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Do the Demographic Differences Manifest in Motivation to Learn Science and Impact on Science Performance? Evidence from Sri Lanka

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Abstract The present study examined whether gender, ethnicity, instructional medium and school category differences manifest in science performance and motivation to learn science among secondary school students in Sri Lanka. The mean of five successive term test scores was used as the measure of science performance. Level of motivation in terms of six dimensions was measured by using the Science Motivation Questionnaire. A sample of 1316 grade 11 students representing Sinhala, Tamil, and Muslim ethnic groups from the three categories of public schools, which provide instructions in the vernacular languages of Sinhala or Tamil, participated in the study. Girls showed significantly higher performance in science compared to boys, and there was a significant gender difference in the levels of motivational dimensions in favor of girls. Although Tamil medium students possessed a higher level of motivation to learn science, Sinhala medium students outperformed their Tamil medium counterparts in science performance. Significant differences in science performance between Sinhala, Tamil, and Muslim students were also observed. However, motivation towards learning science between Tamils and Muslims was not significantly different. Highly significant differences in both motivation to learn science and performance in science were found between three categories of schools. The present study provides information to education officials who have to achieve equity across gender, ethnicity, medium of instruction, and school category, teachers who deliver the subject and school principals who design academic support programs.

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The aim of the present study is to investigate how differences in students' demography manifest in motivation to learn science and impact on performance in science among secondary school students in Sri Lanka. The examination of students' attitudes towards learning science has been a characteristic feature of the science education researches in the past few decades. Its current global importance is emerging from the prevailing evidence of the developmental decline in science motivation among students and the falling numbers of students choosing to pursue the study in the field of science (Gottfried, Marcoulides, Gottfried, & Oliver, 2009; Kiemer, Gröschner, Pehmer, & Seidel, 2015; Nyamba & Mwajombe, 2012; Vedder-Weiss & Fortus, 2011). Especially during the secondary school career, this developmental decline has been reported (Galton, 2009; Osborne, Simon, & Collins, 2003; Vedder-Weiss & Fortus, 2011). Motivation to learn science has become a matter of global concern (Osborne & Dillon, 2008), because it is strongly associated with students' performance in science (Williams & Williams, 2011). Research studies carried out with a particular focus on students' motivation towards learning science document that there is a correlation between students' motivation and their performance in science (Atta & Jamil, 2012; Chow & Yong, 2013; Glynn, Taasoobshirazi, & Brickman, 2007, 2009). In order to explain students' motivation, it is important to investigate what contributes to it (Bryan, Glynn, & Kittleson, 2011). Because the demographics of students continue to change, investigating differences in motivation for groups of students is necessary. Although some studies have examined differences in motivation to learn science by gender (Bryan et al., 2011; Chow & Yong, 2013), ethnicity (Barton, 2002; Leaper, Farkas, & Brown, 2012; Stedman, 2009), or ability group (Chow & Yong, 2013), demographic variables are not always considered (Obrentz, 2012; Zusho, Pintrich, & Coppola, 2003).

Therefore, the present study attempts to fill the knowledge gap existing in terms of the effect of demographic variables on motivation to learn science and science performance. In particular, the present study investigates how gender, medium of instruction, ethnicity, and school category differences manifest in motivation to learn science as measured in terms of the six dimensions described within the social cognitive framework (Bandura, 2001; Schunk, 2001) and impact on science performance. An in-depth examination of the factors affecting science performance in secondary school has a great importance because it is the period of life that students contemplate and negotiate their future trajectories (Singh, Granville, & Dika, 2002). The rest of this article is composed of an overview of general education system of Sri Lanka, a literature review, which examines the theoretical and empirical background of the study, the research methodology applied, research findings, discussions, and conclusions, respectively.

General Education System of Sri Lanka

Out of the three main ethnic groups, Sinhalese is the largest ethnic group in Sri Lanka that can be distinguished primarily by their mother tongue, Sinhala. The second largest ethnic group collectively known as Tamils uses the Tamil language as their native tongue. Muslims, the third largest ethnic group, comprise a group of people practicing the religion of Islam. The majority of Muslims also uses Tamil Language as their mother tongue. Therefore, public schools provide instruction either in Sinhala or Tamil language, which leads to categorize them as Sinhala medium and Tamil medium schools.

In the Sri Lankan secondary school curriculum, science is a compulsory subject for all the students from Grades 6 to 11. Students of all levels of ability in the cohort follow the same science curriculum offered by all categories of public schools. A comparison of Sri Lankan public schools based on the *School Census Preliminary Reports 2016* (Ministry of Education, 2016) is given in Table 1 in order to elaborate the findings of the present study.

Sri Lankan children are entitled to get admission to their nearest public school. At grade 6, however, 1AB schools enroll a group of students, who perform well in the national level examination known as Grade 5 Scholarship Examination. The average number of students in 1AB schools is very high compared to the other types. Although per pupil expenditure on public schools is the same, the government has taken special measures to upgrade infrastructure facilities, mainly in selected 1AB schools situated in all over the country. As a result, 1AB schools are generally well-equipped compared to the other categories.

