the mean scores in work avoidance orientations differed for low and high performers. Barkur et al. (2013) explained that the work avoidance type of goal orientation amongst the low performer group may account for their performance, which was lower compared with that of the high performer group.

Ong (2014) determined the goal orientations of adult students in the context of Malaysia and indicated that mastery of goal orientation registers the highest mean amongst adult students. Elias et al. (2011) determined that mastery and performance goals exhibit a crucial role in academic achievements. That is, students with high mastery and performance goals have high flow in their learning activities. Those who pursue mastery goals want to acquire new skills, enhance their competence and increase knowledge and understanding by exerting effort during learning. Moreover, students with performance goals opt to receive favourable judgment towards competence, consistently showcase high abilities and avoid failure. Students' goal orientations and learning strategies are context-specific traits rather than general traits. Ames and Archer (1988) provide

the following arguments: Firstly, situational demands are initiating factors that form students' individual perceptions, thereby influencing their adoption of various goal orientations. Secondly, goal orientations eventually result in variance in the use of learning strategies by students. These arguments are crucial because they exhibit vibrant interaction amongst social, motivational and cognitive factors, which influence learning behaviour (Somuncuoglu & Yildirm, 1999).

Numerous studies have provided mixed results regarding the influence of achievement goal orientation on academic success. Dupeyrat and Mariné (2005) found a positive relationship between achievement goals and academic success. Vermunt, Vermetten and Lodewijks (2001) explained that effort and outcome exist together in academic succeed. Elliot and Dweck (1988) argue that students who opt for the performance approach are competitive and feel considerable success when outperforming their peers. Archer (1994) asserted that students who are performance-oriented exert effort to achieve short-term learning, thereby avoiding incompetence. However, such a technique has no contribution to their long-term success in academics. Elliot and McGregor (2001) posited that performance goals and performance avoidance are positively and negatively related, to success in academia. The results of the aforementioned study indicate that mastery and performance approach goals are positively related to academic success. By contrast, performance and work avoidance are related to poor academic performance. Therefore, mastery and performance approach goals are suggested to be associated with learners' academic success. Sins, Joolingen, Savelsbergh and Wolters (2008) tested their model, which comprises achievement goal orientation, self-efficacy, cognitive processing and performance on a computer task. Their log-file findings suggest that the mastery approach substantially influences achievement, thereby mediating students' deep cognitive processes. Moreover, the results of the aforementioned study indicated a lack of relationship between performance avoidance and achievement or between surface processing and achievement.

Several studies (e.g. Coutinho & Neuman, 2008; Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002) have indicated that students adopt multiple goal orientations that are independent of one another based on the learning task. Midgley, Kaplan and Middleton (2001) proved that performance goal learners exert effort to study and obtain short-term success or avoid failure. The aforementioned research notes that learners who exhibit work avoidance exert minimal effort to complete a task to avoid failure and other difficult responsibilities. Therefore, students with performance goals do not avoid challenging learning tasks to avoid feelings of incompetence but to avoid negative consequences, such as repeating a course. Lau, Liem and Nie (2008) indicated that students with a mastery approach to goal orientation exert effort to obtain knowledge and skills, whereas mastery avoidance learners avoid misunderstanding and forgetting materials, thereby possibly leading to a sense of incompetence. Conversely, performance approach learners strive to outperform their peers, whereas performance

avoidance learners veer away from demonstrating incompetence. Evidently, the mastery and performance approach and avoidance aspects significantly influence success in academics.

Methodology

Research design

This study aims to analyse the role of goal orientation (i.e. mastery (MAS), performance (PER), avoidance (AVO), learning approaches (i.e. namely, deep (DEE) and surface (SUR) approaches) in scientific achievement (ACH). A quantitative correlational design that describes and measures the degree of relationships among two or more variables was used to achieve this objective. This design includes goal orientation, learning approaches and scientific achievement. A priori model with five endogenous variables and two exogenous variables was developed on the bases of these variables. Exogenous variables comprise goal orientation and learning approaches. Scientific achievement is considered the endogenous variable. Learning approaches in the priori model acts as an exogenous and endogenous variable. A cross-sectional design survey was used to examine the interrelationships amongst variables in this structural research design. Additionally, this design addresses the manner by which individuals perceive their respective roles. This survey can be administered to one or more groups of subjects via questionnaires and can be tested without involving treatment. This survey type is often beneficial in assessing interrelationships amongst different variables within a population and is ideally suitable for descriptive and predictive purposes. The current survey provided a comprehensive view of the interrelationships amongst this study's research variables.

