Differences between gender and Higher-order thinking skills

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Abstract. This study aimed to identify the differences between gender and High Order Thinking Skills (HOTS). A total of 85 form two students from secondary schools in Kuala Nerus, Terengganu, were selected as the sample in this study. Pupils are chosen randomly. Researchers have used a questionnaire instrument that is divided into three parts, namely student demographics, close-ended HOTS questions and open-ended HOTS questions. The findings of the study show that there is a difference between the levels of HOTS, which is analysing and evaluating in regards to the gender of students for closed-ended questions. Meanwhile, there are differences in all four levels of HOTS with respects to the gender of students for open-ended HOTS questions. The results of this study will enable the Malaysian Examinations Council to plan questions that are appropriate to the level of HOTS of all students in Malaysia. Meanwhile, the Malaysian Ministry of Education can focus on programmes for male students to reduce the gender gap in international and national examinations.

Keywords: High Order Thinking Skills (HOTS), Gender, Secondary School, Close-Ended Question, Open-Ended Question

INTRODUCTION

Elements of Higher Order Thinking Skills (HOTS) have been given the main focus by the Malaysian Ministry of Education in the Malaysian Education Development Plan (PPPM 2013-2025) (KPM, 2012). High-level thinking skills are essential for everyone living life in the new millennium. High-level thinking skills encompass the level of HOTS in terms of applying, analysing, evaluating and creating (BPK, 2016). In the 21st Century Learning (PAK 21), students must be able to use knowledge, skills and values in reasoning and problem solving (Roselizam Daud, Roslan Ab Rahman and Amirah Wahidah Adnan, 2020). A study by Mohd Saifulkhair Omar and Mohd Isha Awang (2021) has confirmed that there is a relationship between student attitudes and HOTS.

The international benchmarks of TIMSS and PISA have been adopted to assess the performance of Malaysian students (MOE, 2012). TIMSS and PISA assessments are used to measure the level of high-level thinking skills of students all across the globe. However, Malaysia's low position in the test proves that Malaysian students find it difficult to apply high-level thinking skills (MOE, 2012). The Malaysian Ministry of Education targets the country to be in the top one-third group in the TIMMS and PISA international assessments. However, the results of PISA 2018 found that Malaysia's position has been in the middle one-third position among member countries (MOE, 2019). Therefore, efforts to improve the country's position still need to be continued as the level of achievement of students in the 21st century is measured using TIMMS and PISA assessments.

Studies have found that there are differences between high-level thinking skills and the gender of students. A survey of 96 seventh-grade junior high school students in Kediri, Indonesia, showed that there were differences in HOTS among male and female students (Nur Miftahul Fuad, Siti Zubaidah, Susriyati Mahanal & Endang Suarsini, 2017). Meanwhile, a study by Abdul Halim et al. (2017) showed that there are significant differences in the level of knowledge and application of HOTS based on demographic factors such as gender and school location. However, a study on 56 students from SMP Batik Surakarta found no difference between HOTS and the gender of students in Mathematics (Permatasari, Budiyono and Pratiwi, 2020). These findings are in line when there are studies that found the level of HOTS of secondary school students is low, and also there is no significant difference between genders (Gulistan, Saedah, Abu Bakar & Omed Saadallah, 2018; Siti Nur Hasanah, Sunarno & Prayitno, 2020). Therefore, inconsistent study findings exist here. This study needs to be conducted to enable the Ministry of Education Malaysia to plan programs to bridge the gender gap.

In addition, researchers have used various independent variables in finding factors that can improve the HOTS of students in Malaysia. Among the variables are using science laboratory learning environment (Mohd Saifulkhair Omar and Mohd Isha Awang, 2020), existing knowledge and readiness of students (Tuan Rahayu Tuan Lasan, Mohd Aderi Che Noh and Mohd Isa Hamzah, 2017), teacher readiness (Bernard Tahim Bael, Suppiah Nachiappan and Maslinda Pungut, 2021), teacher teaching style (Asmawati Mohamad Ali, Norizal Abdul Karim, Anita Mohamed and Noraihan Ismail, 2018) and also teacher knowledge and attitude level (Nur Shahirah Mat Isa and Zamri Mahamod, 2021). These factors were found to have a positive relationship with students' HOTS. Efforts to improve the HOTS of students in Malaysia is an ongoing effort to ensure that the country's position

in the assessment of international HOTS improves by 2025. The objective of this study is to study the differences between HOTS and the gender of students.