Literature Review

Without focusing only on student cognition, research in science teaching and learning should also address the affective component to cognition (Tuan, Chin, & Shieh, 2005). Within the affective components, motivation is very important because students' motivation plays a vital role in science performance (Pintrich, 2003; Williams & Williams, 2011). In the following subsections, demographic factors manifest in motivation to learn science and impact on science performance is briefly discussed.

Table 1 A profile of the public schools in Sri Lanka

School category	Number of schools	Number of students	Number of teachers	Average number of students	Student teacher ratio	Grade spans
1AB	1016	1,626,565	76,012	1601	21	Grades 1–13 or 6–13 with advanced level science stream
%	10.0	39.2	32.7			
1C	1805	1,034,743	60,001	573	17	Grades 1–13 only with advanced level arts and/or commerce streams
%	17.8	25.0	25.8			
Type 2	3408	826,255	61,586	242	13	Grades 1–11
%	33.5	20.0	26.5			
Type 3	3933	655,767	35,004	167	19	Grades 1–5 or 1–8
%	38.7	15.8	15.0			
Total	10,162	4,143,330	232,603		18	
%	100	100	100			

Students' Performance in Science

Enormous attempts are being made by almost all the countries around the world to enhance the quality of their science education with the view of developing scientific literacy which is essential in the contemporary world. Trends in International Mathematics and Science Study (TIMSS), however, indicates that science achievement of the majority of the participating countries is low. In 2011, nationally representative samples of grade 8 students from 63 countries participated in TIMSS. Only 16 countries achieved in science above the TIMMS scale centerpoint of 500 (Martin, Mullis, Foy, & Stanco, 2012).

Based on a national level study conducted in Sri Lanka to assess grade 8 students' science performance, the National Education Research and Evaluation Centre (NEREC), University of Colombo, reports that only 33% of students scored more than 50 marks out of 100 in 2014 (NEREC, 2015). The Department of Examination (DOE) reports that out of the grade 11 students who sat for GCE (Ordinary Level) Examination in 2016, only 29% were able to achieve more than 50 marks out of 100 in science (DOE, 2017).

Motivation to Learn Science

Social cognitive theory presented by Bandura (2001, 2005) describes motivation as an internal state that arouses, directs, and sustains individuals' goal-oriented behavior. With a particular focus on science, the theory defines *motivation to learn science* as "an internal state that arouses, directs, and sustains science-learning behavior" (Glynn et al., 2009). The motivation to learn is a multi component construct, which consists of types and attributes of motivation (Glynn & Koballa, 2006). Intrinsic motivation, extrinsic motivation, relevance to personal goals, self-determination, self-efficacy, and test or assessment anxiety are considered as key constructs within the self-regulatory system that strengthen a child's overall motivation to learn and, subsequently, achievement (Bandura, 2001; Schunk, 2001). These constructs have been treated as dimensions of students' overall motivation to learn science (Chow & Yong, 2013; Glynn & Koballa, 2006; Glynn et al., 2009).

Glynn and Koballa (2006) designed the Science Motivation Questionnaire (SMQ) to serve as empirical indicators of the above mentioned six dimensions of students' motivation towards learning science in college courses. Later, the SMQ was revised to target positive, mutually supporting motivators. Therefore, test anxiety items were removed. In addition, extrinsic motivation was transformed into two scales, namely grade motivation and career motivation (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). The revised SMQ is referred to as the Science Motivation Questionnaire II (SMQ-II). Both questionnaires are being extensively used in the current motivational researches related to college students as well as school students (Barak, Ashkar, & Dori, 2011; Chow & Yong, 2013; Ersoy & Aliçka, 2016; Salta & Koulougliotis, 2015), because they combine a number of key motivational dimensions in a single scale and their validity has been established (Salta & Koulougliotis, 2015; Zeyer et al., 2013). The following paragraphs summarize studies on motivational dimensions and students' performance, with a main focus on the studies conducted at the secondary level by using SMQ or SMQ-II.

The doing of a task for its inherent contentment rather than for some other separable results is known as intrinsic motivation and the doing of a task because it leads to a separable outcome is referred to as extrinsic motivation (Ryan & Deci, 2000; Xie, Debacker, & Ferguson, 2006). Ersoy and Aliçka (2016) adapted the SMQ to measure secondary school students' motivation to learn physics and reported that the six dimensions described a total of 59.653% of the variance, in which intrinsic and extrinsic motivation contributing 26.517 and 10.013%, respectively. Correlations between motivation to learn science and performance in science have been reported in terms of both intrinsic and extrinsic motivation (Chow & Yong, 2013; Glynn et al., 2011).

In relation to science, personal relevance is the relevance of learning science to a student's personal goals (Cavallo, Rozman, Blinkenstaff, & Walker, 2003). Interventions that encourage students to make connections between their lives and what they are studying in science classes increase their course grades (Hulleman & Harackiewicz, 2009). If the scientific content is understandable, relevant, and interesting, students get motivated to learn science (Holbrook, Rannikmäe, Yager, & De Vreese, 2003; Osborne & Collins, 2001). For a group of Bruneian secondary school students, Chow and Yong (2013) reported a low correlation coefficient of 0.21 between personal relevance and performance in science. For a group of Turkish high school students, the level of personal relevance was the lowest out of six motivational dimensions (Tüysüz, Yıldıran, & Demirci, 2010).

