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A COMPARISON OF GENDER DIFFERENCES TOWARD MATHEMATICS' COGNITIVE LEARNING OUTCOMES IN A MIDDLE SCHOOL

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ABSTRACT

This research examined whether there is any difference of performing mathematics in the topic of Indices & Surds on cognitive learning outcomes between female and male students in grade 9. The research method used was causal-comparative, conducted in t-test for independent means to represent the comparison of mathematics' cognitive learning outcomes between female and male students, with the significance level 5%. There were 113 respondents who were selected using the convenience sampling technique and they consisted of 68 female students and 45 male students. There were two independent means samples that were going to be compared. The instrument used to obtain students' demographic characteristics of gender and students' mathematics cognitive learning outcomes in the topic of Indices & Surds was their score list in midterm report card. Based on the result, it was obtained that t_{obt} 1.69 less than t_{cv} (1.69 < 1.98). Therefore, Ho is accepted, means that there is no mean score differences in mathematics' cognitive learning outcomes in the topic of Indices & Surds between grade IX female students and grade 9 male students. Thus, the conclusion is that gender as a causal factor in this research gave no difference towards grade 9 students' cognitive learning outcomes, particularly in mathematics ability in the topic of Indices & Surds in ABC Middle School.
Keywords: Gender difference, learning outcomes, indices, surds

ABSTRAK

Tujuan dari penelitian ini adalah untuk melihat apakah ada perbedaan nilai rata-rata dari hasil belajar kognitif matematika pada topik pangkat dan akar antara siswa perempuan kelas IX dan siswa laki-laki kelas IX. Metode penelitian yang digunakan adalah kausal-komparatif, dilaksanakan dengan teknik *t-test for independent means* untuk merepresentasikan perbandingan hasil belajar kognitif matematika antara siswa laki-laki dan siswa perempuan, dengan taraf signifikansi 5%. Terdapat 113 responden yang dipilih dengan teknik *convenience sampling*; terdiri dari 68 siswa perempuan dan 45 siswa laki-laki, sebagai dua sample rata-rata independen yang akan dibandingkan. Instrument yang digunakan untuk memperoleh data demografis jenis kelamin siswa dan data hasil belajar kognitif matematika siswa pada topik pangkat dan akar adalah daftar nilai di buku raport tengah semester. Dari hasil penelitian, diperoleh t_{obt} yaitu 1.69 dimana kurang dari t_{cv} (1.69<1.98). H_o diterima, yang berarti tidak terdapat perbedaan nilai rata-rata dari hasil belajar kognitif matematika pada topik pangkat dan akar antara siswa perempuan kelas IX dan siswa laki-laki kelas IX. Sehingga, dapat diambil kesimpulan bahwa jenis kelamin sebagai kausal faktor dalam penelitian ini tidak memberikan perbedaan terhadap hasil belajar kognitif siswa kelas IX, khususnya dalam kemampuan matematika pada topik pangkat dan akar di Sekolah Menengah ABC.
Kata Kunci: Perbedaan gender, hasil belajar, pangkat, akar.

INTRODUCTION

God create men and women equally in His divine image. However, men and women are fully equal in a personhood, dignity, and worth. ABC Middle School is a school that offer Christian education. In teaching and learning process, teachers treat all students in the same way. It is clearly seen that the school believe that every student has the same ability. Being a Christian school, providing adequate education to all students is a crucial importance in society. But somehow, gender has long been cited as a plausible reason for the reported discrepancies in mathematics abilities and scores among boys and girls (Paslov, 2016), which become a signal that male tend to perform better than female. In fact, "women are human beings, and all human beings are created with rationality and equal rights" (Wollstonecraft, 1792, as cited in Kohm, 2008, p. 340). An accepted point of view, about differences believed to exist between girls and boys (refer to Table 1), may have a real impact on how children and young people perceive themselves. The students whose a wrong image of mathematics – thinking of mathematics is something for men and not for women (refer to Table 1), can cause a subordination and stereotyping among men and women. This conception is affected by human sinful nature. It is a task for the teachers to help both male and female students to understand the greatness of God and see themselves as an equal human being, who have same opportunity and responsibility to use their God's gift to glorify Him such as performing in mathematics. The opportunity to do the internship program in a school that provides Christian education which treat all students equally, makes researcher want to find more scientific evidence that every student has the same capability and need to be treated equally. From that background, the research question of this research as; is there any difference of performing mathematics in the topic of Indices & Surds on cognitive learning outcomes between female and male students in grade IX?