METHOD

This study is a survey using a questionnaire. A questionnaire is a research tool or instrument that contains a set of questions to obtain information from respondents (Fauzi Hussin, Jamal Ali and Mohd Saifoul Zamzuri Noor, 2014). Researchers have used the Higher Order Thinking Level Test (HOTLT) questionnaire constructed and developed by Gulistan Ahmed Mohammed Artosh (2016), which are closed-ended type questions. As for the open-ended type questions, the researcher has built and developed a KBAT questionnaire adapted from the Form 3 Assessment questions (PT3) in 2016 and 2017. Next, the verification of field experts from 5 Terengganu science-expert teachers was conducted. After obtaining the confirmation of the field experts, the data collection process will begin.

Before the data collection process began, the researcher applied for permission to conduct a study from the Education Policy, Research and Development (EPRD), Ministry of Education Malaysia. After approval was obtained, the researcher applied for permission from the Terengganu State Education Department (JPNT) to conduct the study in Terengganu state secondary schools. Next, the researchers sent emails to the selected secondary schools for permission to complete the survey in their schools. After consent was obtained, the researchers distributed the questionnaires to the secondary schools involved. A period of two weeks will be given to the schools involved to return the questionnaires.

Research Instruments

The researcher has used a set of questionnaires that contain three parts, namely: a) Respondents' demographic, b) Closed-ended HOTS questions, and c) Open-ended HOTS questions.

Part A. This section contains only one item – students are required to indicate their respective genders. The responses consisted of male and female, which is nominal type data.

State your gender
☐ Male
☐ Female

Part B. Consists of 10 closed-ended response questions. These questions were adapted from the Higher Order Thinking Level Test (HOTLT) constructed by Gulistan Ahmed Mohammed Artosh (2016). There are 3 levels of HOTS tested in these questions, namely the levels of applying, analysing and evaluating, which have incorporated Bloom's Taxonomy Model (1956).

Table 1. Number of items in HOTLT by construct

HOTLT	Total Items	Item Number
Applying	3	1, 2, 3
Analysing	5	4, 5, 6, 7, 8
Evaluating	2	9, 10
	10	

Part C. Meanwhile, part C consists of 8 open-ended response questions. Researchers have constructed these questions using Bloom's Taxonomy Model (2001), which include the level of HOTS – applying, analysing, evaluating and creating. These open-ended response questions were adapted from the Form 3 Assessment examination (PT3) in 2016 and 2017. Next, the researcher asked 5 science-expert teachers from the Angkatan Kerja Rajin Amalan Mulia (AKRAM) Terengganu for the validation process.

Table 2. Number of items in HOTS by construct

HOTS	Total Items	Item Number
Applying	2	1, 5
Analysing	2	2, 6
Evaluating	2	3, 7
Creating	2	4, 8
	8	

Normality Test

Once the data were successfully collected, the researcher conducted a normality test to determine the appropriate type of test to use, whether parametric or non-parametric analysis.

Table 3. Normality test

Variables	Kolmogorov-Smirnov			Shapiro-Wilk			Normal/ Abnormal
	Statistics	df	Sig.	Statistics	df	Sig.	
HOTS (Closed-ended)	.163	85	.000*	.936	85	.000	Abnormal
HOTS (Open-ended)	.194	85	.000*	.869	85	.000	Abnormal

*This is a lower bound of the true significance.

The value of sig. .000 for the Kolmogorov-Smirnov test in the table above shows the Null Hypothesis, which is that the data are not normally distributed if $p<.05$ fails to be rejected. Therefore, the data of the two dependent variables above are abnormally distributed. Next, the researcher will use non-parametric analysis to answer the research questions. The researcher will use Chi-square analysis to answer the first research question and the Mann-Whitney U test to answer the second research question.