The control and choice that students have over the subject content and the way that content to be learned is defined as self-determination (Glynn & Koballa, 2006; Reeve, Nix, & Hamm, 2003). Self-determination plays an important role in children's motivation to learn science (Lavigne, Vallerand, & Miquelon, 2007). Chow and Yong (2013) as well as Glynn et al. (2011) reported a positive correlation between self-determination and performance in science. In Turkey, Tüysüz et al. (2010) observed that the level of university students' self-determination over science learning was higher than that of the high school students.

According to Bandura (1997), self-efficacy is "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). More specifically, in relation to science, the same is defined as the belief of students' ability that they can perform well in science (Baldwin, Ebert-May, & Burns, 1999). Researchers have confirmed that there is an association between self-efficacy and students' science performance at all levels (Adnan & Akbas, 2006; Britner, 2008; Britner & Pajares, 2006; Bryan et al., 2011). For a group of Bruneian secondary school students (Chow & Yong, 2013) as well as for a group of college students in the USA (Glynn et al., 2011), a significant and positive correlation between self-efficacy and achievement in science is found.

Test anxiety is referred to as a psychological condition of mind in which a child indicates uncertainty, concern, fear, and helplessness prior to, throughout, or after a test (Olatoye & Afuwape, 2003). In contrast to the dimensions of motivation described so far, test anxiety is commonly reported to have a negative relationship with the academic performance. Olatoye (2009) found test anxiety as an important predictor, which had a negative effect on students' performance in science among the secondary school students in Nigeria. Some other researchers (Cassady & Johnson, 2002; Chapell et al., 2005; Chow & Yong, 2013; Lin, McKeachie, & Kim, 2002) also reported similar results with respect to the test anxiety.

Gender Difference Manifested in Science Performance

In many scientific disciplines, males outperformed females in achievement tests (Grigg, Lauko, & Brockway, 2006; Miyake et al., 2010). By conducting a cross-cultural evaluation of science performance, TIMMS uncovered that at the eighth grade level, on average across the participated countries, girls outperformed boys (Amunga, Amadalo, & Musera, 2011; Martin et al., 2012). But, the boys were better performers in physics, while the girls were better in biology and chemistry. According to a study conducted in the USA, eighth grade girls completed the school year with lower science achievement marks than boys, and the significance of this disparity continuously increased during secondary school (Bacharach, Baumeister, & Furr, 2003). In terms of gender, a significant difference was not observed in science performance among junior secondary students in Nigeria (Afuwape, 2011; Olatoye, 2009; Oludipe, 2012) and in Brunei Darussalam (Chow & Yong, 2013). In Sri Lanka, a series of national assessment studies revealed that girls' performance in science was higher than that of the boys (NEREC, 2008, 2013, 2015). For instance, girls achieved an average of 42.80%, while boys achieved 39.41% in 2014 (NEREC, 2015).

Gender Difference Manifested in Motivation to Learn Science

Many researchers investigated how gender manifested in the six motivational dimensions described above. However, only several studies have been conducted taking all six dimensions together to examine the effect of gender on motivation to learn science (Chow & Yong, 2013; Glynn et al., 2007; Zeyer, 2010). Evidence accumulated so far, however, is inconclusive. While some researchers (Ayub, 2010; Lai et al., 2006) evidenced that there were differences between male and female students in relation to intrinsic and extrinsic motivation, some others found no difference (Glynn et al., 2009; Rusillo & Arias, 2004). Hon-Keung, Man-shan, and Lai-fong (2012) reported that there was no gender difference manifested in intrinsic motivation towards learning science. Although science is traditionally known as a masculine-stereotyped subject, some researchers uncovered a higher level of relevance for learning science among girls (Çetin-Dindar & Geban, 2010; Chow & Yong, 2013). Self-determination was higher among female students as reported in some studies (Glynn et al., 2011; Glynn et al., 2009), while there was no significant difference as evidenced by some other studies (Bryan et al., 2011; Chow & Yong, 2013). Among the motivational dimensions, self-efficacy has been extensively explored. While some researchers (Glynn et al., 2011; Glynn et al., 2009) reported that self-efficacy was higher among male students, some others reported that there was no significant difference between two groups (Bryan et al., 2011; Chow & Yong, 2013). Many researchers uncovered a higher level of test anxiety among female students than male students (Chapell et al., 2005; Chow & Yong, 2013; Glynn et al., 2009). But, Olatoye (2009) found no gender difference in test anxiety among a group of Nigerian secondary school students.