LITERATURE REVIEW

Gender

Gender is an identity constructed by social role which represent a person as a male or female which attached to their nature being as a man or woman. Gender and sex are not the same thing. The term 'sex' refer to biological characteristics and their direct consequences. The term 'gender' refer to what society and culture make of those biological differences, and frequently applied to the social characteristic and patterns distinguishing women's and men's lives (Bird & Rieker, 2008). In here below, Table 1 present a description of gender-stereotypic dimension, particularly in cognitive dimension:

Table 1

Description of gender-stereotypic dimension: Cognitive dimension

Gender-Stereotypic Dimension		
Characteristics of Dimensions	*Masculine Cognitive*	*Feminine Cognitive*
Attributes in dimension	Analytical	Imaginative
	Mathematical	Intuitive
	Good with numbers	Artistic
	Exact	Expressive
	Good at reasoning	Perceptive
	Good at abstractions	Verbally skilled
	Good at problem solving	Creative
	Quantitatively skilled	Tasteful

Source: (Cejka & Eagly, 1999, p. 416)

Benbow's study (as cited in Ardila A., et al., 2011, p. 984), classify three major differences in cognitive abilities between men and women that have usually been reported: (1) higher verbal abilities, favoring women; (2) higher spatial abilities, favoring men; and, (3) higher arithmetical abilities, also favoring men. However, differences in calculation abilities have at times been interpreted as a result of men's superior spatial abilities.

In fact, there are some effects from gender differences that lead into gender inequality, as Woodward states that another source of inequality can be found in gender relations (Woodward, 2004, p. 21). The first one is subordination, which based on Merriam-Webster's Dictionary of Synonyms (1984), subordinate is comparable when they mean placed in or belonging to a class, rank, or status lower than the highest or the first in importance or power. Eagly and Wood (1999, p. 409) state that, according to social structure theory, men develop more dominant (i.e., controlling, assertive, directive) behaviors as an accommodation to more powerful roles, and women develop more subordinate (i.e., compliant, less aggressive, more cooperative, and conciliatory) behaviors as a way of accommodating to available roles with less power and status. The second one is stereotyping, defined as a simplified representation of the most typical characteristics associated with a category (Woodward, 2004, p. 52). As the effect, for instance, reminding women of negative stereotypes about their mathematics abilities can immediately lower their mathematics test performance and even cause differences in brain activation (Miller & Halpern, 2014, p. 41). Those effects that may appear caused by the gender difference, unfortunately give more negative effects for women. If people see male and female have different dignity or worth, the wrong perspective is come from human sinfulness and human sinful nature. Sin makes human become blind and cannot see what God's did in the right way. In God's image, He perfectly create all human with equal ability, ratio, and rights. There is nothing like man is better than woman, or man is more powerful than woman, or man is smarter than woman.

Mathematics Cognitive Learning Outcomes

Learning outcomes are statements of what is expected that the student will be able to do as a result of learning the activity (Jenkins & Unwin, 2001, p. 1). The form of learning outcomes itself, means an evaluation of student's ability through the learning process which is determined or specified in the form of numbers. Learning outcomes in the cognitive domain related to information and knowledge, concepts, principles, and intellectual learning outcomes (Bloom, as cited by Sudjana, 2009, pp. 22-23). To measure the learning outcomes itself, the researcher uses the archival data of students' formative test results which is daily exam (researcher does not use the data of summative test due to the school that does not held midterm exam or final exam). The researcher uses the results of the students' formative tests as the measurement. The students' learning outcomes can be measured by using some kind of test, there are diagnostic test, formative test, and summative test. Formative test intends to measure students' absorption towards the material that has been delivered. Formative test given in each learning unit. The form of this test such as quiz and daily exam. In an accomplishment of student's learning outcomes, there are some factors which can affect the learning outcomes itself. Those factors are classified by Aisyah (2015, pp. 46-48) into two major sections: internal factors (physiological factors and psychological factors), and external factors (family, school, and society environment).

Researcher use Indices and Surds as the chosen topic. According to the literature review, the researcher proposes the research hypothesis, which is there is no difference in the mathematics' cognitive learning outcomes in the topic of Indices & Surds between female and male students in grade IX.

