Pertanika J. Soc. Sci. & Hum. 26 (4): 2243 - 2258 (2018)

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

Exploring the Relationship between Motivation and Science Achievement of Secondary Students

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ABSTRACT

Motivation plays an important role in students' learning and academic performance. It is believed that intrinsic and extrinsic motivation contributes in the learning process in different ways. This study examined the effects of intrinsic and extrinsic motivation on student science achievement using the Trends in Mathematics and Science Study (TIMSS) 2011 data. Furthermore, the study explored how intrinsic and extrinsic types of motivation function across different cultures. The sample consisted of eighth grade students from the United States, England, Malaysia, and Singapore. Students from the Western culture value extrinsic motivation higher than intrinsic motivation in science learning. The findings also showed that students with high intrinsic motivation perform better than students with low intrinsic motivation across the four countries. Positive relationship between motivation and science achievement supported motivation theory in which higher motivation led to higher achievement scores. Students with intrinsic motivation obtain higher score in science compared to extrinsically motivated students. This study also showed cultural differences affect students' types of motivation. Furthermore, this study could be practically valuable in providing insight on understanding the motivation levels in enhancing students' science achievement.

Keywords: Extrinsic motivation, intrinsic motivation, learning science, science achievement

ARTICLE INFO

Article history:
Received: 17 July 2018
Accepted: 23 January 2018
Published: 24 December 2018

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ISSN: 0128-7702
e-ISSN 2231-8534

INTRODUCTION

Motivation can be defined as an internal process leading a human to behave in a particular way. It is the set of requirements, forces, and desires that can activate, stimulate, guide, and maintain behavior over time (Brophy, 2004). Various definitions are used to describe the concept of motivation in the literature. For instance, Ainley (2004) defined motivation as energy, direction as well as the reasons for behaviors. Motivation is a complex term in explaining human effort and endeavor in different activities and the factors that led to human behavior (Cavas, 2011; Sevinc, Ozmen, & Yigit, 2011; Watters & Ginns, 2000). Ryan and Deci (2000) describe motivation as the move to do something or aspiration to act. Brophy (2004) related motivation with goal-oriented behavior where motivation was used to explain beginning, direction, force, and insistence of goal-oriented behavior. In other words, motivation gets an individual going, keeps an individual going, and determines the direction an individual is targeting (Slavin, 2000). In general, motivation is related to various psychological concepts such as curiosity and interest, learning and performance, goals and goal orientation (Sprinthall, Sprinthall, & Oja 1998).

Furthermore, motivation is a vital educational variable essential to the learning process because it activates, stimulates, and maintains learning behavior (Palmer, 2005). From the psychology viewpoint, motivation is needed for behavioral change and learning is part of behavioral change (Brunner et al., 2010). In addition, Barlia and Beeth (1999) described motivation as being involved in the process of learning behavior including learning, unlearning, and relearning by stimulating new skills and behavior as well as performance of learned skills and behaviors. Driscoll (2000) suggested that educators should analyze who the learners were and incorporated motivational concerns into instruction.

Meanwhile, motivation in learning science is important so that students will take the initiative to understand the subject. Students may not feel bored learning science and will truly enjoy the beauty of the subject. To increase students' knowledge in science, educators have utilized many pedagogical strategies to improve subject delivery. Studies have shown that students with high interest and motivation performed better in the science subjects. Student achievement in science-related subjects improved when high motivation in learning is achieved.

Intrinsic Versus Extrinsic Motivations

According to Ryan and Deci (2000), people have different level of motivation (the amount of motivation) as well as different orientations of motivation (the types of motivation). The type of motivation is determined by the underlying attitude, reasons, motives and goals that lead the action or the move. Intrinsic and extrinsic types of motivation are equally essential and have been widely deliberated in the literature based on self-determination theory. These two types of motivation play a crucial role in education practice and human development.

Intrinsic motivation refers to doing something for itself, pleasure and its inherent satisfaction instead of for separable outcome or consequence (Cokley, Bernard, Cunningham, & Motoike, 2001). Intrinsic motivation also reflects internal control by doing an activity because it is interesting, fun or challenging in nature based on the curiosity motive. Conversely, extrinsic motivation refers to doing something because it leads to separable outcome. It also reflects external control by focusing on the desire to receive a reward or to avoid punishment (Watters & Ginns, 2000). Furthermore, self-determination theory explains that motivation takes place at the time where the expected result does not occur with the individual's behavior (Cokley et al., 2001). However, motivation withdraws when individuals perceive that the output or result is out of their control.