Ethnicity Difference Manifested in Performance in Science and Motivation to Learn Science

Characteristics, which are identical to a specific ethnic group, bring different styles of students' views, values, and strategies in their process of learning (Turingan & Yang, 2009). For instance, Kohlhaas, Lin, and Chu (2010) found that there were significant differences in science performance between different ethnic groups of grade 5 students and ranked the science scores of ethnic groups in the USA. White students got the first rank and Asian, Hispanic, and African American got second, third, and fourth places, respectively. Among the three significant variables affecting students' performance in science, namely ethnicity, gender, and poverty, ethnicity was the one which most significantly influenced on their performance. Stedman (2009) found that European American students outperformed Hispanic students. The black-white science gap was somewhat greater than it had been in the early 1990s. Leaper et al. (2012) exposed that among 13–18-year-old American girls, White European American girls scored significantly higher than Latina girls on the measures of both motivation to learn science and science grades. Girls from other ethnic backgrounds scored in the middle. Weinburgh (2000), however, found no difference between White and African American students' motivation to learn science. In Malaysia, there was a significant difference in chemistry performance between Malay, Chinese, and Indian students (Veloo, Hong, & Lee, 2015).

Disparities in science performance have been reported with respect to the medium of instruction, which is directly associated with the ethnicity of secondary school students in Sri Lanka. In the national level studies on science performance, Sinhala medium students have outperformed the Tamil medium students (NEREC, 2008, 2013, 2015). For instance, Sinhala medium students achieved the average score of 44.30%, while Tamil medium students achieved the average score of 32.38% in 2014 (NEREC, 2015).

School Category Difference Manifested in Performance in Science and Motivation to Learn Science

Among the factors affecting students' performance in science, school and its resources play an important role. Based on TIMMS 2011 results, Martin et al. (2012) revealed that students in the schools, which were not affected by resource shortages, had higher average science achievement than their counterparts in the less well-resourced schools worldwide. Stedman (2009) uncovered that American nonpublic school students' performance in science was higher than that of the public school students. Studies in Sri Lanka also found large disparities in students' science performance between the three types of public schools (NEREC, 2008, 2013, 2015). Students attending 1AB schools clearly outperformed those in 1C and Type 2 schools. In 2014, 1AB schools achieved the national average performance of 49.18%, while 1C and Type 2 schools achieved the national averages of 33.0 and 31.2%, respectively. The cumulative percentage of students, who scored less than the pass mark in 1AB schools, was only 20.8%. But, the same cumulative percentages of 1C and Type 2 schools were 69.3 and 77.4%, respectively (NEREC, 2015).

Research Methodology

This section describes the research framework, population, selection of the sample, and the adaptation process of the survey instrument.

Research Framework

The present research study applies the quantitative research method using the survey design. Students' demographic factors, namely gender, medium of instruction, ethnicity, and school category, are taken as independent variables, while students' science performance and motivation towards learning science are taken as dependent variables. The average of term test scores in science for three school terms in 2015 and first two terms in 2016 was taken as the measure of students' science performance. By administering the SMQ developed by Glynn and Koballa (2006), students' level of motivation towards learning science was measured. The test scores were collected from, and the questionnaire was administered to the grade 11 students in public schools. The data were analyzed by applying independent sample *t* test and one-way ANOVA using SPSS for Windows version 17.

Population and Sampling

The population of interest was the cohort of secondary school grade 11 students who had almost completed the grade 6–11 science course. In the period of data collection, they were getting ready for GCE (Ordinary Level) Examination to be held in December 2016. The sample comprised a group of students from all nine provinces. Within a province, the highest performing educational zone and the lowest performing educational zone were selected based on zonal level performance in the GCE (Ordinary Level) Examination held in December, 2015. From each selected zone one 1AB school, one 1C school and one Type 2 school were randomly chosen. From each selected school, one class of grade 11 students, which was nominated by the principal, participated in the study. Out of the total of 1316 students, 619 were boys and 697 were girls. The average age of the respondents was 16 years.

Science Motivation Questionnaire

The SMQ composed of 30 self-assessment items to be marked with a 5-point Likert type scale ranging from one for *never* to five for *always*. The SMQ items combine the six dimensions of motivation discussed above. There are five items coming under each dimension and they are randomly arranged. For the 30 items in the SMQ, the minimum score that a student can get is 30 and the maximum is 150, which is an indicator of the level of overall motivation. The test anxiety items are reverse scored when added to the total, so a high score on this dimension means less test anxiety (Glynn et al., 2009). Students who score for the SMQ in the range of 30–69, 70–109, and 110–150 are treated as having low, moderate, and high level of overall motivation, respectively. Students' level of motivation in each dimension is determined by adding up the scores of all five items under each dimension. The minimum and the maximum scores for each dimension are 5 and 25, respectively. Those who score in the range of 5–11.7, 11.8–18.3, and 18.4–25 are considered as bearing a low, moderate, and a high level of motivation in the particular dimension, respectively.

