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Secondary Students' Perceptions of Assessments in Science, Technology, Engineering, and Mathematics (STEM)

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The problems of the decreasing enrolment of science students at secondary school level as well as the lagging science and mathematics achievement and literacy of Malaysian secondary students in international assessment studies point to a serious challenge for the government to improve Science, Technology, Engineering and Mathematics (STEM) education. One of the key steps that can be taken is to identify the current assessments in STEM related subjects at the secondary school level because according to OECD (2005), assessment is an integral component of the education process. Thus, this study (which is part of a larger research project) aimed to examine secondary students' perceptions of assessments in STEM related subjects. The researchers employed a cross-sectional survey research design and the sample comprised of 1215 Form Four students from three categories of secondary schools in Peninsular Malaysia. A five-point Likert scale questionnaire containing 10 items was used to elicit Form Four students' perceptions of assessments such as examinations or assignments in STEM related subjects. The questionnaire was developed based on the STEM Education Quality Framework (2011). Analysis of 1005 complete questionnaires from the sample indicated that the students showed positive overall perceptions of assessments in STEM related subjects. The results also indicated that there was a statistically significant difference in overall perceptions of assessments in STEM related subjects in terms of school category but there was no statistically significant difference in overall perceptions of assessments in STEM related subjects in terms gender.

Keywords: STEM, secondary students, assessments, gender, school category

INTRODUCTION

Malaysia needs a new workforce of problem solvers, innovators, and inventors who have the knowledge and skills to innovate and compete in the new global marketplace. As Science, Technology, Engineering, and Mathematics (STEM) education forms the core technological underpinnings of an advanced society, a key to producing and sustaining this new workforce is improving STEM education in our country. STEM education is an interdisciplinary area of study that bridges the four disciplines of science, technology, engineering, and mathematics. In fact, in any country the strength of the STEM workforce is viewed as a strong indicator of the nation's ability to generate ideas towards the creation of innovative products and services

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State of the literature

- Science is perceived as largely irrelevant to most people, physics is particularly difficult, males are more likely to be attracted to science and technology than females, there is a perceived lack of practical/investigation sessions in school science, and most school students' interest in science declines from the final year of primary schooling through secondary school
- Majority of students state that they enjoy school science but would not consider study of STEM related subjects beyond compulsory education or a STEM related career.
- Students show positive perceptions of accounting career. But, there are gender differences in some areas in their perceptions of accounting career.

Contribution of this paper to the literature

- Lack of studies that specifically examine secondary students' perceptions of assessments in STEM related subjects.
- This study employed a questionnaire consisting of 10 quality STEM learning experiences based on the STEM Education Quality Framework (2011) to elicit Form Four students' perceptions of assessments in STEM related subjects.
- This study will help resolve the decreasing interests in STEM subjects at the secondary level as well as create ways to inspire and motivate students to embark on STEM disciplines at the tertiary level by providing quality STEM learning experiences

as well as to sustain itself. This is due to the fact that STEM literate students have the ability to identify, apply and integrate concepts from science, technology, engineering, and mathematics to understand complex problems and to innovate to solve them (National Governors Association, n.d.).

However, there are several problems in improving STEM education in our country. The first problem lies in the decreasing enrollment of science students at secondary school level as reported by the Ministry of Science, Technology and Innovation (2012) in the Science and Technology Human Capital Roadmap: Towards 2020:

> *"The current enrolment ratio of 20 to 80 for Science and Arts students is extremely low compared to the targeted ratio of 60:40. The low ratio indicates that the supply of human resources has never been inclined towards science and technology even though the programme has been introduced since 1967. The reasons of the declining interest among young people for science studies are blamed largely to the school's system or curriculum in teaching science, unattractive career path and lack of incentives. Currently, there are 29 Research Scientists and Engineers (RSE) for every 10,000 workforce in Malaysia. The ratio is considered very low compared to the world competitiveness ranking which is discouraging for a nation that aspires to be a developed nation (Science and Mathematics Cluster Committee, the National Council of Professors 2011)" (p. 6).*