The transition from the perspective of behavioral to cognitive brought a reintegration of motivation with learning (Driscoll, 2000). There is no single, widely accepted theory to explain all of human motivation in learning. In fact, intrinsic motivation has emerged as central focus in the education field for reflecting the natural human tendency to gain knowledge and skills owing to curiosity and interest (Ryan & Deci, 2000). Because of high-quality learning and creativity resulting from intrinsic motivation, it is important to discover factors that stimulate intrinsic motivation. On the contrary, extrinsic motivation is related to external reward or separable outcome as the stimulation for learning activity. Extrinsic motivation is categorized as an impoverished yet powerful form of motivation (deCharms, 1968). Educators cannot depend on intrinsic motivation to foster student learning behavior all the time. This is because some learning tasks may not be fun or enjoyable for particular students; however, students may be able to perform if they are extrinsically motivated. Hence, educators need to understand and learn how to apply extrinsic motivation as an essential teaching strategy for effective learning (Ryan & Deci, 2000). Notably, students could be motivated by extrinsic learning goals or performance goals. Students with performance goals will have the desire to acquire additional knowledge or master new skills although they are externally being pushed into action initially (Ormrod, 2000).

Motivation in Science Learning and Science Achievement

In the constructivist learning theory, learners construct new knowledge based on their experience and the interaction with the environment. In this case, the students are active knowledge constructors. When students discover meaningful learning tasks, they will link this new knowledge with their existing experience by engaging actively in the learning tasks. If the learning task is less meaningful, students usually use lower order learning strategies such as memorization to understand the material (Pintrich & Schunk, 1996). Von Glasersfeld (1998) highlighted that motivation was influenced by students' learning goals. Students' ability to construct their scientific knowledge could be attributed to their learning strategies and learning values. Motivation would be the catalyst for goal-directed science activities to continue (Pintrich & Schunk, 1996).

One of the goals of science education in schools is to improve students' scientific literacy (National Research Council [NRC], 1996). Students are required to master the essential science concepts, to relate the application of science knowledge in their daily lives, understand the nature and beauty of science, and most importantly continue pursuing science related subjects in higher education. Research in science classrooms must not only focus on learning, but instead also investigate what motivates students in learning the subject. Thus, the affective domain should also be given equal emphasis as compared to the cognition domain (Duit & Treagust, 1998; Lee & Brophy, 1996; Pintrich, Marx, & Boyle, 1993). In understanding the motivation to learn science, studies have explored the reasons students learn science, how hard they tried and the beliefs, emotions and feelings endured during this whole process (Glynn, Taasoobshirazi, & Brickman, 2009). Past research has shown motivation played a crucial role in science learning: the conceptual change processes, critical thinking, learning strategies, and science achievement (Kuyper, van der Werf, & Lubbers, 2000; Lee & Brophy 1996). In addition, motivation in learning science helps students build their own conceptual understanding of the subject (Cavas, 2011).

A few studies has been done on identifying factors in motivation and science learning and science achievement (Barlia & Beeth, 1999; Lee & Brophy, 1996). Previous researches have shown that students' low motivation is associated with low self-esteem, lack of responsibility, and strained family relationship (Erb, 1996). On the other hand, highly motivated students generally portray high intrinsic motivation attributes such as enjoying the lesson, strong personal interest, high commitment in the class, and strong belief in effort lead to success (Ng, Areepattamannil, Treagust, & Chandrasegaran, 2012).

Studies have established factors influencing motivation in learning science from the students' perspective such as general goals and affective components, achieving scientific understanding, interest in the subject and the results obtained in class, progress in scientific understanding and interpretation of what constitutes the task (Barlia & Beeth, 1999; Hynd, Holschuh, & Nist, 2000; Lee, 1989; Lee & Brophy, 1996; Nolen & Haladyna, 1989). According to Pintrich et al. (1993), self-efficacy, science learning values and students' learning goals are essential in the motivation of learning science. The students will get involved in the learning science if they believe in their ability and think that it is meaningful to take part in the science subject where their learning goal is to gain competence. Factors such as individual's goals toward the tasks, task value, and the learning environment influence students' learning motivation (Brophy, 2004; Pintrich & Schunk, 1996).