The SMQ was translated into Sinhala and Tamil. In translating a questionnaire from one language to another, it is necessary to consider whether the original questionnaire is validated, whether it is possible to validly translate the questionnaire items, and whether the translated questionnaire is valid (Griffee, 1998). Glynn et al. (2009) have established evidence for the construct validity of the original questionnaire, while other researchers (e.g. Chow & Yong, 2013; Salta & Koulougliotis, 2015; Zeyer et al., 2013) have acknowledged it as a valid tool. To assure that questionnaire items are validly translated, the procedure proposed by

Spielberger and Sharma (1976) was followed. First, two native speakers of Sinhala and Tamil languages who are fluent in English and senior science educators of the National Institute of Education, Sri Lanka, separately translated the SMQ into two languages. Second, the translated versions were back translated into English by two other senior science educators from the same institute who are blind to the original questionnaire. The cross-language equivalence between the original SMQ and the translated versions was established by administering them to a group of bilingual students.

Minor changes were made to a few items of the SMQ so that they were compatible with the local context. For instance, the term “science course” in the item 12 was replaced with “science subject” as the original term is not familiar to the Sri Lankan respondents. Another change was made to the item 15 by replacing the term “grade point average” with “average score” as students’ grade point average is not reported in Sri Lankan schools.

Finally, the following measures were taken to assure the validity and reliability of the translated questionnaires. The face validity of the Sinhala and Tamil medium questionnaires was established by a group of science teachers and respective language teachers. Then, the questionnaires were subjected to a pilot test with a group of 64 Sinhala and 58 Tamil medium students in July 2016. From each medium, 15 students who participated in the pilot study were interviewed using the orientation and four questions given in Glynn et al. (2009).

Followed by the pilot study, the reliability of the questionnaires was determined in terms of Cronbach’s alpha. The alpha value of the 30 items in Sinhala and Tamil medium questionnaires was 0.889 and 0.854, respectively. Each sub-scale had the alpha value greater than 0.7. Bivariate correlation analysis showed a significant positive correlation of 0.625 between students’ motivation to learn science and performance in science. Similarly, six dimensions of motivation also had statistically significant associations with the performance. As each student’s level of motivation determined by the SMQ was highly in line with the same determined by the interview, the validity of translated questionnaires was confirmed.

Research Findings

At the outset of this section, statistics are provided to support the reliability of survey instruments adapted for local languages. Thereafter, the results of statistical analysis illustrating the differences in students’ performance and motivation to learn science in terms of demographic variables are presented.

Reliability of Science Motivation Questionnaire

The reliability of questionnaires in terms of Cronbrach’s alpha is given in Table 2. Because all alpha values in the table are greater than the threshold value of .7, all 30 items together and each set of items under motivational dimensions are appropriate to measure motivation to learn science. The SMQ translated into other languages has also shown alpha value within the range of .8 to .9 (Çetin-Dindar & Geban, 2010; Mai, Yusuf, & Saleh, 2015).

Table 2 Reliability of questionnaires in terms of Cronbach's alpha values

	Sinhala Medium	Tamil Medium
Overall motivation	.894	.861
Intrinsic motivation	.828	.839
Extrinsic motivation	.806	.773
Personal relevance	.827	.838
Self-determination	.733	.781
Self-efficacy	.802	.785
Test anxiety	.749	.758

A Demographic Profile of the Respondents

A demographic profile of 1316 students in terms of gender, medium of instruction, ethnicity, and school category is given in Table 3. The percentage of girls in the sample is higher than boys. Percentages of students representing two mediums and three ethnic groups approximately represent the national level compositions of those two criterions. At the national level, percentage of 1AB students is the highest. In the sample, however, their representation is slightly lower than that of the 1C school students.

Science Performance in Terms of Gender, Medium of Instruction, Ethnicity, and School Category

To test if there was a significant difference in science performance between male and female, the independent sample t test was applied. Table 4 shows the results. As shown in Table 4, girls' science performance is higher than that of the boys. Here, the homogeneity of variances assumption was met as assessed by Levene's test of equality of variances, and the p value (<.001) of the t test was significant. Therefore, there is a statistically significant difference in science performance between girls and boys.

Table 3 A demographic profile of the students participated in the study

		Frequency	Percentage %
Gender	Male	619	47.0
	Female	697	53.0
Medium	Sinhala	905	68.8
	Tamil	411	31.2
Ethnicity	Sinhala	898	68.2
	Tamil	287	21.8
	Muslim	128	9.7
School Type	1AB	486	36.9
	1C	493	37.5
	Type 2	337	25.6

Table 4 Performance in science based on gender

	Gender	*N*	Mean	Std. deviation	*t*	*df*	Sig. (two-tailed)
Science performance	Male	619	42.4847	15.61483	−4.205	1314	.000*
	Female	697	46.0574	15.17653			

$^*p < .05$

The independent sample *t* test was run to see if there was a significant difference in students' performance in science with respect to the medium of instruction. The results are given in Table 5. Sinhala medium students have achieved a higher science performance than their Tamil medium counterparts. The *t* test confirms that the difference in science performance between Sinhala and Tamil medium students is statistically significant.

Students' performance in science with respect to the ethnicity is presented in Table 6. Performance of Sinhala students is the highest. While Tamil students have achieved the second highest science performance, Muslim students have achieved the lowest.