The second problem lies in the lagging science achievement and literacy of Malaysian secondary students in international assessment studies. More specifically, the 1999, 2003, 2007 and 2011 Trends in the International Mathematics and Science Study (TIMSS) results showed a worrying trend in the secondary students' science achievement. The average scale scores for science in TIMSS 1999 and TIMSS 2003 were 492 and 510, which were higher than the international average of 488 and 473, respectively. But in TIMSS 2007 and TIMSS 2011 the average scale scores declined to 471 and 426, respectively and these average scale scores were lower than the TIMSS 2007 and TIMSS 2011 scale average of 500 (Martin, et al., 2000, 2004, 2008, 2012). In addition, Malaysia was ranked 52nd in science literacy among 74 countries which participated in the Program for International Student Assessment (PISA) conducted by the Organisation of Economic Cooperation and Development (OECD) in 2009. In particular, the average score of Malaysian students was 422 which was much lower than the international average of 463 and even much lower than the OECD average of 501 where our closest neighbour, Singapore, was ranked 4th with an average score of 542 (OECD, 2010).

The third problem is the lagging mathematics achievement and literacy of Malaysian secondary students in international assessment studies. More specifically, the 1999, 2003, 2007, and 2011 TIMSS results indicated a more worrying trend in the secondary students' mathematics achievement than in the science achievement. In TIMSS 1999 the average scale score for mathematics was 519 which was higher than the international average of 487. In TIMSS 2003 although the average scale score for mathematics was still higher than the international average of 466, it declined from 519 in TIMSS 1999 to 508. But, in TIMSS 2007 and TIMSS 2011 the average scale scores declined further to 474 and 440, respectively and these average scale scores were lower than the TIMSS 2007 and TIMSS 2011 scale average of 500, respectively (Mullis, et al., 2000, 2004, 2008, 2012). Further, Malaysia was ranked 57th in mathematics literacy among 74 countries which participated in the PISA 2009 conducted by the OECD. In particular, the average score of Malaysian students was 404 which was much lower than the international average of 458 and even much lower than the OECD average of 496 where our closest neighbour, Singapore, was ranked 2nd with an average score of 562 (OECD, 2010).

These major problems point to a serious challenge for the government to improve STEM education and improve the enrolment of students into the STEM fields at the secondary education level. One of the key steps to be taken is to identify the current assessments in STEM related subjects at the secondary school level because according to OECD (2005), assessment is an integral component of the education process. Assessment can be summative which measures what students have learnt through tests and examinations. It can also formative which measures student progress and understanding during teaching and learning in classroom. Traditionally, the information collected from assessment was used to certify the results of student achievement and streaming students. However, a strong case has been put forth within the last decade to widen the purpose of assessment beyond the traditional view (McMillan, 2004). Assessment should support students' learning of STEM related subjects and provide useful information to both teachers and students. It is integral to teaching and learning process that informs and guides teachers as they make instructional decisions to enhance students' learning. In short, assessment should not merely be done to students but also it should be done for students in order to guide and enhance their learning (National Council of Teachers of Mathematics, NCTM, 2000).

Further, when assessment is properly designed and appropriately used in classroom practice it can contribute to more effective instruction and greater student learning (Gronlund, 2006). In fact, research findings indicate that making assessment an integral part of instruction in classroom practice is associated with improved student learning (NCTM, 2000). In a review of about 250 research studies, Black and Wiliam (1998) concluded that in classrooms where teachers include attention to formative assessment in making judgments about teaching and learning, students' learning, including low achievers, is generally enhanced. As such, it is important to explore students' perceptions of the current assessments in STEM related subjects at the secondary school level so that steps can be taken to improve assessment practices in STEM related subjects.

In general, there were some gender differences in science and mathematics achievement in international assessment studies. Specifically, in the TIMSS 2011 fourth grade science assessment, of the 50 participating countries 23 had no significant gender difference in science achievement whereas of the 27 remaining countries, 16 had relatively small differences favouring boys, and 3 had relatively small differences favouring girls. Eight countries had relatively larger differences favouring girls. However, in the TIMSS 2011 eighth grade science assessment gender differences in science achievement were larger, on average, than at the fourth grade, with the difference favouring girls. Likewise, the gender difference in the TIMSS 2011 eighth grade science assessment varied across countries, with no difference in 17 of the 42 participating countries, a difference favouring boys in 10 countries, and a difference favouring girls in the remaining 15 countries (Martin, et al., 2012).