Combining the constructivist learning and motivation theories, Tuan, Chin, and Sheh (2005) found six important factors that were self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation for science learning motivation. Self-efficacy, active learning strategies, and science learning value are categorized as intrinsic motivation because these factors focus on the students' internal factor including how they perceive their ability, their value as well as their learning strategies in science. Meanwhile, performance goal, achievement goal, and learning environment stimulation are considered as extrinsic motivation. Performance goal and the achievement goal lead the students' learning motivation with the students' aims to impress their parents or teachers and to perform better than their peers. The learning environment comprises external learning factors such as teachers' teaching strategies, class activities, and the classroom environment that might enhance the student motivation in science learning (Tuan et al., 2005).

Students' motivation level in science learning has a significant effect on their academic achievement. Research showed that a positive relationship exists between academic achievement and motivation level. For instance, as the motivation level increases the higher the academic achievement scores (Bolat, 2007; Patrick, Kpangban, & Chibueze, 2007; Shih & Gamon, 2001). Altun (2009) discovered that students with low motivation have higher chances of failure in the subject. Students with higher motivation levels performed better in science compared to those with lower motivation levels. Similarly, Shih, and Gamon (2001), and Singh, Granville, and Dike (2002) had mentioned that students' motivation levels affect their academic performance. In conclusion, most of the studies show that academic achievement is affected by motivation level.

Purpose of Study

It is a well-known belief that students with higher motivation in learning would be more likely to do well in assessments. However, few studies have investigated the effects of motivation and the relationship with academic achievement for Asian students and Western students in particular for science subjects (Lay, Ng, & Chong, 2015; Palmer, 2007). Hence this article would like to contribute to the literature on how the types of motivation affect science achievement.

The purpose of this study is threefold. First, we compare the intrinsic motivation and extrinsic motivation scores of Western and Asian students in learning science. Second, the study investigates whether there is any difference in students' levels of motivation and their science achievement. Third and finally, the study explores the relationship between the motivation levels of students' and their science performance. This study will attempt to answer the following research questions:

1. What is the intrinsic and extrinsic motivation of Western and Asian students in learning science?
2. Is there any significant difference in the levels of motivation and science achievement between Western and Asian students?
3. Is there any significant relationship between the types of motivation and science achievement between Western and Asian students?

As this study intends to investigate how extrinsic and intrinsic motivation affect science achievement, it would be interesting to know whether students with different combinations of these two motivation differ in science performance. Given the interest in cultural differences, we are also interested to assess any culture-specific effects, namely Western (U.S. and England) versus Asian (Malaysia and Singapore) countries. Generally, the Western education system emphasizes individuality and diversity in learning. It values creativity over conformity, and eschews rote memorization and drill learning. Students in the Western education system are encouraged to have fun while learning. On the other hand, the Asian education system emphasizes exercises and testing. It is also important to avoid criticism, ridicule, and rejection and to win approval and acceptance, which is more reserved and conservative (Ma, 2012; Zappia, 2014). This means that students in Asian classrooms will speak less because they tend to fear voicing views that the teacher or fellow students will find unacceptable. The Western education system generally encourages active student participation in the classroom by sharing ideas and some believe that this will lead to better academic achievement. But contrary to this common belief, according to the latest international student assessment report such as PISA and TIMSS, East Asian countries are the top achievers in the international assessments.

In this study, the United States and England are selected to represent the Western education system while Malaysia and Singapore were chosen to represent the Asian education system. Malaysia and Singapore were selected to represent the Asian students because both countries have similarities in terms of educational systems, cultural background, ethnicity, multilanguages, and geographical location (OECD, 2014).

Singaporean students have maintained their high mathematics and science achievement scores in international assessments such as TIMSS and this has always been a topic of interest for researchers. The United States is used as the benchmark in this study because of its science and technology advancement while England was chosen due to its strong influence on the education system in Malaysia and Singapore; therefore it is used as a comparison in this study. Hence, it might be interesting to see if there is any difference in terms of motivating factors and levels in science achievement among the Western countries and Asian countries.