Population and sample

This study's sample population comprised secondary school students aged 16–17 years. These students were from schools in 11 different districts in academic year of 2016–2017. The total number of the target population was 872. A total of 268 secondary school students in Pahang were selected as a target sample through simple random sampling (Krejcie & Morgan, 1970). The current study employed cluster sampling to select the sample from the target population. Initially, the researchers randomly selected 3 out of the 11 districts: Bentong, Raub and Kuala Lipis. Subsequently, they randomly selected 3 to 4 schools from each selected district and 1 class from each selected school. Lastly, all students in the 10 selected classes comprised this study's sample. We collected data from 350 students of the sample. After excluding the uncompleted questionnaires, 300 complete questionnaires comprised this research's actual samples. SPSS was used for the analysis of the data from these questionnaires.

Achievement goal orientation questionnaire administration

Achievement goals were measured using the achievement goal scale developed by Midgley et al. (2001). This scale measures types of goals, namely mastery, performance approaches and performance avoidance goals. This scale includes three subscales, with six items assessing

mastery goals (e.g. 'In science courses like this, I prefer class materials that certainly challenge me so I can learn new things'), six items measuring performance approach goals (e.g. 'I want to do well in this science course to showcase my ability to my family, friends, advisors or others') and six items measuring performance avoidance goals (e.g. 'I wish this science course was not graded.). Cronbach's alphas were .84, .88 and .92, respectively (Elliot & Church, 1997). This instrument was used to assess achievement goal orientation as a predictor of students' academic success.

Learning approach questionnaire administration

Students' approached their learning in a variety of ways, thereby operating in response to a series of internal and external motivations. Deep and surface learning originated from Marton and Säljö (1976). These concepts describe the manner by which students manage their learning. Learners may use deep or surface strategies or a combination of both throughout their study. The present research utilised RASI (Duff, 2004), which is a five-point Likert scale used to assess approaches in studying the predictors of academic success relative to deep and surface approaches. The deep learning approach is associated with the objective of substantially understanding the subjects, as well as conducting comprehensive content analysis and meaning construction regarding the study materials to be learned. Deep learning students treat the study materials as a structure of meaning. Furthermore, they attempt to critically understand the content and determine its implications and underlying concerns.

Scientific achievement

Four inventory science examinations were developed by the educational department of the entire district of Pahang to measure scientific achievement in the current study.

Data analysis

This research used path analysis to test a structural model that examines the relationships between achievement goals through the mediation of learning approaches. Goodness of fit was assessed by analysing several indices that were selected to include measures of absolute degrees of freedom and comparative fit index. Additionally, the root mean square error of approximation (RMSEA) was selected to indicate the approximation error of the hypothesised model to the population, with the RMSEA at a 90% confidence interval. Adequate fit is typically assumed when comparative fit indices are equal to or above .90. An RMSEA below .08 indicates a fair fit (Hu & Bentler, 1999).

Mean and standard deviation of variables

Table 1 shows the means and standard deviation of the following variables: ACH (achievement), PER (performance approach), AVO (avoidance approach), MAS (mastery approach), DEE (deep approach) and SUR (surface approach). Additionally, Table 1 tabulates the mean and standard deviation of the study variables.