In the TIMSS 2011 fourth grade mathematics assessment, of the 50 participating countries 26 had no significant gender difference in mathematics achievement whereas of the 24 remaining countries, 20 had small differences favouring boys, and 4 had relatively larger differences favouring girls. But, in the TIMSS 2011 eighth grade mathematics assessment gender differences in mathematics achievement were larger, on average, than at fourth grade, with the difference favouring girls. Similarly, the gender difference in the TIMSS 2011 eighth grade mathematics assessment varied across countries, with no difference in 22 of the 42 participating countries, a difference favouring boys in 7 countries, and a difference favouring girls in the remaining 13 countries (Mullis, et al., 2012).

In addition, Freeman (2004) found that there was little significant difference between boys' and girls' mathematics scores in the National Assessment of Educational Progress. The scores fluctuated year by year, but the average scores of boys in calculus, computer science, and science on Advanced Placement examinations were higher than those of girls.

Azina and Awang (2012) examined the relationship between student and background factors and mathematics achievement among secondary school students in Malaysia using the the TIMSS 2007 data. They found that female, educational resources, students' attitude, homework and school environment have significant positive effect on mathematics performance. However, there is lack of research on gender differences in students' perceptions of assessments in STEM education in the literature. Thus, it is also important to explore gender differences in students' perceptions of the current assessments in STEM related subjects at the secondary school level so that help can be provided to male or female students to improve assessment practices in STEM related subjects.

OBJECTIVES OF THE STUDY

The primary objective of this study was to elicit Form Four students' perceptions of assessments in STEM related subjects. The secondary objectives were to determine whether there were significant differences in the perceptions of assessments in STEM related subjects in terms of gender and school category. Specifically, this study aimed to address the following research questions:

What were Form Four students' perceptions of assessments in STEM related subjects?
Was there a statistically significant difference in the students' perceptions of assessments in STEM related subjects between male and female students?
Was there a statistically significant difference in the students' perceptions of assessments in STEM related subjects among Daily High-Performing, Full Boarding High-Performing and Daily Normal schools?

METHODOLOGY

Research design and sample

The researchers employed a cross-sectional survey research design as it was effective for providing a snapshot of the current secondary students' perceptions of assessments in STEM related subjects in a population (Gay, Miles & Airasian, 2011). The sample comprised 1215 Form Four students from three categories of secondary schools in Peninsular Malaysia, namely Daily High-Performing (149), Full Boarding High-Performing (172) and Daily Normal (684). However, 1005 students from the sample completely answered the questionnaire. These students comprised 571 females and 434 males. Table 1 shows the distribution of these students in each school category.

Instrument

The instrument used to elicit Form Four students' perceptions of assessments in STEM related subjects consisted of a questionnaire which had two sections, namely Section A and Section B. Section A contained items on the students' demographic data such as gender and school category. Section B contained 10 items on assessments in STEM related subjects. Examples of STEM related subjects in the secondary school curriculum are Biology, Chemistry, Physics, Science, Health Science, Integrated Living Skills, Mathematics and Additional Mathematics. The 10 items on assessments in STEM related subjects in the questionnaire were developed by the researchers based on the STEM Education Quality Framework (2011). The framework was developed by the Dayton (Ohio) Regional STEM Center in collaboration with Dr. James Rowley of the University of Dayton's School of Education and Allied Professions. It consists of 10 quality STEM learning experiences: (1) Potential for engaging students of diverse academic backgrounds; (2) Degree of STEM integration; (3) Connections to non-STEM disciplines; (4) Integrity of the academic content; (5) Quality of the cognitive task; (6) Connections to STEM careers; (7) Individual accountability in a collaborative culture; (8) Nature of assessment; (9) Application of the engineering design process; and (10) Quality of technology integration.

All the items in Section B had a five-point Likert scale response options, namely strongly disagree, disagree, not sure, agree and strongly agree. The students' responses to each item received weighted values from 1 (strongly disagree) to 5 (strongly agree).