METHODS

This study utilized the correlation research design. The sampling technique of this study follows the TIMSS 2011 sample design. In the TIMSS study, the two-stage random sample design was employed in two stages, with a sample of schools drawn at the first stage and selection of one or more intact classes of students in the second stage (Joncas & Foy, 2012). The population of this study consists of Grade 8 students from the United States, England, Singapore, and Malaysia.

Samples

The samples of this study involved eighth grade students only from the United States, England, Malaysia, and Singapore who participated in TIMSS 2011. This international assessment is the fifth series of comparative studies to assess student achievement in mathematics and science at the fourth and eighth grades. The total number of Grade 8 (13 -14 years) participants was 9,713 from the United States, 3,842 from England, 5,409 from Malaysia, and 5,804 from Singapore.

Measures

Twenty-six items were selected from three main questions selected in this motivation study are from the questionnaires provided by TIMSS 2011. Each item is presented as a Likert-type item scored using a 4-point response ranging from "1" (*Agree a lot*) to "4" (*Disagree a lot*). The scale was developed to measure individuals' perceptions of motivation regardless of their actual achievement in the science subject. The selected questions are grouped into two main factors: intrinsic motivation and extrinsic motivation as summarized in Table 1. There are 13 items each in the self-constructed intrinsic and extrinsic motivation factors. All positive Likert-type items are converted into ascending order score with "1" (*Disagree a lot*) to "4" (*Agree a lot*). Then each of the items is summed under the motivation categories, resulting in the total values of 52 and 56 points for each category. All the analyses conducted in the following sections were performed using the weighted data (TOTWGT, total student weight --sums to the national population). TOTWGT is used to represent the actual national population size to compute all the significance tests to mitigate the sample bias issue. The Likert-type items listed in Table 1 are used to test for the relationship between science achievement and intrinsic/extrinsic motivation factors. The Cronbach's alphas are used in assessing the consistency and reliability of the Likert-type items in each motivation category. In general, the alpha values are .875 and .896 for intrinsic and extrinsic motivations, suggesting adequate reliability of the Likert-type items in each category. These two forms of motivation were positively correlated with the Pearson coefficient of 0.8 at 1% significance level.

To address the construct validity of the TIMSS questionnaire, a factor analysis was conducted on all the items from the questionnaire. Using the principal component analysis and varimax rotation produced six factors with Eigen values greater than one. Items with loadings greater than .5 were retained in the six factors. The factor pattern showed that (a) Factor 1 was measured by five items and was called self-efficacy; (b) Factor 2 was measured by three items and was named active learning strategies; (c) Factor 3 was represented by five items was named science learning; (d)

Table 1
Selected variable description

	Motivation factors	Questionnaires	Variable names
Intrinsic motivation	1. Self-efficacy	1. I like science	BSBS17F
		2. Science is not one of my strengths	BSBS19C
		3. Science makes me confused and nervous	BSBS19E
		4. Science is harder for me than any other subject	BSBS19I
		5. I would like a job that involves using science	BSBS19N
	2. Active learning strategies	1. I read about science in my spare time.	BSBS17C
		2. I learn things quickly in science	BSBS19D
		3. I need science to learn other school subjects	BSBS19K
	3. Science learning value	1. I enjoy learning science.	BSBS17A
		2. I wish I did not have to study science.	*BSBS17B*
		3. Science is boring	*BSBS17D*
		4. I learn many interesting things in science	BSBS17E
		5. I think learning science will help me in my daily life	BSBS19J
Extrinsic motivation	1. Performance goal	1. I know what my teacher expects me to do	BSBS18A
		2. Science is more difficult for me than for many of my classmates	*BSBS19B*
		3. I am good at working out difficult science problems	BSBS19F
	2. Achievement goal	1. It is important to do well in science	BSBS17G
		2. I usually do well in science	BSBS19A
		3. I need to do well in science to get into the <university> of my choice	BSBS19L
		4. I need to do well in science to get the job I want	BSBS19M
	3. Learning environment stimulation	*1. I think of things not related to the lesson*	*BSBS18B*
		2. My teacher is easy to understand	BSBS18C
		3. I am interested in what my teacher says	BSBS18D
		4. My teacher gives me interesting things to do	BSBS18E
		5. My teacher thinks I can do well in science <programs/classes/lessons> with difficult materials	BSBS19G
		6. My teacher tells me I am good at science	BSBS19H

Note: The variable names are the coded variable from the TIMSS 2011 international database. The sentence in *italics* represents a negative statement.