Table 1

Descriptive statistics of the variables

Construct	M	SD
MAS	3.90	0.89
AVO	3.36	0.86
PER	3.19	1.19
SUR	2.78	0.83
DEE	3.77	1.10

Table 1 shows that mastery goal orientation (*M* = 3.90, *SD* = 0.89) recorded the highest mean, whereas the lowest mean was registered by the surface approach to goal orientation (*M* = 2.78, *SD* =.83). The mean of performance goal orientation (*M* = 3.19, *SD* = 1.19) was slightly lower than avoidance approach goal orientation. The standard deviation values were small (*SD* = 0.83 to 1.19), thereby indicating that the distance of all values is not distant from the mean and the group of respondents is considered homogeneous. Evidently, the mean of the mastery goal orientation (*M* = 3.90, *SD* = 0.89) is the highest amongst the students. This result denotes that they adopt mastery goal orientation in their course of study. Moreover, students adopt the deep approach in learning science, whilst the mean of the surface approach is the lowest (*M* = 2.78, *SD* = 0.83). Thus, students intend to understand, engage with, operate in and value the subject. They actively endeavour to understand the material or subject, vigorously interact with the content and use evidence, inquiry and evaluation. Furthermore, they broadly view the subject and easily relate ideas to one another.

Findings

Table 1 presents the descriptive statistics, Cronbach's alpha coefficients and correlations amongst variables. A preliminary confirmatory factor analysis (CFA) was performed at the individual level across all items and constructs to be included in the empirical model. Each construct in the overall model was treated as a latent variable and the respective items were used as observed variables. Scientific achievement outcomes was also treated as a latent variable. The overall CFA model provided (1) a correlation matrix amongst the measured variables by considering their unreliability measurement and (2) a baseline of comparison for all subsequent SEM models nested in this model. The CFA model and all other SEM models tested in this study were assessed using AMOS. The model fit was evaluated using the following indices: ratio between chi-square and degree of freedom (χ^2/df), comparative fit index (CFI), RMSEA, standardised root mean square and Tucker–Lewis index (TLI). Good fit indices, particularly for large samples, are the value of χ^2/df that falls below 5.00, CFI above .90, RMSEA below .08, SRR at .05 or below and TLI values that approximate .95. These fit indices indicate that the data in this study fit the overall CFA model extremely well, with χ^2/df

= 2, CFI = 1.00, RMSEA = .013 and TLI = .997. The factor loadings for goal orientation items ranged from .75 to .66, whilst those for learning approaches ranged from .60 to .65. All loadings were significant at $p < .001$.

Discriminant validity

Discriminant validity is the extent to which a construct does not correlate with the measures of another construct (Hair et al., 2006). Discriminant validity is assumed present when the amount of variance shared between a construct and its indicators is above the amount of variance shared amongst the other constructs of the current study (Fornell, Tellis & Zinkhan, 1982). Generally, discriminant validity evaluates whether the constructs are different from one another. The correlations between the constructs are compared with the square root of the average variance extracted (AVE) value for a particular construct to assess its discriminant validity (Teo & Koh, 2010). The discriminant validity for a construct is present if the diagonal value for that construct is larger than the strength of its correlations with other constructs. Table 2 shows that all constructs satisfied this criterion. This result indicates that discriminant validity was satisfactory for all constructs.

Table 2

Discriminant validity of the entire model's constructs

Construct	1	2	3	4	5	6
ACH	1.000					
AVO	.119	1.000				
DEE	.203	.478	1.000			
MAS	.246	.493	.588	1.000		
PER	.281	.513	.477	.588	1.000	
SUR	−.095	.073	.035	.025	.246	1.000

Pertaining to the proposed model, the correlations provided initial support for the hypotheses on the relationship of goal orientation and learning approaches to mediators and outcome variables. These correlations may also be classified as significant factors that affect high scientific achievement amongst the students. Consistent with the hypotheses, the significant correlations between goal orientations and learning approaches suggested that both variables may be regarded as potential mediators in the current study. Overall, the correlations amongst the study variables were insignificant to moderate, which ranged from −.095 to .588.

Table 3

Significance testing the results of structural model path coefficients

Path	Path coefficients	t-values	p-values	Significance level
AVO -> ACH	.16	1.34	.09	P > .05
AVO -> DEE	−.14	1.21	.28	P > .05
AVO -> SUR	−.05	.39	.69	P > .05
DEE -> ACH	.45	6.62	.00	P < .01
PER -> ACH	.55	4.11	.00	P < .01
MAS -> ACH	.43	6.41	.00	P < .01
MAS -> DEE	.22	1.76	.08	P > .05
MAS -> SUR	−.12	.14	.84	P > .05
PER -> DEE	.14	1.29	.20	P > .05
PER -> SUR	.41	3.51	.00	P < .01
SUR -> ACH	.12	1.87	.32	P > .05

