Senior high school student’s higher order thinking skills based on gender and grade

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Abstract. The current curriculum in Indonesia focuses on developing higher order thinking skills. However, this achievement at the level of education varies widely, even in the same school. This study aims to determine the effect of differences in gender and grade of students on high school students' high order thinking skills. This research was conducted by giving 45 points multiple-choice questions to 94 students in four class of XI senior high school. The items given are questions based on higher order thinking aspects. Based on the analysis results, 27 male students scored in the high domain, and only two male students scored in the low field. Twenty female students scored in the high field, and nine students achieved in the low field. The gender has a significant correlation to students' higher order thinking skills, with an association coefficient or a contingency coefficient of 0.1. In other words, the student’s gender is affecting the student’s higher order thinking skills. The grade variable does not have a significant correlation with student’s higher order thinking skills. In other words, the student's grade affects the student’s higher order thinking ability is not proven.

1. Introduction

Educators must be able to develop Higher Order Thinking Skills (HOTS) in classroom learning because they have significant benefits for students. The information conveyed by the teacher is studied and processed by students. With the HOTS process, the information will be remembered longer and clearly than the information obtained through rote memorization or the low order thinking process. Students with more profound conceptual knowledge will access information and use the new language to explain it [1]. Higher order thinking skills covers critical thinking, logical thinking, reflective, metacognitive, and creative thinking [2]. We must understand that HOTS is the best teaching and learning skills in the real world by varying the scenarios to use the skills they have acquired. Therefore, HOTS is very important for the quality of education [1]. Along with the
development of knowledge and technology, students need higher order thinking skills to be able to compete in developments that will continue to occur.

High-level thinking that has been known is in the realm of bloom taxonomic thinking, namely the skills to analyze, evaluate, and create. Physics is in that cognitive domain [3]. When it comes to analysis, there is already a physic process [4]. Generally found in academic achievement, male students outperformed in mathematics while female students outperformed in language [5]. It is believed that because of the differences in the brains of male and female, it was found that female generally focus on concrete, practical, emotional, and personal things, while male generally focus on intellectual, abstract, and objective things [6]. many things can contribute to affect gender differences such as socio-economic conditions, socio-cultural norms, values, and ideology [7]. Gender gap still exist in student achievement and motivation, even though men and women should have equal opportunities in education [8].

There are cross-country variations in math and science abilities and economies in 35 countries. Male outperform female in 25 countries, there is no significant gender difference, and in 5 countries, female outperform male [9,10]. For example, in the mechanics concept, there is a gap between the male and female pretest scores, where the male pretest score is 12% superior to the female pretest score [11]. Stereotypes have a big effect on gender gap, the effect that made most female have no flare compared to their male counterparts to study physics. The influence of negative stereotypes in social interactions among female affects them in achievement in physics. With these stereotypes, the performance of female in physics will always be low and makes the achievement gap in physics between female and male will always exist [9].

Based on the things that have been described above, the main purpose of this study to examine how the influence of gender and Grade on students' higher order thinking abilities of physics. It is hoped that the findings will provide new information for the world of education.

2. Methods
This study's method uses a correlational method with a quantitative approach, which aims to find out in-depth about the effect of gender and grade on high school students' higher-order thinking skills. The population in this research was high school students of class XI with a sample of 94 students of class XI in a high school in Yogyakarta. The instrument used in this study is a test to measure the level of higher-order thinking skills. The test instrument is based on the characteristics of the higher-order thinking ability test tested for validation and reliability first. The test has been declared valid and reliable to assess higher order thinking skills.

The results of the study were analyzed using the Chi-Square test. Chi-Square is also known as Kai Squared. Chi-Square is one kind of non-parametric comparative test carried out on two variables, where the data scale of the two variables is nominal. (If of the two variables, there is one variable with a nominal scale, then the chi-square test is carried out by referring that the test must be used at the lowest degree). Formula Chi-square

\[ \chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} \]  

A Chi-square test can be used to see the magnitude of the relationship between two variables expressed in the form of the association coefficient or the contingency coefficient. The degree of relationship is expressed in the association coefficient or contingency coefficient given the symbol C.

\[ C = \frac{\chi^2}{N + \chi^2} \]
where $C$ is the contingency coefficient, $\chi^2$ is the Chi-square, and $N$ is the number of respondents with the formula above, the magnitude of the influence relationship between the two variables can be seen. So, it can be stated how much one variable affects the other variable.