Factor 4 was represented by three items and was labeled performance goal; (e) Factor 5 was measured by four items and named achievement goal; and (f) Factor 6 was represented by six items called learning environment stimulation. Self-efficacy, active learning strategies, and science learning value were grouped under intrinsic motivation whereas performance goal, achievement goal, and learning environment stimulation were grouped under extrinsic motivation based on the construct validation study done by Tuan et al. (2005).

RESULTS

To answer the first research question on "What are the intrinsic and extrinsic motivation of Western and Asian students in learning science?", descriptive statistics were utilized. Table 2 presented the mean and standard deviation of the students' intrinsic and extrinsic motivation scores. The intrinsic motivation mean scores were higher for students from the Malaysia (*M* = 38.64) and Singapore (*M* = 38.63) when compared to United States (*M* = 36.64) and England (*M* = 37.93) students. However, the extrinsic motivation mean scores were higher for students in Western countries (*M* = 39.46) when compared to Malaysian (*M* = 37.26) and Singaporean (*M* = 37.94) students. When analyzing the standard deviation scores for intrinsic motivation and extrinsic motivation, Western students obtained a higher value than the Asian students in learning science. This informs us that the spread of the motivation scores in Western countries is slightly bigger than for their Asian counterparts. In other words, the motivation scores in learning science for Western students are more inconsistent than their Asian counterparts.

Table 3 compares the science achievement of students according to their level of motivation scores. Students' motivation scores were divided into three

Table 2
Means and standard deviations of intrinsic and extrinsic motivation scores

Country	Sample Size	Mean	*SD*
Panel A: Intrinsic Motivation			
U.S.	9,713	36.64	8.72
England	3,455	37.93	8.43
Malaysia	5,409	38.64	7.18
Singapore	5,804	38.63	7.91
Panel B: Extrinsic Motivation			
U.S.	9,713	39.46	7.83
England	3,455	39.46	7.18
Malaysia	5,409	37.26	6.77
Singapore	5,804	37.94	7.08

Note: Maximum scores are 52 for both intrinsic and extrinsic motivation scores.

categories of low, medium, and high. The scores were divided into three equally distributed groups, in which, the lowest 33% belongs to low, the highest 33% belongs to the high category, and the rest belongs to medium group. The results showed that all students from the four countries with high intrinsic motivation scores also had the highest mean in science achievement. Similarly, students with high extrinsic motivation scores also were the best performers in science achievement. Interestingly, science achievements of students with high intrinsic motivation scores are better than those with high extrinsic motivation between each of the four countries. However, students with low extrinsic motivation scored higher in science achievement than students with low intrinsic motivation between all the countries except the United States. Science achievement scores for students with low intrinsic motivation in Singapore were the highest, followed by England, the United States, and Malaysia in the same category. The science achievement scores for students with low extrinsic motivation showed a similar result. When comparing students with medium motivation scores, the results showed that students with intrinsic motivation performed better than students with extrinsic motivation in the United States and England. However, students with medium extrinsic motivation performed better than students with medium intrinsic motivation in Malaysia. In Singapore, there is no noticeable difference for student in this medium motivation category. The reported Cohen's effect size is large for the science achievement in the low and high motivation categories. However, the effect size is much lower for extrinsic motivation compared

Table 3
Means and standard deviations of science achievement grades for intrinsic and extrinsic motivation