Respondents' Profile

A total of 85 Form Two students were involved in this study. These pupils were drawn from two different schools.

Table 4. Respondents' profile

No.	Respondents' Profile	Frequency (*f*)	Percentage (%)
1	Male	35	40.2
2	Female	50	58.8
		85	100.0

Based on the table above, a total of 35 (40.2%) male students and 50 (58.8%) female students were involved in this study. The researcher has selected two schools, namely a

school with good achievement and a school with poor achievement in the Form 3 Assessment (PT3) 2017.

RESULT

Research Question 1: Is there a relationship between higher-order thinking skills (closed-ended questions) and the students' gender?

Null hypothesis 1a: There is no association between higher-order thinking skills (closed-ended questions) (applying) and the students' gender.

Table 5. Chi-square test of independence for the relationship between higher-order thinking skills (closed-ended questions) (evaluating) and the students' gender

Category	Male	Female	Total
Correct	4 (30.8%)	9 (69.2%)	13 (15.3%)
Wrong	31 (43.1%)	41 (56.9%)	72 (84.7%)
Total	35 (41.2%)	50 (58.8%)	85 (100%)

The value of Chi-square, χ^2 = .686, p > .05. *Minimum expected count* = 5.35.

The Chi-square results conducted found no association between higher-order thinking skills (closed-ended questions) (applying) and the students' gender (Pearson Chi-Square value, χ^2 = .686, p> .05). Therefore, H_{01a} failed to be dismissed.

Null hypothesis 1b: There is no association between high-order thinking skills (closed-ended questions) (analysing) and the students' gender.

Table 6. Chi-square test of independence for the relationship between higher-order thinking skills (closed-ended questions) (analysing) and the students' gender

Category	Male	Female	Total
Correct	12 (28.6%)	30 (71.4%)	42 (49.4%)
Wrong	23 (53.5%)	20 (46.5%)	43 (50.6%)
Total	35 (41.2%)	50 (58.8%)	85 (100%)

The value of Chi-square, χ^2 = 5.446, p < .05. *Minimum expected count* = 17.29.

The Chi-square results conducted found that there was an association between higher-level thinking skills (closed-ended type questions) (analysing) and the students' gender (Pearson Chi-Square value, χ^2 = 5.446, p <.05). Hence, H_{01b} is rejected.

Null hypothesis 1c: There is no association between higher-order thinking skills (closed-ended questions) (evaluating) and the students' gender.

Table 7. Chi-square test of independence for the relationship between higher-order thinking skills (closed-ended type questions) (evaluating) and the students' gender

Category	Male	Female	Total
Correct	19 (25.5%)	43 (69.4%)	62 (72.9%)
Wrong	16 (69.6%)	7 (30.4%)	23 (27.1%)
Total	35 (41.2%)	50 (58.8%)	85 (100%)

The value of Chi-square, χ^2 = 10.492, p < .05. *Minimum expected count* = 9.47.

The Chi-square results conducted found that there was an association between higher-order thinking skills (closed-ended questions) (evaluating) and the students' gender (Pearson Chi-Square value, $\chi^2 = 10.492$, $p < .05$). Therefore, H_{01c} is rejected.

Research Question 2: Is there a difference between higher-order thinking skills (open-ended type questions) and the students' gender?

Null hypothesis 2a: There was no difference between higher-order thinking skills (open-ended type questions) (applying) and the students' gender.

Table 8. Mann-Whitney U test for differences between higher-order thinking skills (open-ended type questions) (applying) and the students' gender)

Gender	N	*Mean Rank*	Z	Sig.
Male	35	35.51	-2.44	.015
Female	50	48.24		

The Mann-Whitney U results above showed a significant difference ($p = .015 < .05$) in terms of scores between the male and female gender groups. The Z-score showed -2.44 <.05. The male gender group had a mean rank of 35.51, while the female gender group had a mean rank of 48.24. Therefore, H_{02a} is rejected.

Null hypothesis 2b: There was no difference between higher-order thinking skills (open-ended type questions) (analysing) and the students' gender.

