

**SECONDARY SCHOOL STUDENTS' ATTITUDE TOWARDS PHYSICS BASED
ON GENDER AND GRADE LEVEL DIFFERENCES****ANDRIE CHAERUL***andrie.chaerul@staff.unsika.ac.id*Dosen Program Studi Pendidikan Bahasa Inggris
Fkip – Universitas Singaperbangsa Karawang**ABSTRACT**

The main purpose of the present study is to investigate the differences on students' attitudes toward Physics based on gender and grade level among Senior Secondary Education students. A group of approximately 864 male and female in eleventh- and twelfth-grade students, equally proportioned by gender were assigned to take part in this study. A standardized instrument namely The Test of Science Related Attitudes (TOSRA) questionnaire has been employed to collect data. A two-way Analyses of Variance (ANOVA) was used to quantitatively analyze the collected data. The study found that in general, male students do show more positive attitudes toward Physics than their female counterparts. Regarding grade level, twelfth grader show more positive attitudes toward Physics than eleventh graders.

Keywords: *TOSRA, attitude towards science, gender, grade level*

A. INTRODUCTION

For the past couple of decades, Indonesian women have made tremendous progress in Education. In fact, the gap in education levels between women and men has approximately disappeared. For instance, Japan International Cooperation Agency (2011) reported that the net enrolment rate of primary education is over 90%, and there is little gap between boys and girls. However, there is disparity among regions, in particular for secondary and higher education. In some areas, the enrolment rate of secondary education for girls is higher than that of boys. In addition, Badan Pusat Statistik (2015) based on SUSENAS 2014, in their collaborative work with *Kementrian Pemberdayaan Perempuan dan Perlindungan Anak* have also demonstrated a comparable conclusion that gender gap in education between male and female in Indonesia has almost departed. This trend indicates that Indonesian women have made an important step toward closing the education gap. Closing the gender gap in overall educational attainment, however, is not considered

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sufficient. It is also important to examine how women have progressed in specific areas, such as science education which is regarded to both their economic and social growth.

As a matter of fact, a number of previous studies reveal that women in the science and technological fields are still underrepresented compared to their male counterparts (American Association of University Women, 1992, National Science Foundation, 1994). A number of studies, more over, have investigated factors which may affect the women underachievement in science as well as their attitudes toward science (Lee & Burkam, 1988; Rodriguez, 1998; greenfield, 1996). Besides, Keeves and Morgensten (1992) investigated the selection of science courses in high school and college and the choice of science as a career. Interestingly, Pollack (2013) revealed that only one-fifth of physics Ph.D.'s in the USA awarded to women, and only about half of those women are American; of all the physics professors in the United States, only 14 percent are women. While, these studies have primarily been conducted in developed countries, the similar study is apparently significant to carry out in Indonesia educational setting to investigate students' attitude toward science.

B. LITERATURE REVIEW

The existence of gender-based differences both in achievement and participation in science and science related fields has been widely recognized among educators. In fact, a number of studies reveal that gender differences in science achievement present consistently (Beaton, *et al.*, 1996; Lee & Burkam, 1998; Ogunkola & O'Neale, 2013; Voyer & Voyer, 2014; Eddy, *et al.*, 2014; Baye & Monseur, 2016). The similar studies have also exposed that there is a pro-male science gender gap in Indonesia (Chaerul, 2002; Shafiq, 2011;). The achievement gap between males and female's students is not constant across subjects. For example, Beaton *et. al* study (1996) shows that gender differences in Earth Science, Physics and Chemistry reflected advantages for male students, on the other hand, in Life Science and Nature of Science boys and girls had similar performance.

There has been a growing body of research conducted to analyze factors which may have contributed to the existence of science achievement differences between male and female students. Researchers have identified a number of factors in order to understand

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the underachievement of girls in science (Baker, 1989; Baker & Leary, 1995; Ceci., *et al*, 2014; Hofer, 2015; Hofer & Stern, 2016;). Unfortunately, the researchers have failed to come to an agreement since the results have been mixed. In fact, National Theory holds a very strong belief that intellectuality is one of the innate factors in human beings (Burke, 1951). The theory attributed the presumed lower levels of achievement among female to sex-based biological characteristics. Another researcher claims that hormone levels have been suggested as a cause in differences in ability between men and women (Kimura, 1989). On the other hand, some theorists maintain that socio-psychological factors have significantly contributed to the underachievement of women in science instead of biological factor (Baker, *et al.*, 1992; Settles, 2014; Perez, *et. al*, 2014; London *et.al*, 2014). The proponents of the theory suggest that by making education equal for both sexes, women will be able to achieve up to their potential.