Table 1. Number of students by school category and gender

		Gender		Total
		Male	Female	
School Category	Daily High-Performing	82	67	149
	Full Boarding High-Performing	59	113	172
	Daily Normal	293	391	684
Total		434	571	1005

Table 2. Means and standard deviations of students' perceptions of assessments in STEM related subjects

Item	Statement	*M*	*SD*
	The examinations or assignments in STEM related subjects that I had gone through took account of:		
1	my learning experience at school.	3.98	.90
2	my daily experience.	3.79	.91
3	the concepts related to these subjects in an integrated manner.	3.84	.80
4	the connections among these subjects.	3.91	.79
5	my ability to solve problems.	3.95	.80
6	my ability to manage project-type assignments.	3.77	.88
7	the method of thinking more deeply.	3.97	.85
8	the work done in a group.	3.91	.93
9	my understanding and skills regarding engineering design.	3.32	1.09
10	the use of multiple sources of information and technology.	3.85	.95
	Overall perceptions	3.85	.62

The questionnaire was piloted with a sample of 221 Form Four students and 170 students from the sample completely answered the questionnaire. The value of the Cronbach's alpha for all the items from the analysis of the 170 questionnaires was .83, indicating a high degree of internal consistency of the items in the questionnaire.

RESULTS

The results of this study are presented in the following sections according to the three main research questions:

(1) Students' perceptions of assessments in STEM related subjects

Table 2 shows the means and standard deviations of the 1005 Form Four students' perceptions of assessments in STEM related subjects for each item in the questionnaire and overall perceptions as well. As illustrated in Table 2, the means of the Form Four students' perceptions for all items in the questionnaire were above 3.00, suggesting that the students generally showed positive perceptions of assessments in STEM related subjects. The mean of the students' perceptions for Item 9 (3.32) was the lowest, indicating that the examinations or assignments in STEM related subjects that the students had gone through took the least account of their understanding and skills regarding engineering design. The highest mean of the students' perceptions was 3.98 (Item 1), suggesting that the examinations or assignments in STEM related subjects that the students had gone through took the most account of their learning experience at school. In addition, the mean of the students' overall perceptions was 3.85, indicating that they showed positive overall perceptions of assessments in STEM related subjects.

(2) Difference in the perceptions of assessments in STEM related subjects in terms of gender

Table 3 shows the results of the independent-samples t-tests using SPSS version 20 for Windows for each item in the questionnaire and overall perceptions of assessments in STEM related subjects. As shown in Table 3, the mean scores of the Form Four male and female students' perceptions of assessments in STEM related subjects are equal for Item 5. For Items 1, 2, 3, 4, 6 and 10, the mean scores of the Form Four male students' perceptions of assessments in STEM related subjects were lower than those of the female students. But, for Items 7, 8 and 9, the mean scores of the Form Four male students' perceptions of assessments in STEM related subjects were higher than those of the female students.

However, the differences in the mean scores for Items 1, 2, 3, 5, 6, 7, 8 and 10 were not statistically significant between male and female students at the significance level of .05, suggesting that there were no statistically significant differences in the perceptions of assessments in STEM related subjects as measured by these items between male and female students. Nevertheless, the differences in the mean scores for Item 4 and Item 9 were statistically significant between male and female students at the significance level of .05, indicating that there were statistically significant differences in their perceptions of the examinations or assignments in STEM related subjects that took account of the connections among these subjects as well as their understanding and skills regarding engineering design, favouring the female and male students for Item 4 and Item 9, respectively.

In addition, the mean score of the Form Four male students' overall perceptions of assessments in STEM related subjects was slightly lower than that of the female students. But, the difference in the mean scores for overall perceptions was not statistically significant between male and female students at the significance

Table 3. Results of the Independent-Samples *t*-Tests

Item		Male (n = 434)		Female (n = 571)		t	df	Sig. (2-tailed)
		M	SD	M	SD			
The examinations or assignments in STEM related subjects that I had gone through took account of:								
1	my learning experience at school.	3.97	.90	3.98	.90	-2.08	1003	.84
2	my daily experience.	3.77	.95	3.81	.87	-.58	1003	.56
3	the concepts related to these subjects in an integrated manner.	3.81	.84	3.87	.76	-1.05	877.31	.29
4	the connections among these subjects.	3.85	.81	3.96	.76	-2.30	901.18	.02*
5	my ability to solve problems.	3.95	.80	3.95	.80	.08	1003	.94
6	my ability to manage project-type assignments.	3.75	.91	3.78	.85	-.55	1003	.58
7	the method of thinking more deeply.	4.00	.83	3.95	.87	.90	1003	.37
8	the work done in a group.	3.94	.93	3.89	.92	.83	1003	.41
9	my understanding and skills regarding engineering design.	3.43	1.14	3.23	1.03	2.91	880.59	.00*
10	the use of multiple sources of information and technology.	3.84	1.00	3.86	.90	-.31	875.12	.76
	Overall perceptions	3.84	.63	3.85	.61	-.14	1003	.89

level of .05, indicating that there was no statistically significant difference in the overall perceptions of assessments in STEM related subjects in terms of gender.