Table 9. Mann-Whitney U test for differences between higher-order thinking skills (open-ended type questions) (analysing) and the students' gender

Gender	N	*Mean Rank*	Z	Sig.
Male	35	32.00	-3.49	.000
Female	50	50.70		

The Mann-Whitney U results above showed a significant difference ($p = .000 < .05$) in terms of scores between the male and female gender groups. The Z-score showed -3.49 <.05. The male gender group had a mean rank of 32.00, while the female gender group had a mean rank of 50.70. Hence, H_{02b} is rejected.

Null hypothesis 2c: There was no difference between higher-order thinking skills (open-ended type questions) (evaluating) and the students' gender.

Table 10. Mann-Whitney U test for differences between higher-order thinking skills (open-ended type questions) (evaluating) and the students' gender

Gender	N	*Mean Rank*	Z	Sig.
Male	35	33.39	-3.05	.002
Female	50	49.73		

The Mann-Whitney U results above showed a significant difference ($p = .002 < .05$) in terms of scores between the male and female gender groups. The Z-score showed -3.05 <.05. The male gender group had a mean rank of 33.39, while the female gender group had a mean rank of 49.73. Therefore, H_{02c} is dismissed.

Null hypothesis 2d: There was no difference between higher-order thinking skills (open-ended type questions) (creating) and the students' gender.

Table 11. Mann-Whitney U test for differences between higher-order thinking skills (open-ended type questions) (creating) and the students' gender

Gender	N	*Mean Rank*	Z	Sig.
Male	35	34.23	-2.78	.005
Female	50	49.14		

The Mann-Whitney U results above showed a significant difference ($p = .005 < .05$) in terms of scores between the male and female gender groups. The Z-score showed -2.78 <.05. The male gender group had a mean rank of 34.23, while the female gender group had a mean rank of 49.14. Hence, H_{02d} is rejected.

DISCUSSION

The use of open-ended type questions was found to test the students' HOTS successfully. This is because the HOTS questions are of a problem-reasoning and problem-solving nature. Therefore, students will give different ideas to each other in solving a given problem. A study by Stanger-Hall (2012) has found that the use of structured question is better in promoting high-level thinking skills among students.

The researcher has used two sets of HOTS questions in this study, namely closed-ended and open-ended type questions. For the first research question, it was found that two levels of thinking, namely the level of analysing and evaluating, displayed that there was a relationship between HOTS and the students' gender. Meanwhile, the applying level showed no association between HOTS and the students' gender. The application level means that students can use knowledge, skills, and values in different situations to execute something. The level of analysis implies that students are able to break down information into small parts to understand in more depth and the relationship between the components. While the level of evaluating means that students can make judgments and decisions using their knowledge, experience, skills, and values, as well as providing justification. This has proven that female students have a higher level of thinking in comparison to male students.

Next, the second research question, which is an open-ended response type question, will be discussed. The findings of the research exhibited that all levels of thinking, namely the level of applying, analysing, evaluating and creating, showed that there were differences between the gender of students. Female students have higher scores for all four levels of thinking because of the more positive attitude of female students than male students. A study by Mohd Saifulkhair Omar and Mohd Isha Awang (2021) have proven that HOTS has a relationship with student attitudes. Past studies have also found that HOTS are different between male and female students.

CONCLUSION

To conclude, the researchers suggested that the study be further expanded by finding a solution to the problem of HOTS for male students who are lower than female students. This is because, based on the analysis of TIMMS and PISA results by the MOE, it shows that there is a gap between the sexes. Therefore, further studies need to be conducted to reduce the gender gap. When the gender gap can be narrowed, then the country's achievement in TIMMS and PISA can be improved.

This study has also further strengthened the suggestions of previous researchers that the use of open-ended type questions is better in measuring students' HOTS. This is because HOTS is a student's reasoning skill to solve problems using knowledge, skills and values. In open-ended type questions, students are freer to give their ideas compared to closed-ended type questions. Therefore, the use of open-ended response type questions will be able to improve students' HOTS.

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