A large number of study on students' attitude has evolved to investigate its effects on the other educational variables. Many educators agree, for instance, that correlation between affective and cognitive domains cannot simply be ignored in a learning process. Studies investigating the students' attitudes toward science and their effects have accordingly become common in science education in the last decades (Freedman, 1997; Morrel & Lederman, 1998; Mihaldis, *et.al.*, 2011; Lovelace & Brickman, 2013). Even though the previous studies concerning students' attitudes toward science are primarily based on a similar basic premise, that is, attitudes play an important role on students' achievement, the findings of the research were not always consistent.

Several studies show that there is correlation between students' attitudes toward science and their gender. In general, boys do have a more positive attitude toward science than girls (Banu, 1986; Weinburgh, 1995; Hacieminoglu, 2015). Interestingly, the gap between male and female students' attitude toward science is not constant across science subject matter. For example, many studies found that Biology is favored by girls. Boys, on the other hand, are inclined toward physics and Chemistry (Baker, 1990; Osborne, *et.al*, 2003; Prokop, *et.al*, 2007). The differences on attitudes toward science between male and female students might be affected by feelings about, and interest in science.

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Research has shown that affective factors such as attitude toward science and mathematics have more influence on educational choices than cognitive ones such as achievement (A. Bakker, *et.al*, 2015).

C. RESEARCH METHOD

The main purpose of this study is to investigate the differences between male and female students on their attitudes toward Physics based on their gender and grade level among Senior Secondary Education.

D. RESEARCH QUESTION

Is there any significant difference in students' attitudes toward Physics based on their gender and grade level?

E. SITE AND PARTICIPANT

The target population of this study was eleventh- and twelfth-grade students who were randomly assigned to participate. The participants were chosen from 10 public schools located in Purwakarta, West Java Province. In total, 864 subjects with 440 male students and 434 female students respectively, have been involved to the study.

F. INSTRUMENT

The Test of Science Related Attitudes (TOSRA) questionnaire which was initially developed by Fraser (1977) was applied to measure students' attitudes toward Physics. The TOSRA is "... a multidimensional instrument with a strong theoretical foundation...." (Smits & Owen, 1994). The instrument was firstly validated in Australia in 1977. Since that time, cross-validation data from new samples of secondary science class have become available. TOSRA is organized into seven scales namely: Social Implication of Science, Normality of Scientists, Attitude of Science Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science.

For the purpose of this study, the researcher selected five out of the seven scales as being the most related to the topic of the study. The selected scales are Social Implications
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of Science, Normality of Scientists, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. In addition, this research has also chosen five statement from each scale instead of ten as appeared in the original version. Students used answer sheet separated from the statements' sheet for their responses. Students were required to put cross-check (X) for each statement under the column of Strongly Agree (SA), Agree (A), Neutral (N), Disagree (DA) and Strongly Disagree (SD). For example, a response of Strongly Agree (SA) for the positive statement "Physics classes are fun" would receive a score of 5. On the other hand, a response of Strongly Disagree (SD) for this statement would receive a score of 1.

G. DATA ANALYSES

The statistical method called a two-way Analyses of Variance (ANOVA) was applied to examine the main effects of gender and grade level on students' attitudes toward Physics. Using the ANOVA, students' mean scores resulted from the TOSRA were compared based on their gender and grade level differences. The interactions effect of gender and grade level was examined to analyze the magnitude of interdependency level of the two variables in contributing to the attitudes differences. In addition, the main effects of each gender and grade level were also investigated.

H. RESULTS AND DISCUSSION

Having been analyzed statistically, the results of the overall TOSRA questionnaire are presented in the Table 1 below.