(3) Difference in the overall perceptions of assessments in STEM related subjects in terms of school category

Table 4 shows the results of the one-way between subjects Analysis of Variance (ANOVA) using SPSS version 20 for Windows for each item in the questionnaire and the overall perceptions of assessments in STEM related subjects. From Table 4, it can be seen that the mean scores of the Form Four students' perceptions of assessments in STEM related subjects were the lowest in the Daily Normal Schools for all the items except for Item 8. For Item 8, the mean score of the students' perceptions of assessments in STEM related subjects was the same as that in the Daily High-Performing Schools.

Moreover, the differences in the mean scores for all the items (except for Item 9) were statistically significant among the Daily High-Performing, Full Boarding High-Performing and Daily Normal Schools at the significance level of .05, suggesting that there were statistically significant differences in the perceptions of assessments in STEM related subjects for all the items (except for Item 9) among the three categories of schools. Tukey's post hoc procedures (see Appendix 1) indicated that: (a) for Items 1, 4 and 10 there were no statistically significant differences in the perceptions of assessments in STEM related subjects between Daily High-Performing School and Full Boarding High-Performing School students but there were statistically significant differences (i) between Daily Normal School and Daily High-Performing School students, favouring the Daily High-Performing Schools in all cases and (ii) between Daily Normal School and Full Boarding High-Performing School students, favouring the Full Boarding High-Performing Schools in all cases; (b) for Items 2, 3, 6, and 8 there were statistically significant differences in the perceptions of assessments in STEM related subjects between Daily Normal School and Full Boarding High-Performing School students, favouring the Full Boarding High-Performing Schools in all cases but there were no statistically significant differences (i) between Daily Normal School and Daily High-Performing School students and (ii) between Daily High-Performing School and Full Boarding High-Performing School students; and (c) for Items 5 and 7 there were no statistically significant differences in the perceptions of assessments in STEM related subjects between Daily Normal School and Daily High-Performing School students but there were statistically

Table 4. Results of the one-way between subjects ANOVA

Item		Daily High-Performing (n = 149)		Full Boarding High-Performing (n = 172)		Daily Normal (n = 684)		F	T	Sig. (2-tailed)
		M	SD	M	SD	M	SD			
The examinations or assignments in STEM related subjects that I had gone through took account of:										
1	my learning experience at school.	4.13	.77	4.20	.76	3.89	.94	10.97	(2,1002)	.00*
2	my daily experience.	3.88	.85	4.02	.75	3.71	.95	8.58	(2,1002)	.00*
3	the concepts related to these subjects in an integrated manner.	3.86	.82	3.98	.72	3.80	.81	3.56	(2,1002)	.03*
4	the connections among these subjects.	4.06	.71	4.12	.69	3.83	.81	12.73	(2,1002)	.00*
5	my ability to solve problems.	4.00	.76	4.24	.77	3.87	.80	15.73	(2,1002)	.00*
6	my ability to manage project-type assignments.	3.81	.83	3.94	.84	3.71	.89	5.03	(2,1002)	.01*
7	the method of thinking more deeply.	4.03	.81	4.28	.67	3.88	.88	16.54	(2,1002)	.00*
8	the work done in a group.	3.88	.96	4.08	.88	3.88	.93	3.24	(2,1002)	.04*
9	my understanding and skills regarding engineering design.	3.37	1.11	3.32	1.13	3.30	1.07	.23	(2,1002)	.79
10	the use of multiple sources of information and technology.	4.07	.82	4.03	.88	3.76	.97	10.29	(2,1002)	.00*
	Overall perceptions	3.93	.61	4.02	.45	3.78	.65	12.34	(2,1002)	.00*

** significant at $p < 0.05$*

significant differences (i) between Daily Normal School and Full Boarding High-Performing School students, favouring the Full Boarding High-Performing Schools in both cases and (ii) between Daily High-Performing School and Full Boarding High-Performing School students, favouring the Full Boarding High-Performing Schools in both cases.