Significance and relevance of the structural model's path coefficients

The structural model assessment required bootstrapping, through which the results of the path coefficient, t-value and significance level were calculated for the current study. After bootstrapping, the obtained t-value was compared with the critical t-value at a certain selected level. If this t-value is higher than the critical t-value, then the coefficient is significantly different from 0. The recommended critical t-values for the two-tailed tests are 1.65 ($\alpha = .10$), 1.96 ($\alpha = .05$) or 2.58 ($\alpha = .01$) (Hair et al., 2013). Performance goals demonstrated the highest contribution, with $\beta = .55$ and a t-value of ($4.11 > 1.96$, $p < .01$) in reviewing the influence of variables on scientific achievement. This variable was followed by the deep approach with $\beta = .45$ and a t-value of ($6.62 > 1.96$, $p < .01$). Amongst the remaining constructs, mastery goals (β .43, t-value ($6.41 > 1.96$, $p < .01$) were also revealed to exhibit a relatively significant influence on scientific achievement.

For the influence of exogenous variables, performance goals showed a significantly direct effect on surface approach with $\beta = .41$ and a *t*-value of ($3.51 > 1.96$, $p < .01$). By contrast, mastery and avoidance goals did not exhibit any significant direct effect on the surface approach. Additionally, the results revealed that mastery and avoidance goals did not show a significant direct effect on the deep approach with regard to performance goals.

Coefficient of determination R^2

The corrected R^2 value in the figure refers to the explanatory power of the predictor variable(s) over the respective constructs. The coefficient of determination R^2 was used to analyse how differences in one variable may be explained by a difference in the second variable. The coefficient of determination is similar to the correlation coefficient R. The correlation

coefficient formula showed a strong linear relationship between the two variables in this study. Thus, the coefficient of determination R^2 is considered a measure of the model's predictive accuracy and is calculated as the squared correlation between the dependent construct and the predicted values (Hair et al., 2013). For model validity, Chin (2010) classified the endogenous latent variables as substantial, moderate or weak on the bases of the R^2 values of .67, .33 or .19, respectively. The R^2 value provides an idea of the number of data points that fall within the results of the line formed by the regression equation. A high coefficient leads to a high percentage of points where the line passes through when the data points and the line are plotted. A value of 1 or 0 indicates the regression line representing all or none of the data. A high coefficient is an indicator of an improved goodness of fit for the observations.

Table 4 demonstrates that the R^2 value for scientific achievement construct is .50 (moderate), thereby indicating that 50% of the variance in this construct was explained by such factors as epistemological beliefs, implicit intelligence, mastery, performance, avoidance goals, learning approaches and self-efficacy. Further analysis has revealed that mastery and performance goals with R^2 values of .69 and .66 respectively, exhibiting strong effects. By contrast, avoidance goals and surface approaches contributed an extremely small percentage of 11% and 1% respectively, thereby representing weak effects. The R^2 value for a deep approach was .43, thereby representing moderate effects. Overall, the model explained that 50% of the variance in achievement was described as being close to that of the substantial endogenous latent variable. This study obtains a goodness of fit (GoF) value of .53, which exceeds the cut-off value of .36 for the large effect sizes of R^2 (Cohen, 1988). Therefore, the model exhibits a better predictive power than baseline values, that is, GoF criteria. This finding adequately and globally validates the complex Partial Least Squares (PLS) model. Note that the GoF index can be estimated for PLS path modelling. The PLS–SEM approach is beneficial when predicting and explaining target constructs (Hair et al., 2014). Path analysis was used to test the current study's objective to identify the relationships among achievement goals through the mediation of learning approaches. AVE was evaluated by PLS and its values range from .50 to .71 for the variables. Hair et al. (2010) indicates that the AVE value must be above .5.