To test if there are significant differences in science performance between three ethnic groups, a one-way ANOVA was run. The results are presented in Table 7. The *p* value of the test revealed that at least one pair of ethnic groups differs from each other in terms of science performance. Tukey's post hoc test was applied to identify the pairs, which were significantly different from each other. Those pairs are also shown in the last column of Table 7.

Statistically significant differences in science performance were observed between Sinhala and Tamil as well as between Sinhala and Muslim students. However, there was no statistically significant difference between Tamils and Muslims.

Descriptive statistics of students' performance in science with respect to the school category are given in Table 8.

Students of 1AB schools outperformed their counterparts in both 1C and type 2 schools. To find if there is a statistically significant difference in students' science performance between three types of schools, a one-way ANOVA was run. Table 9 presents the results.

The test confirmed that at least one pair was different from each other in terms of science performance. As assessed by Tukey's post hoc test, pairs of schools with a statistically significant difference in performance are also shown in Table 9.

Table 5 Performance in science based on the medium of instruction

	Medium	*N*	Mean	Std. deviation	*t*	*df*	Sig. (two-tailed)
Science Performance	Sinhala	905	46.2628	15.80426	−2.987	1314	.003*
	Tamil	697	43.2504	15.26470			

$^*p < .05$

Table 6 Students' performance in science with respect to the ethnicity

	N	Mean	Std. deviation
Sinhala	898	48.4	15.1
Tamil	287	43.5	15.3
Muslim	128	41.7	16.1
Total	1316	44.4	15.5

Motivation to Learn Science in Terms of Gender, Medium of Instruction, Ethnicity, and School Category

The level of overall motivation and levels of motivation in terms of each dimension are presented in Table 10. The average level of overall motivation, which is 100.43, indicates that students are moderately motivated to learn science.

Out of the six dimensions, intrinsic motivation, extrinsic motivation, and self-efficacy were at a high level; personal relevance and self-determination were at a moderate level; test anxiety was at a low level. As test anxiety was determined by the reversed scores, it should be considered that students have a high anxiety towards science tests and exams.

Table 11 presents the differences in overall motivation and motivational dimensions in terms of gender. By referring the test statistics of Levene's test, to test if gender difference in overall motivation and its dimensions are statistically significant either *t* test or non-parametric statistics (Mann-Whitney *U*) were conducted. Test results confirmed that overall motivation and all motivational dimensions significantly differed in terms of gender. The female students' level of overall motivation and motivational dimensions except self-determination were higher than their male counterparts.

The difference in medium of instruction manifested in motivation to learn science was also tested. The descriptive statistics are given in Table 12. The level of overall motivation and levels of motivational dimensions were higher among Tamil medium students. Further testing confirmed that the differences were statistically significant.

By referring the *p* value of Levene's test, either ANOVA or non-parametric statistics (Kruskal-Wallis test, based on rank) were used to test if the level of motivation and its dimensions differ between students of three ethnicities. To identify the pairs with a statistically significant difference, either Tukey's post hoc test or Dunnette's T3 procedure was used. Table 13 presents descriptive statistics and pairs with significant differences.

Table 7 Comparison of students' science performance with respect to the ethnicity

	Sum of squares	*df*	Mean square	*F*	Sig.	Different pairs
Between groups	6378.770	3	2126.257	9.034	.000	Sinhala-Tamil
Within groups	308,796.287	1312	235.363			Sinhala-Muslim
Total	315,175.058	1315				

Table 8 Students' performance in science with respect to the school category

	N	Mean	Std. deviation
1AB	486	51.0	15.0
1C	493	43.7	14.1
Type 2	337	35.9	13.8
Total	1316	44.4	15.5

The level of overall motivation between all three ethnicities showed a statistically significant difference. Tamils and Sinhalese as well as Tamils and Muslims had statistically significant differences in relation to intrinsic motivation, personal relevance, and self-efficacy. Level of extrinsic motivation showed a statistically significant difference between the pairs of Sinhalese-Tamil and Sinhalese-Muslim. In terms of self-determination, Sinhalese-Muslim and Tamil-Muslim pairs showed statistically significant differences. Only Tamils and Sinhalese differed from each other with respect to the test anxiety.

Table 14 presents differences in the level of motivation in terms of the school category. The level of overall motivation showed a statistically significant difference between 1AB-1C and 1C-Type 2 pairs. The same pairs were different in terms of extrinsic motivation. Intrinsic motivation of 1AB-1C and 1AB-Type 2 pairs had a statistically significant difference. In terms of the level of self-efficacy, only 1AB and Type 2 school students differed from each other.

Finally, a bivariate correlation analysis was done between overall motivation and its dimensions with science performance. The results are shown in Table 15.

As given in Table 15, motivation to learn science alone and its dimensions separately show statistically significant associations with science performance. Only the test anxiety has a negative association, while motivation to learn science and its other dimensions have positive associations with science performance.