RESEARCH METHODOLOGY

This research is conducted in a quantitative method, causal-comparative design. The dependent variable is students' mathematics cognitive learning outcomes in the topic of Indices & Surds and the independent variable is students' gender. This research is done with students of grade IX in ABC Middle School. The samples are taken from 113 respondents who selected using convenience sampling technique; consisted of 68 female students and 45 male students. Sample sizes can be considered equal if the larger group is not more than 1½ times larger than the smaller group (Morgan, et al., 2004).

A causal-comparative analyses using *t*-test for independent means technique, can be conducted if the data stated normal and homogeny. Therefore, before doing the *t*-test calculation, the researcher did normality test and homogeny test, as it is stated by Riadi (2014, p. 150), "before do the causal-comparative analyses, the data that going to be process should fulfill two primary assumptions, a normal distribution and homogeneity (or equality) of variance". The normality of the data in this research calculated by using Kolmogorov – Smirnov test. For the data with the level of significance 5%, accept H_o of the data are normally distributed if $D < D_{table}$ (D_{table} = critical value of Kolmogorov-Smirnov test). The result of normality test (refer to Table 2) shows that it stated normal since $D < D_{table}$ ($0.068 < 0.128$).

The variables are homogeny, if $F < F_{cv}$. Since $F < F_{cv}$ (3.172< 3.92), then H_o of the data are homogeny is accepted.

Table 2
Result on normality test

Source	***df***	**SS**	**MS**	***F***
Between Groups	1	615.03	615.03	3.172
Within Groups	111	21519.01	193.86	
Total	112	22134.04		

Calculation for *t*-test for Independent Means

Table 3
Result on the t-test

	Female (1)	Male (2)
Mean (μ):	76.63	71.87
σ:	12.66	15.65
N:	68	45
$\sqrt{N-1}$:	8.19	6.63
SE_{μ_x}:	1.55	2.36
$SE_{\mu_x}^2$:	2.39	5.56

Based on Table 3, researcher obtain the value of t_{obt} : 1.69. Before interpreting, researcher need to determine the degrees of freedom (*df*). Based on Table 3, researcher obtain the value of $N_1 = 68$ students and $N_2 = 45$ students, so the degrees of freedom (df) is 111. The alternative hypothesis is two-tail with α = 0.05. The critical value of *t* (t_{cv}) for a two-tail test with 120 degrees of freedom (120 is approaching to 111) is $t_{cv} = 1.98$. The result is reported in APA style as cited in (Jackson, 2009, p. 230): *t* (111) = 1.69, p > .05 (two-tailed). Based on the calculation, the t_{obt} is less than the t_{cv} ($t_{obt} < t_{cv}$) (1.69 < 1.98). Thus, the null hypothesis is accepted and conclude that there is no statistically mean score differences between the two groups.

By the statistical analysis that has been done, the researcher found that the statement of H_a: There is any mean score differences in mathematics' cognitive learning outcomes in the topic of Indices & Surds between grade IX female students and grade IX male students, is rejected. The value of *t* =1.69 shows that the value is positive. In APA style, the result is reported as: *t* (111) = 1.69, p > .05 (two-tailed). The researcher had not found a significant difference – no effect size would have to be calculated (as the two groups would have only differed due to random fluctuation or chance). By examining the group means from the calculation of students' mathematics cognitive learning outcomes, an examination of the group means indicate that females (μ_1 = 76.63, σ_1= 12.66) get a bit higher mean score (even though the difference is not statistically significant) on the mathematics' cognitive learning

outcomes than did males (μ_2= 71.87, σ_2= 15.65). The result of females' mean score a bit greater than the expected, when males tend to be better in mathematics performance.

DISCUSSION

Referring to the result, it can be said, gender as a causal factor in this research gives no significance difference towards grade IX students' cognitive achievement, particularly in mathematics ability in the topic of Indices & Surds.