	Motivation Scores						
	Low		Medium		High		Effect Size
Country	*n*	Mean (SD)	*n*	Mean (SD)	*n*	Mean (SD)	d
	Panel A: Intrinsic Motivation						
U.S.	4,218	503.42 (2.78)	2,373	530.37 (2.96)	3,123	559.79 (2.90)	0.72
England	1,309	508.67 (5.04)	889	540.18 (5.37)	1,257	566.76 (5.15)	0.79
Malaysia	1,721	387.33 (7.70)	1,662	424.13 (5.80)	2,026	465.83 (6.02)	0.81
Singapore	1,972	554.55 (4.35)	1,611	591.11 (4.47)	2,221	622.62 (4.86)	0.74
	Panel B: Extrinsic Motivation						
U.S.	2105	497.69 (3.62)	2,888	516.16 (2.62)	4,720	549.22 (2.78)	0.60
England	685	510.93 (5.94)	1,228	528.50 (4.84)	1,645	556.04 (5.56)	0.57
Malaysia	1,426	395.42 (8.69)	2,227	431.81 (6.02)	1,822	449.00 (6.30)	0.53
Singapore	1,460	557.61 (4.76)	2,293	591.17 (4.25)	2,051	614.03 (5.33)	0.58

Note: The effect size was calculated based on the mean difference between the High and Low science achievement grades and the means are all significantly difference at 1% level.

to intrinsic motivation. This indirectly indicates that there is a significant difference in science achievement scores between the low and high motivation categories. Besides, the results also show the effect size in science achievement is higher for intrinsic motivation than extrinsic motivation for all the four countries. The effect size between 0.2 and 0.5 is categorized as small; for effect size between 0.5 and 0.8 is categorized as medium and for effect size greater than or equal to 0.8 is categorized as large (Nunally & Bernstein, 1994). In other words, there is a significant difference in science achievement based on the motivation categories.

Table 4 presents the correlation between science achievement score and type of motivation. The correlation coefficients were tested using Pearson correlation test and all the estimated coefficients are significant at 1% level. Malaysian students have the highest significant correlation score of 0.35 between intrinsic motivation and science achievement, followed by Singapore, the United States, and England. The correlation between science achievement and extrinsic motivation among the United States students had the highest value of 0.29, followed by the other three countries. All the four countries obtained a higher correlation between intrinsic motivation and science achievement than the correlation between extrinsic motivation and science achievement. Interestingly, there are significant differences between the correlation for intrinsic and extrinsic motivation with science achievement with Malaysian students having the largest difference among the four countries. When extrinsic and intrinsic motivation is combined as a single motivation factor, the correlation with science achievement showed that Malaysian students obtained the highest correlation of 0.32, followed by England with 0.30 and both the United States and Singapore with 0.29.

Table 4
Correlation coefficients between science achievement scores and motivation scores

	Science Achievement vs. Motivation factors		
Country	Intrinsic	Extrinsic	Intrinsic + Extrinsic
U.S.	0.32	0.29	0.29
U.K.	0.31	0.24	0.30
Malaysia	0.35	0.24	0.32
Singapore	0.32	0.24	0.29

Note: All the correlation coefficients are tested using Pearson correlation test. All the estimated coefficients are significant at 1% level.

DISCUSSION

This present investigation based on cross-country analyses focuses on motivation factors in influencing science achievement among eighth grade students. The motivation factors (intrinsic and extrinsic) were evaluated using the selected questions from the TIMSS 2011 survey.

As shown in Table 2, students from the Western culture obtained a higher mean score in extrinsic motivation than their Asian students. This suggested that students in Western countries value extrinsic motivation higher than intrinsic motivation when learning science in consistent with the view of educational psychologists. Teachers play an important role in students' learning in the Western culture by encouraging and making learning fun. However, the results showed that students in Asian countries value intrinsic motivation higher than extrinsic motivation in learning science. This suggests that students from the Asian culture have a positive attitude in learning science and value the importance of science that is similar to the findings by Zhu and Leung's (2011).

The science achievement results of Singaporean students' were better than Malaysian students even though both countries had quite similar motivation scores. This may be due to the coherent and rigorous science curriculum in Singapore and the selection of the top performing students to be science teachers. Another reason for the differences in results might be due to the fact that almost 41% of science teachers in Malaysia do not have an undergraduate degree, which may have an effect in the subject delivery in the classrooms (Academy of Science Malaysia [ASM], 2015).

The findings in Table 3 describe the low, medium, and high motivation score of students and their science achievement score. One of the interesting findings is that students with high intrinsic motivation perform better than students with high extrinsic motivation across the four countries. This would indicate that self-efficacy is an important factor for students who perform well in science achievement across the Western and Asian cultures. The results showed that students with low extrinsic motivation have higher science achievement scores than students with low intrinsic motivation indicate that other external factors such as encouragement from teachers and parents play a more important role that students' own self efficacy in science achievement. The findings of large effect size of the low and high motivation categories further support how motivation factors are related to science achievement (Ng et al., 2012).