Table 4

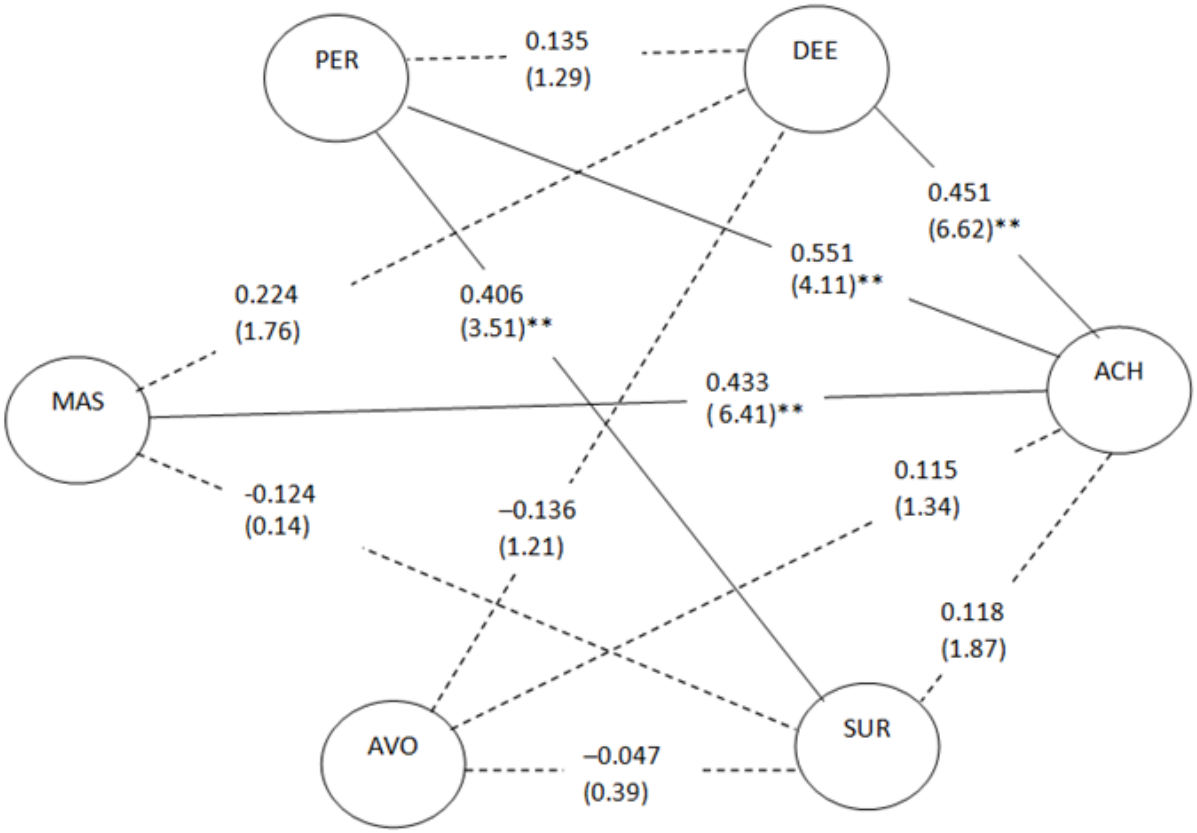
Systematic evaluation of PLS-SEM results

Construct	AVE	R^2	GoF = $\sqrt{(AVE^x R^2)}$
Avoidance goal	.56	.11	
Deep approach	.58	.43	
Self-efficacy	.57	.23	.50
Surface approach	.71	.01	
Mastery goal	.60	.69	
Performance goal	.50	.66	

Mediating model estimations were calculated to examine the mediating role of a learning approach. This model comprised goal orientation, learning approaches and scientific achievement. Figure 1 illustrates the estimation results. Deep and surface approaches were observed to play a partial mediating role in performance goals (β = .47, t = 1.99, p < .05) and avoidance goals (β = .05, t = 1.86, p < .05). However, no such effect was observed in the other constructs. This study revealed that a deep approach plays a mediating role in mastery and performance goals. However, no such effect was observed for avoidance. Figure 1 presents the detailed results of the mediation effects of this model. The findings showed that a deep learning approach partially mediates the relationship between goal orientation and mastery goals, as well as goal orientation and performance goals. By contrast, the surface approach does not mediate the relationship amongst performance, mastery or avoidance.