Discussion and Conclusion

The present study provides information essential to the educational officials who are to achieve equity across gender, medium of instruction, ethnicity, and different categories of schools, teachers who deliver the subject, and school principals who are to design academic support programs to enhance students' motivation and performance.

Table 9 Comparison of students' science performance with respect to school category

	Sum of squares	*df*	Mean square	*F*	Sig.	Different pairs
Between groups	45,464.112	2	22,732.056	110.664	.000	1AB – 1C
Within groups	269,710.945	1313	205.416			1AB – Type 2
Total	315,175.058	1315				1C – Type 2

Table 10 Level of overall motivation and motivational dimensions

	Minimum	Maximum	Mean	Std. deviation	Level of motivation
Overall motivation	59.00	129.00	100.4	11.5	Moderate
Intrinsic motivation	7.00	25.00	19.6	4.0	High
Extrinsic motivation	6.00	25.00	19.6	4.1	High
Personal relevance	6.00	25.00	18.2	4.1	Moderate
Self-determination	5.00	24.00	13.2	3.9	Moderate
Self-efficacy	5.00	25.00	19.1	4.0	High
Test anxiety	5.00	23.00	10.7	3.7	Low

By using the SMQ, the present study confirms that there is a positive association between students' performance in science and motivation towards learning science. With the help of the same instrument, other researchers have also established the same (Chow & Yong, 2013; Glynn & Koballa, 2006; Glynn et al., 2009). Although science has traditionally been a masculine-stereotyped subject, the present study reveals that secondary school girls' science performance is higher than that of the boys in Sri Lanka. Other studies have also reported the same in relation to the Sri Lankan context (NEREC, 2008, 2013, 2015). This finding is highly in line with the girls' higher level of motivation towards learning science compared to the boys and the significant association of motivation with performance as revealed in the present study. Girls' higher performance in science may be resulted due to the fact that girls do not attribute their success to the ability, but to the effort and hard work (Meece, Glienke, & Burg, 2006). Therefore, before concluding that differences in science performance are generated by gender, educators and educational researchers need to be sensitive to the high

Table 11 Gender differences manifested in motivation to learn science

	Gender	*N*	Mean	Std. deviation
Overall motivation	Male	619	98.0	12.1
	Female	696	102.5	10.4
Intrinsic motivation	Male	619	18.6	4.3
	Female	696	20.4	3.6
Extrinsic motivation	Male	616	18.7	4.3
	Female	693	20.4	3.7
Personal relevance	Male	619	17.6	4.2
	Female	697	18.7	4.0
Self-determination	Male	619	13.6	3.8
	Female	697	12.9	4.0
Self-efficacy	Male	619	18.1	4.3
	Female	697	20.1	3.6
Test anxiety	Male	619	11.5	3.9
	Female	697	10.0	3.4

Table 12 Medium of instruction differences manifested in motivation to learn science

	Medium	*N*	Mean	Std. deviation
Overall motivation	Sinhala	904	98.7	11.6
	Tamil	404	104.3	10.2
Intrinsic motivation	Sinhala	905	18.9	4.0
	Tamil	410	20.9	3.7
Extrinsic motivation	Sinhala	905	19.0	4.2
	Tamil	411	20.8	3.6
Personal relevance	Sinhala	904	18.0	4.1
	Tamil	405	18.5	4.3
Self-determination	Sinhala	905	13.0	3.8
	Tamil	411	13.8	4.2
Self-efficacy	Sinhala	905	18.6	4.0
	Tamil	411	20.4	3.8
Test anxiety	Sinhala	905	11.1	3.7
	Tamil	411	9.9	3.6

Table 13 Ethnicity differences manifested in motivation to learn science

		N	Mean	Std. deviation	Different pairs
Overall motivation	Sinhala	898	98.6	11.6	Sinhala-Tamil
	Tamil	287	105.5	9.4	Sinhala-Muslim
	Muslim	128	101.6	11.2	Tamil-Muslim
Intrinsic motivation	Sinhala	898	18.9	4.1	Sinhala-Tamil
	Tamil	287	21.6	3.4	Tamil-Muslim
	Muslim	128	19.3	3.8	
Extrinsic motivation	Sinhala	898	19.0	4.2	Sinhala-Tamil
	Tamil	287	21.0	3.4	Sinhala-Muslim
	Muslim	128	20.2	3.9	
Personal relevance	Sinhala	898	18.0	4.1	Sinhala-Tamil
	Tamil	287	19.0	4.2	Tamil-Muslim
	Muslim	128	17.6	4.2	
Self-determination	Sinhala	898	13.0	3.8	Sinhala-Muslim
	Tamil	287	13.4	4.5	Tamil-Muslim
	Muslim	128	14.6	3.1	
Self-efficacy	Sinhala	898	18.6	4.0	Sinhala-Tamil
	Tamil	287	20.9	3.4	Tamil-Muslim
	Muslim	128	19.3	4.1	
Test anxiety	Sinhala	898	11.1	3.7	Sinhala-Tamil
	Tamil	287	9.6	3.5	
	Muslim	128	10.5	3.7	