But, the difference in the mean scores for Item 9 was not statistically significant among the Daily High-Performing, Full Boarding High-Performing and Daily Normal Schools at the significance level of .05, indicating that there was no statistically significant difference in the students' perceptions of the examinations or assignments in STEM related subjects that took account of their understanding and skills regarding engineering design among the three categories of schools.

The mean score of the Form Four students' overall perceptions of assessments in STEM related subjects in the Daily Normal Schools was the lowest among the three categories of schools. Further, the difference in the mean scores for the overall perceptions was statistically significant among the three categories of schools at the significance level of .05. Thus, there was a statistically significant difference in the overall perceptions of assessments in STEM related subjects in terms of school category. Tukey's post hoc procedures (see Table 5) indicated that there were statistically significant differences in the perceptions of assessments in STEM related subjects between Daily Normal School and Daily High-Performing School students, favouring the Daily High-Performing School students as well as between Daily Normal School and Full Boarding High-Performing School students, favouring the Full Boarding High-Performing School students. But, there was no statistically significant difference between Daily High-Performing School and Full Boarding High-Performing School students.

DISCUSSION AND CONCLUSION

The results of this study showed that the students showed positive overall perceptions of assessments in STEM related subjects. However, the mean of the students' perceptions for Item 9 was the lowest, indicating that the examinations or assignments in STEM related subjects that the students had gone through took the least account of their understanding and skills regarding engineering design. According to the STEM Education Quality Framework (2011), engineering design is the formulation of a plan to help an engineer build a product which involves a number of steps such as brainstorming, researching, creating, testing and improving the product. However, this important multi-step process of engineering design is not being emphasized in the teaching and learning as well as assessment of most of the STEM related subjects at the secondary school level. This might be due to the fact that engineering design is not included in the syllabus of most of the STEM related subjects at the secondary school level. Thus, the results suggest that engineering design should be given greater emphasis not only in the teaching and learning of STEM related subjects but also in the assessment of those subjects at the secondary school level. This is because when assessment is properly designed and appropriately used in classroom practice it can contribute to more effective instruction and greater student learning (Gronlund, 2006).

The results also showed that there was no significant difference in the overall perceptions of assessments in STEM related subjects in terms of gender at the significance level of .05. Although there were no statistically significant differences in the perceptions of assessments in STEM related subjects between male and female students for Items 1, 2, 3, 5, 6, 7, 8 and 10 at the significance level of .05, there were statistically significant differences in their perceptions of the examinations or assignments in STEM related subjects that took account of the connections among these subjects (Item 4) and their understanding and skills regarding engineering design (Item 9), favouring the female and male students for Item 4 and Item 9, respectively. The results suggest that more help should be provided to male and female students to make connections among STEM related subjects and to improve their understanding and skills regarding engineering design, respectively. In general, these results on gender differences also concur with the results of TIMSS 2011 which show that there were some gender differences in science and mathematics achievement and the results of Freeman's (2004) study which show that there was little significant difference between boys' and girls' mathematics scores in the National Assessment of Educational Progress.

The results also indicated that there was significant difference in the overall perceptions of assessments in STEM related subjects in terms of school category at the significance level of .05. In particular, there were statistically significant differences in the perceptions of assessments in STEM related subjects between Daily Normal School and Daily High-Performing School students as well as between Daily Normal School and Full Boarding High-Performing School students, favouring the Daily High-Performing School and Full Boarding High-Performing School students, respectively. But there was no statistically significant difference between Daily High-Performing School and Full Boarding High-Performing School students. In fact, the mean scores of the Form Four students' perceptions of assessments in STEM related subjects were the lowest in the Daily Normal Schools for all the items except for Item 8. These results imply that the examinations or assignments in STEM related subjects that Daily Normal School students had gone through should take more account of their learning experience at school, the concepts related to these subjects in an integrated manner, the connections among these subjects, their ability to solve problems, their ability to manage project-type assignments, the method of thinking more deeply, their understanding and skills regarding engineering design as well as the use of multiple sources of information and technology.