Figure 1

Relationship of achievement goals and learning approaches in scientific achievement



Discussion

Goal orientation and learning approaches are related to the scientific achievement of students

This study's findings on mastery goals are consistent with those of Fadlelmula, Cakiroglu and Sungur (2015), who investigated the interrelationships amongst the motivational beliefs of students, such as achievement goal orientations, self-efficacy, perception of classroom goal structures, the use of learning strategies and achievement. Amongst the achievement goals, only mastery goals were significantly related to the use of learning strategies and scientific achievement. Hence, the authors concluded that when students value learning for its own sake and focus on expanding their skills, they have the tendency to use additional learning strategies and become successful in science. Several studies have also reported that only mastery goals predict in-depth strategies (Elliot & McGregor, 1999). In contrast to the existing literature, the results of the current study showed that performance goals are also related to learning approaches. Students who have attempted to outperform others use additional strategies to achieve improved results in science. These findings are consistent with those of Kadioglu and Uzuntiryaki (2014), which showed that performance goals are linked to learning approaches.

The current results showed that students with performance goals recognise the significance of the lessons. Hence, those who are being taught attempt to understand their lessons, integrate information and reflect on topics. They look for overall meaning and attempt to process information in a holistic manner. The students manage to develop their own content interpretation by integrating it with their existing knowledge. This strategy enables them to develop critical analysis skills and encourages the long-term retention of concepts. Deep learning is valued and fostered by educators. The findings of the current study on avoidance goals were consistent with those of Fadlelmula et al. (2015). Students who avoid the perception that they are incompetent may not use further learning strategies or attain achievements in science. Kadioglu and Uzuntiryaki (2014) claimed that avoidance goals are not a significant predictor of learning strategies. A goal theorist posited that learners become passive and pessimistic in learning when they adopt an avoidance goal. Subsequently, they tend to withdraw from learning, thereby impeding learning approaches (He, 2004).

The present findings concluded that students in Malaysia merely focus on details and components of the information that they consider important. Moreover, they emphasise on memorising individual details or pieces of information to signify sufficient comprehension for assignment completion. For these students, tasks are treated as an imposition or hurdle to be overcome and are their requirements to pass. Thus, learning may become increasingly superficial and considerably difficult to understand. Students may likewise focus on unconnected facts that they believe are needed to be reproduced later in assessments, including examinations. Science educators have already considered the importance of these motivational

factors and suggested that these factors alone were insufficient to foster students' achievements in science. By contrast, the use of deep learning strategies may mediate the association between motivational factors and scientific achievement. For indirect relationships, Barron and Harackiewicz (2001) suggested that optimal achievement outcomes may result when students pursue mastery and performance goals together. When students have the option to pursue both types of goals, they can improve their achievement experience by focusing on the achievement goals that are specifically relevant at a particular time.

Learning approaches play a mediating role between goal orientation and scientific achievement

The application of structural linear equation analysis to the proposed model provides only a few clear contributions to the existing research in this area. The results of the present study reflect those encountered by other research and clarify this field of investigation. The current findings reveal that learning approaches significantly influence science performance. Consistent with other investigations, students who study with a surface approach to learning have a tendency to perform poorly, whereas deep-approach students perform well. A crucial aspect has yet to be thoroughly considered in the research on epistemological beliefs. That is, situational demands are the initiating factors that shape the individual perceptions of students, thereby influencing their adoption of different goal orientations. Moreover, goal orientations eventually lead to variance in students' use of learning strategies.

The present study provides several important implications for curriculum designers and teachers, particularly those in science education. The findings propose that teachers are supposed tend to the learning processes of their students. Therefore, they should consider the knowledge construction and utilisation of students as they help them improve the latter's learning strategies. Moreover, preservice teachers should be assisted in developing adequate epistemological beliefs as a factor influencing their classroom behaviour to support this process. Apart from course content, teaching style and instructional approaches, perceptions on science, learning strategies and the purpose or goals of learning affect teaching and learning science. Therefore, teachers in training programmes should design instructional strategies by incorporating the epistemological and motivational beliefs of students and effective science learning approaches. Science teachers can utilise the findings of this study in assessing the ability of their students in science. Additionally, teachers may apply these findings to assess the scientific ability of students in other branches of calculus or science.