Table 14 School category differences manifested in motivation to learn science

		N	Mean	Std. deviation	Different pairs
Overall motivation	1AB	486	101.9	11.3	1AB-Type 2
	1C	493	100.6	10.9	1C-Type 2
	Type 2	337	98.1	12.2	
Intrinsic motivation	1AB	486	20.1	4.0	1AB-1C
	1C	493	19.4	3.9	1AB-Type 2
	Type 2	337	19.1	4.2	
Extrinsic motivation	1AB	486	20.2	3.8	1AB-Type 2
	1C	493	19.7	4.0	1C–Type 2
	Type 2	337	18.4	4.4	
Personal relevance	1AB	486	18.7	4.2	1AB-Type 2
	1C	493	18.1	4.0	
	Type 2	337	17.6	4.1	
Self-determination	1AB	486	13.0	3.8	
	1C	493	13.3	4.0	
	Type 2	337	13.5	4.0	
Self-efficacy	1AB	486	19.5	4.0	1AB-Type 2
	1C	493	19.2	3.9	
	Type 2	337	18.5	4.3	
Test anxiety	1AB	486	10.4	3.7	
	1C	493	10.9	3.7	
	Type 2	337	11.0	3.9	

correlation between motivation towards learning science and performance in science as evidenced by the current research.

As per the present study, Sri Lankan students possess higher levels of intrinsic and extrinsic motivation towards learning science. Zhu and Leung (2011) found that while a higher level of extrinsic motivation exerts a detrimental effect on the Western students' learning, utilizing intrinsic and extrinsic motivation in promoting students' learning is more effective for Asian students. Therefore, especially in the Asian countries, teachers by integrating constructivist approaches to science teaching and parents through the effective involvement in science learning need to make more efforts to enhance

Table 15 Correlations of overall motivation and its dimensions with science performance

	Overall motivation	Intrinsic motivation	Extrinsic motivation	Personal relevance	Self-determination	Self-efficacy	Test anxiety
Pearson Correlation	.609**	.406**	.460**	.448**	.122**	.422**	−.190**
Sig. (two-tailed)	.000	.000	.000	.000	.000	.000	.000
N	1316	1316	1316	1316	1316	1316	1316

**Correlation is significant at the 0.01 level (two-tailed) students' intrinsically and extrinsically motivated science learning, which will lead to the development of performance in science.

As found in the present study, Sinhala medium students outperformed their Tamil medium counterparts. This result is consistent with the studies conducted by NEREC (2008, 2013, 2015). This disparity has existed in the Sri Lankan education system for many decades. Although Sinhala medium students' performance in science is higher than that of Tamil medium students, it is noteworthy that the level of motivation to learn science is higher among Tamil medium students. Most of the Tamil medium students participated in this study were from the underdeveloped Northern and Eastern provinces, where Tamil and Muslim ethnic groups are highly concentrated. They were also highly affected by the civil war, which lasted for 30 years in Sri Lanka. After ending the civil war, however, the government and non-governmental organizations have taken so many steps to rehabilitate these areas with a particular focus on children for last 8 years. Higher level of motivation to learn science among Tamil and Muslim students may occur as a result of these attempts as well as special programs launched by those schools. The lower science performance among ethnic groups can be ascribed to any or all of the issues such as insufficient learning opportunities in the curriculum, instruction, evaluation, school organization, educational policies, and a failure to link with children's homes and community environments (Lee & Luykx, 2007). The education system of any country, which caters students from diverse cultural backgrounds, needs to take appropriate measures to address the aforesaid issues. Performance gaps between ethnic groups that exist in such systems can be minimized by making science more relevant to their socio-cultural lives (Seiler, 2001), reconciling the subject content with students' cultures and languages (Lee & Fradd, 1998), incorporating the real-world problems together with community participation (Bouillion & Gomez, 2001), incorporating the understanding of non-mainstream cultures and languages with the assessment process (Solano-Flores & Trumbull, 2003), and preparing teachers with the knowledge, skills, and attitudes needed for culturally responsive teaching (Gay, 2002).

While all the schools are implementing the same curriculum, providing the free education together with textbooks and uniform, and enjoying the pupil-teacher ratio of lower level particularly by 1C and Type 2 schools, wide gaps in students' performance and motivation towards science are found between school categories. Especially in the developing countries, these gaps are simply seen as consequences of the disparities in resource allocation among schools. Therefore, educational authorities always pay attention to the provision and development of physical and human resources, leaving the significance of nurturing students' affective domain. Many researchers have, however, reported that the provision of school resources affects the development of students' performance to a lesser extent in both developing and developed countries (Borg, Borg, & Stranahan, 2012; Hanushek, 2006). Therefore, without delaying to eradicate resource disparities first, and then develop students' affective components such as motivation latter, making both efforts parallel may result improved students performance as well as enhanced productivity of investments on school education in the developing countries.

Motivation and performance are certainly multidimensional and are not susceptible to easy measurement in terms of a small range of assumed factors. In addition, they depend on many other variables. Therefore, focusing only on six dimensions of motivation and four demographic variables affecting motivation and performance is a limitation of the study.

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