In conclusion, we acknowledge our limitations in making any generalizations from the results of this study which used a cross-sectional survey research design and self-report questionnaire. Moreover, only 1005 out of the 1215 students in the sample completely answered the questionnaires. Nevertheless, the results of this study suggested for this sample of 1005 students that the students generally had positive overall perceptions of assessments in STEM related subjects.

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Appendix 1. Results of Tukey's post-hoc procedures

Item	(I) School Category	(J) School Category	Mean Difference (I-J)	Sig.
	Daily High-Performing	Full Boarding High-Performing	-.076	.725
		Daily Normal	.237*	.009
	Full Boarding High-Performing	Daily High-Performing	.076	.725
		Daily Normal	.313*	.000
	Daily Normal	Daily High-Performing	-.237*	.009
		Full Boarding High-Performing	-.313*	.000
2	Daily High-Performing	Full Boarding High-Performing	-.138	.357
		Daily Normal	.164	.109
	Full Boarding High-Performing	Daily High-Performing	.138	.357
		Daily Normal	.303*	.000
	Daily Normal	Daily High-Performing	-.164	.109
		Full Boarding High-Performing	-.303*	.000
3	Daily High-Performing	Full Boarding High-Performing	-.123	.348
		Daily Normal	.056	.712
	Full Boarding High-Performing	Daily High-Performing	.123	.348
		Daily Normal	.180*	.022
	Daily Normal	Daily High-Performing	-.056	.712
		Full Boarding High-Performing	-.180*	.022
4	Daily High-Performing	Full Boarding High-Performing	-.056	.796
		Daily Normal	.233*	.003
	Full Boarding High-Performing	Daily High-Performing	.056	.796
		Daily Normal	.289*	.000
	Daily Normal	Daily High-Performing	-.233*	.003
		Full Boarding High-Performing	-.289*	.000
5	Daily High-Performing	Full Boarding High-Performing	-.238*	.019
		Daily Normal	.135	.143
	Full Boarding High-Performing	Daily High-Performing	.238*	.019
		Daily Normal	.373*	.000
	Daily Normal	Daily High-Performing	-.135	.143
		Full Boarding High-Performing	-.373*	.000
6	Daily High-Performing	Full Boarding High-Performing	-.130	.378
		Daily Normal	.100	.412
	Full Boarding High-Performing	Daily High-Performing	.130	.378
		Daily Normal	.230*	.006
	Daily Normal	Daily High-Performing	-.100	.412
		Full Boarding High-Performing	-.230*	.006
7	Daily High-Performing	Full Boarding High-Performing	-.258*	.017
		Daily Normal	.148	.124
	Full Boarding High-Performing	Daily High-Performing	.258*	.017
		Daily Normal	.406*	.000
	Daily Normal	Daily High-Performing	-.148	.124
		Full Boarding High-Performing	-.406*	.000
8	Daily High-Performing	Full Boarding High-Performing	-.196	.139
		Daily Normal	.001	1.000
	Full Boarding High-Performing	Daily High-Performing	.196	.139
		Daily Normal	.197*	.034
	Daily Normal	Daily High-Performing	-.001	1.000
		Full Boarding High-Performing	-.197*	.034
9	Daily High-Performing	Full Boarding High-Performing	.049	.913
		Daily Normal	.066	.777
	Full Boarding High-Performing	Daily High-Performing	-.049	.913
		Daily Normal	.017	.981
	Daily Normal	Daily High-Performing	-.066	.777
		Full Boarding High-Performing	-.017	.981
10	Daily High-Performing	Full Boarding High-Performing	.038	.930
		Daily Normal	.307*	.001
	Full Boarding High-Performing	Daily High-Performing	-.038	.930
		Daily Normal	.269*	.002
	Daily Normal	Daily High-Performing	-.307*	.001
		Full Boarding High-Performing	-.269*	.002
Overall perceptions	Daily High-Performing	Full Boarding High-Performing	-.086	.421
		Daily Normal	.153*	.016
	Full Boarding High-Performing	Daily High-Performing	.086	.421
		Daily Normal	.239*	.000
	Daily Normal	Daily High-Performing	-.153*	.016
		Full Boarding High-Performing	-.239*	.000

* *significant at* $p < 0.05$