As Samuelsson, M. and Samuelsson, J. (2016) stated, this result also relevance with other researchers Lindberg, et al. (2010) who concluded that the gender gaps in mathematics are insignificant. In addition, Robinson and Lubienski (2011) showed that girls have obtained slightly better grades in mathematics over the last four decades than boys and Brown and Kanyongo (2010) also supported these findings (as cited by Samuelsson and Samuelsson, 2016). Aiyedun (2000), Jahun and Momoh (2001), Abiam and Odok (2006) reported non-significant statistical differences on how male and female students perform in mathematical tasks. The reason for the equal performance of male and female students may not unconnected with the fact that both see themselves as equals and capable of competing and collaborating in classroom activities (as cited by Agah and Sule, 2015). Even boys' mathematics performance often better than girls, but girls get better grades throughout their school years. Their better grades must reflect some combination of greater effort, greater interest, and better work habits (Maccoby & Jacklin, 1974). These statements have the same perception with Collaer and Hines as they mention that there are no differences between male and female performance on tests of general intelligence (Collaer & Hines, 1995, as cited by Lips, 2005, p. 217).

In Mansory (as cited in Mushtaq, 2013, p. 19) he clarify that when a survey was conducted on 1 – 9 grade classes, both genders had the same achievements in math. The males and females in causal-comparative studies that have been used frequently to study the differences between them, have demonstrated the superiority of girls in language and boys in math at certain age levels. Moreover, the attributing of these differences to gender – as cause – must be tentative. One could hardly view gender as being caused by ability, but there are many other probable links in the causal chain, including societal expectations of males and females (Fraenkel & Wallen, 2008).

NCTM (National Council of Teacher of Mathematics) has identified the Five Process Standard that link to mathematical thinking ability needed from pre-kindergarten through grade 12: Problem solving, reasoning and proof, communication, connection, and representation. These fundamental and intertwining ways of learning mathematics, thinking and using mathematical knowledge are considered important in mathematics education (NCTM, 2000) and belong to Higher Order Thinking Skill (HOTS). Further analyzing is done to see the difference of HOTS between male and female. According to Fennema and Tarte's study (1985), they did not find any significance difference in ability to solve mathematical problems, but difference in patterns of problem solving. It was influenced by students'

learning style. In Umay and Kaf research (2005), they find no significant influence on students' logical reasoning in mathematics and by this ability, it can help the students to understand basis of all the rules and operations of mathematics (as cited in Agah and Sule, 2015). Stated by MZ (2013) that girls have better ability in mathematical communication (verbal), more motivated, and well organized in study. The aim of Feriyanto's study (2018) is to describe the ability of students' mathematical proof in different gender and one of the indicator is students able to connect facts/premises to concepts which must be mastered. The finding is females have the same ability with the male students. Even though male students had higher scores in solving problem quickly in unfamiliar circumstances by using representation to a model and higher self-perceptions of mathematical ability, they did not attain significantly higher scores than female students on the mathematics test overall, or on either type of problem. Male and female students employed algorithmic, intuitive, and guess strategies about equally, but female students omitted more items than did male students (Gallagher, A. M., et al., 2000). That's why we need to treat all students equally because all of them have a same capability to think and learn.

CONCLUSION

The finding of this research is no mean score differences in mathematics' cognitive learning outcomes in the topic of Indices & Surds between the grade IX female students and grade IX male students. The conclusion is according to the result of the causal-comparative analyses by using *t*-test for independent means technique. Based on the *t*-test calculation, the t_{obt} is less than the t_{cv} ($t_{obt} < t_{cv}$) (1.69 < 1.98). The value of t =1.69 shows that the value is positive. In APA style, the result is reported as: t (111) = 1.69, p > .05 (two-tailed). The result of the examination indicates (μ_1 = 76.63, σ_1= 12.66) get a bit higher mean score (the difference is not statistically significant) on the mathematics' cognitive learning outcomes than males (μ_2= 71.87, σ_2= 15.65). The result of females means score a bit greater than the expected, when males tend to be better in mathematics performance. The result of the research gave a scientific evidence to proofs; the assumption that gender as a causal factor in this research gives no difference towards grade IX students' cognitive learning outcomes, particularly in mathematics ability in the topic of Indices & Surds and every student has the same capability and need to be treated equally. As a result, the teachers need to keep on believing that either female or male students have the same ability in performing mathematics, and keep treating all of their students in the process of teaching and learning mathematics in the same way. Because as the learning did by the researcher, gender stereotyping, like call or make eye contact on females less often during learning process, these may make female students have a wrong image of mathematics and affect the way they perceive themselves so teachers should give the same opportunity to both of them to participate in the class.

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