3. Result and Discussion

3.1 The influence of gender on students' higher-order thinking skills (HOTS) in Physics

![Figure 1](image-url)

**LEVEL OF STUDENT HOTS BY GENDER**

Based on the data analysis shown in Figure 1, which was carried out on 94 students, it was found that male students were mostly in the high HOTS realm, namely 27 students. In the realm of HOTS, there were more female students, namely 24 students. Whereas in the low HOTS realm, there were more female students, namely nine students. So, it can be concluded that male students have higher HOTS scores than female students. Based on Table 1, the value $x^2_{\text{count}} = 8.098$. $x^2_{\text{table}}$ Value of $\alpha = 5\%$ is 5.991, $x^2_{\text{count}} > x^2_{\text{table}} (8.098 > 5.991)$ so it can be concluded that gender has a significant correlation with HOTS. Furthermore, the student contingency coefficient is 0.079. So, it can be concluded that gender influences student HOTS, which is 0.079. In other words, the effect is minimal.

Following the results study of Prancis, At all it was explained that the subject matter between male and female is different. Females tend to be feminine which makes them underrepresented in physics and engineering [9]. Male tend to be masculine where physics in particular has stereotypes about being the discipline for a brilliant male [12]. Genetic differences do not determine male and female cognitive abilities. As males and females interact with their environment, family, classroom, and society at large, they may determine to what extent their genes influence their cognitive abilities[13]. Experience and interest in socialization in male and female are some other possible causes of gender differences in academic achievement[9]. Male students who have different thinking styles and methods of delivery from female students[14]. As a teacher, it is important to eliminate negative gender bias which will damage the confidence of boys or girls, which affect the development of student interests, and do not help their physical and mental growth. It is very important to eliminate negative stereotypes from students, by always encouraging the development of student interest, adjusting students with extraordinary personalities and eliminating general concepts that hinder students so that students cannot recognize and act on their strengths[15]. So, it can be concluded that physics is a difficult subject, and usually, men can follow it better because
male intelligence matches the typical physics subject. Confidence factors and thinking patterns also affect students' higher-order thinking skills in physics.

3.2 The effect of Grade on students' higher-order thinking skills (HOTS) in physics

Based on the data analysis shown in Figure 2, which was carried out on 94 students, it was found that there were more class D students in the high HOTS realm, namely 15 students. Class B students are mostly in the moderate HOTS realm, namely 12 students. Meanwhile, class A students were mostly in the low HOTS realm, as many as seven students. So, it can be concluded that class D students have higher-order thinking skills higher than other grades.

Based on Figure 2. Obtained $x^2_{count} = 11.72$ dan $x^2_{table}$ value of $\alpha = 5\%$ is 5.991, then $x^2_{count} < x^2_{table}$ (11.72 < 12.592) so it can be concluded that the grade has an insignificant correlation with student HOTS. In other words, based on the data, it was found that grade did not affect students' higher order thinking skills.

4. Conclusion

Based on the student data analysis results, it was shown that, there was a significant effect of the gender variable on students' higher order thinking skills of physics, namely 0.1. In other words, Gender affects students' higher-order thinking skills in physics, but the effect is minimal and Variable Grade has an insignificant effect on the students' higher-order thinking ability. Men's higher-order thinking skills is higher than that of women is influenced by the factors of differences in thinking patterns, self-confidence, and interest. To eliminate this gap can be started by instilling confidence in women that physics is not only a subject for men. Meanwhile, to see the effect of Grade on students' higher-order thinking skills of physics, it is suggested to research schools with a homogeneous grade division.

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