Many students may exhibit slight motivation in science tasks or for pursuing goals, whereas others merely depend on extrinsic motivation. Class environment should be interactive and self-motivating and also display an atmosphere of inquiry, exploration and discovery to enhance the motivation, interest and utilisation of the learning approaches and differential equations of students. Currently, teachers are supposed to attend to the learning processes of

their students and listen and respond to the essence of their reasoning. However, teachers can only function in this capacity when they are aware of the knowledge construction and utilisation of their students. Therefore, they should develop a belief system that directs and constrains the learners' content assumptions. Teachers with beliefs of reduced adequacy may possibly fail to reach these science education goals. Furthermore, teachers may participate in monitoring and development programmes, such as mentorships and feedback, to enable them to develop adequate epistemological beliefs, self-efficacy and learning approaches during academic training.

This study presents important implications to improve the quality and output of the educational process. Educational administrators should realise that academic performance and students' achievements are affected by such factors as learning approaches and goal orientation. Future research could focus on longitudinal studies to allow for a comprehensive examination of the relationships between goal orientation and learning approaches over an extended period and within individual students. In view of the observed influence of beliefs about learning, knowledge and approaches to learning, teaching procedures could be designed to foster reflection and heighten awareness in learning. Such a design could guide students towards comprehensive approaches, significant academic success and enhanced personal development.

Limitations

Firstly, a suitable choice of sample size and cluster sampling from urban and rural areas would allow for the generalisation of findings of this research to the majority of the Malaysian students at the secondary level. Additionally, comparing and confirming demographic information with the institutional data of the participants may be beneficial to delimitate errors in self-reporting data. Secondly, the limitation related to the measurement of the independent variables is present. A weakness of the current study is that it relies on questionnaires to gather data. Unfortunately, directly observing motivational constructs in this study is impossible. Therefore, the data collection method of this study should involve the use of self-report instruments to measure the constructs of interest. Given this limitation, a critical stage in this research is the discussion of the psychometric properties of these instruments. The instruments utilised in this research should be ensured to be reliable and valid. Despite several limitations, the instruments were carefully chosen based on the selection criterion of having advantageous psychometric properties. For example, reliability and validation studies have been performed on the instruments utilised in this study.

Conclusions

Malaysia's vision to become a developed country by 2020 has driven science and technology to be regarded as important subjects for excellence. Recent reports on performances in science

learning, particularly those that highlight students' lack of interest, have sparked significant concern regarding the capability of the country to achieve its goals. Experts highlight the fear of science, technology, engineering and mathematics (STEM) subjects being 'too difficult', meant to be taken by the exceptionally brilliant, thereby being 'less glamorous' fields than others. Students with the potential to excel in science should be identified because the education system must ensure that the country's human capital growth is consistent with the targeted vision and mission of the nation. The practice of an 'open system' in the Malaysia's education system, particularly at the upper secondary level, has resulted in students enrolling in arts-based subjects. The latter include economics, accountancy, Quranic studies, commerce and language-related courses. The number of enrolees in these arts-based subjects has surpassed that of science-based subjects despite a significant number of these students who are qualified to enrol in science-based subjects. This phenomenon is partially caused by the claim that arts-based subjects are supposed to be 'relatively easy' to manage and complete. By engaging in 'easy' subjects, students are likely to ace exams and obtain satisfactory results, thereby allowing them to obtain a clear path for university entrance. By contrast, students who are driven to pursue science as well as technical and vocational courses may not fulfil the requirements.

The Malaysian Ministry of Education should apply reforms in education starting in early years of education by ensuring qualified STEM teachers, sufficient educational support and relevant syllabi in a multipronged approach. Science educators should also evaluate methods wherein Math and Science subjects are taught in schools, especially at the primary school level. They must find alternative methods of teaching these subjects to pique the interest of children by remodelling syllabi and encouraging teachers to have increased interactions with students. The Malaysian Ministry of Education and secondary school teachers, particularly career counsellors, should inform students that their motivation is a factor affecting their individual academic attainment in science. Although motivation may be easily initiated, their actions may not consistently be rewarding unless sustained by learning approaches. Thus, school counsellors should plan motivation programmes and workshops about learning approaches for students. A successful academic performance requires high motivation among students to study and a strong will to learn despite all potential distractions.

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