Table 1
ANOVA results for overall TOSRA questionnaire

Source	DF	SS	MS	F value	Pr>F
Gender	1	410.725906	410.725906	185.53	<.0001
Grade	1	1562.897772	1562.897772	705.99	<.0001
Gender *Grade	1	50.512123	50.512123	22.82	<.0001

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It can be seen from Table 1 that the two-way ANOVA method has detected significant interaction effect of gender and grade level ($p < .001$) on students' attitudes toward Physics. In addition to the interaction effect, the main effects of gender and grade level have also been identified to be significant ($p < .001$). In other word, this study found that male students have more positive attitude toward Physics ($M = 16,39$; $SD = 2.12$) compared with their female counterparts ($M = 15.02$; $SD = 1.89$). However, since the mean difference between male and female students in this study is relatively small, the finding is more in accordance with Kahle and Meece's (1994) study which concluded that although female students have had less positive attitudes toward science than male students, the effects size is small. It can be said that although the gender-based difference is statistically significant, but the practical significance of the such finding is questionable. This study also revealed that students' attitudes toward Physics significantly differ based on their grade level. As a matter of fact, the data shows that students in twelfth-grade ($M 17.11$; $SD = 1.74$) have more positive attitude toward Physics than students in eleventh-grade ($M = 14.43$; $SD = 1.55$).

Table 1 also shows that gender and grade level have unlikely influenced students' attitudes toward Physics independently since the interaction effect of gender and grade level has been detected to be significant ($p < .001$). To summarize, the study reveals that gender and grade level interact with each other in affecting the students' attitude toward Physics. Table 2 below illustrates this interaction effect of gender and grade level in more detail.

Table 2

Contrast for Overall TOSRA Results Based on Gender and Grade Level

Contrast Pr > F	DF	Contrast SS	MS	F value
f vs m at grade 11 < .0001	1	89.635037	89.635037	40.49
f vs m at grade 12 < .0001	1	362.315540	362.315540	163.66
f 11 vs f 12 < .0001	1	509.511325	509.511325	230.16

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m 11 vs m 12

1

1123.444799

1123.444799

507.48

< .0001

The Table 2 indicates that differences in attitude toward Physics between male and female students both in eleventh- and twelfth-grade are statistically significant ($p < .001$). This study found that male students in eleventh-grade have a more positive attitude toward Physics ($M = 14.86$; $SD = 1.43$) compared with their female counterparts ($M = 13.98$; $SD = 1.55$). However, the Mean distinction between these two groups is relatively small and therefore is likely impractical. The similar phenomenon can also be found among twelfth-grade students. Gender differences in attitude toward Physics among students in this group was also found to be statistically significant ($p < .001$). In fact, male students at this grade also showed a more positive attitude toward Physics ($M = 17.99$; $SD = 1.43$) than female students ($M = 16.16$; $SD = 1.54$). The wider gap difference between female and male students in the twelfth-grade compared to the eleventh-graders indicates that gender-based differences in students' attitudes toward Physics are not constant across grade level.

These findings have apparently supported previous studies which have identified a number of factors influencing attitudes towards science such as gender, personality, structural variables and curriculum variables (Osborne *et al*, 2003). Researchers believe that among some factors contributing to students' attitudes toward science, gender is apparently the most significant variable. as Gardner comments, 'sex is probably the most significant variable related towards pupils' attitude to science'. (Gardner, 1975). Students' attitudes toward science have received particular consideration because of the breadth of their potential impact on a students' career choice behaviors. A number of studies investigated the relationship between students' attitudes towards science and science achievement have been been conducted for long time (Lovelace & Brickman, 2013; Freedman, 1997; Morrel & Lederman, 1998; Mihaldis, *et.al.*, 2011). In fact, the female less positive attitudes toward science have not only influenced their achievement, but their levels of interest in science have also affected their course selections, as well as the career paths they eventually pursue; therefore an early avoidance of, or disinterest in science can have long lasting repercussions (Turner & Ireson, 2010). It can be concluded that, female students' less positive attitudes toward science cannot simply be ignored by science teachers as well the government since the effect may disadvantage females' potential.

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The study was undertaken to participate in contributing ideas for the development of Indonesian science curriculum. While it has been clearly discussed above, that the existence of students' attitude difference toward Physics between male and female students cannot be simply be ignored. It should remind Indonesian Physics teachers as well as curriculum developers in Indonesia to seriously consider in developing a more democratic teaching and learning science in the classroom. Indonesia will not be able to sustain the advantage of a large population without attracting as many educated citizens as possible regardless of their gender into science and science-related fields.

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