Despite the weak correlation between motivation factors and science achievement, the correlation between intrinsic motivation and achievement was substantially higher than the extrinsic motivation. Malaysian students' science achievement scores also experience wider spread (with higher standard deviation) across all the categories. On the other hand, the United States has the smallest spread (ranging from 2.80-3.58). This implies that U.S. students are more consistent in their achievement if they have about the same motivation scores, while Malaysian students' science achievements are not that consistent even though they fall under the same level of motivation. The correlation between different motivation scores (intrinsic, extrinsic, and combination of intrinsic and extrinsic) and achievement scores are not too different among the four countries ranging from 0.29-0.32. The finding of weak correlation indicates that there might be other contributing factors in science achievement besides motivation in learning.

The present results show although Singaporean students' achievement scores are higher than that for the other countries, their intrinsic and extrinsic motivation factors are not much different from the rest. Surprisingly, Singaporean and Malaysian students' motivations scores are quite similar in both motivation categories. The most interesting findings are the intrinsic motivation scores are higher in the Asian countries than the Western countries and the opposite is observed for extrinsic motivation. In congruence with Zhu and Leung's (2011) cultural difference theory in education, the results presented here emphasize intrinsic motivation factor is higher than external motivation among the Asian students and vice versa for the Westerners.

Implications

The findings of this study suggest several important implications for educators. Students with high intrinsic motivation also perform well in their science achievement. This study also implies that the educators and parents play a prominent role in exposing students to the benefits of science not only to increase their high self-efficacy toward science but to also produce high-quality learning and creativity. On the other hand, students with low extrinsic motivation have a higher science achievement score than students with low intrinsic motivation. This reflects the significant impact of extrinsic motivation in student performance in science. Educators should not just depend on students' intrinsic motivation in learning science but more efforts are needed in stimulating students' motivation and interest in science learning. Sometimes certain learning tasks are uninteresting but with extrinsic motivation students would take the effort to learn science. Educators should learn how to use extrinsic motivation as a pedagogical tool for effective teaching in science, such as student-centered learning, interactive learning session, and science workshops (Brophy, 2004; Pintrich & Schunk, 1996). This would help students to perform better in science examinations. Students with performance goals from extrinsic motivation would have a stimulus to learn new science skills and be hungry for knowledge.

CONCLUSION

This study investigates student intrinsic and extrinsic motivation factors pertaining to science achievement using the TIMSS 2011 data on eighth grade level students in four selected countries, such as the United States and England in representing the Western educational system and Malaysia and Singapore in representing the Asian educational system. In conclusion, the findings of the present study lend empirical support for the relations of motivation and science achievement scores among the eighth grade students. The cross-country analyses support the existing motivation theory in academic achievement, in which higher motivation leads to higher achievement scores. This phenomenon generally holds true for all the countries under the study of different cultural and social background. Last but not least, the underlying cultural differences in learning raise important issues on student motivation.

To sum up, the present analysis made three important points. First, students from Asian countries value intrinsic motivation highly while the Western students rate extrinsic motivation highly in learning science. However, the spread of the motivation scores in Western countries is slightly bigger than for their Asian counterparts. Second, self-motivation (intrinsic) is more dominant in achieving higher science scores when compared to external motivation (extrinsic) among the Western and Asian students. In addition, there is a significant difference in science achievement based on the motivation categories for all students. Third, there is a stronger correlation between intrinsic motivation and science achievement than extrinsic motivation and science achievement across the four countries.

Future research based on this study with more comprehensive investigation can be done by including the social economic factors and motivation factors in influencing academic achievement. This study can also be extended to examine the intrinsic and extrinsic motivational orientations in other subjects from the Western and Asian educational system perspective. It would also be interesting to understand the stimulating factors of intrinsic motivation among highly motivated students in schools (Ryan & Deci, 2000). Researchers should also consider developing a structural equation modeling of the motivation factors and science achievement. By enhancing both intrinsic and extrinsic motivation, this maximizes the interest of learning science among the students in achieving higher scores and also generates fun in learning.

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