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Attitudes Towards Science: A Study of Gender Differences and Grade Level

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Abstract: It should be noted that learning outcomes are not students' only achievement; attitude is also the main output in learning. This research explores students' attitudes toward science learning based on gender and the grade level of schools in Aceh, Indonesia. The participants are 1,023 students from the sixth grade of primary schools and the eighth grade of secondary schools. The total sample includes 16 schools spread across the province. The data have been collected using TOSRA. By using the Likert scale, this questionnaire is useful for obtaining descriptions of the students' attitudes and assigning scores for a certain group of participants. Based on gender, the results show females reflect more positive attitudes toward science than male students do. According to the grade level of the schools, the data reflect the equality of students' attitudes toward science between primary and secondary schools. Nevertheless, when primary school students enter secondary school, the majority of students enjoy learning science less. This fact is meaningful feedback for science teachers. This result supports the scholars seeking ways to avoid the gender gap in learning activities. Pedagogical implications are also discussed.

Keywords: *Attitudes toward science, gender, grade levels, primary and secondary school students.*

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Introduction

Several researchers have concluded that attitudes toward science (ATS) in primary school students change when they enter secondary school (DeWitt & Archer, 2015; Rabgay, 2018). Based on relevant works, scholars have shown the positive ATS reduces between the ages of nine and fourteen, and in the last couple of years of elementary school, the positive ATS decreases (Pell & Jarvis, 2001; Sorge, 2007). In addition, Said et al. (2016) explained that children are eager to explore the phenomena in the world around them; however, this passion then decreases when they enter junior high school, because the students expect science lessons to be more exciting (Pell & Jarvis, 2001). However, the reality faced by students is different; they are unable to see the links between science and the real world around them. Sometimes, they find science to be a dry and boring subject (DeWitt & Archer, 2015; Osborne & Collins, 2001; Said et al., 2016). At the age of 14, student interest in science drops quickly, and they show a lack of pleasure when engaging in science activities (DeWitt & Archer, 2015). Furthermore, Pell and Jarvis (2001) explain that, generally, from the age of 14, a student's interest in science will carry over into adulthood. They suggest that, when students are in the 11 to 14 age group, this is the best period to encourage students with natural science learning and the various kind of professions in the future they will be able to choose. Previous research conducted by Sorge (2007) examined the attitudes of 1,008 students from rural New Mexico in primary and secondary school, from ages nine through fourteen, and found a significant decrease in their positive attitude to science; this situation is attributed to them moving from primary to secondary school. Therefore, this fact indicates primary and secondary school are the important grade levels to examine the change in children's attitudes toward science.

Many researchers have identified factors that influence attitudes toward science (Khitab et al., 2015; Osborne et al., 2003; Rabgay, 2018). In particular, gender, grade level, personality, and curriculum materials are the crucial components associated with ATS. The essential variable that contributes to students' ATS is gender (Wan & Lee, 2017). Gender had a more consistent and significant effect on students' ATS (Jerrim & Schoon, 2014; Toma et al., 2019; Wan & Lee, 2017). In a quantitative study, Shah et al. (2013) reported that female students had a more positive ATS than male students. Previous studies have pointed to the effect of gender stereotyping on a child's ATS (Osborne et al., 2003). Studies have noticed male students are more energetic in the classroom; as a consequence, the teachers give more attention to them

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(Jerrim & Schoon, 2014; Jones et al., 2000). Indeed, previous researchers pointed out that males are more passionate and enthusiastic about science learning than females (Craker, 2006; DeWitt & Archer, 2015; Toma et al., 2019; Wan & Lee, 2017). The male students show good proficiency in mathematics, science, and social studies, while females show proficiency in arts and language (Siegel & Ranney, 2003). By contrast, some studies have reported that female students show a preference for science compared to males (Greenfield, 1997; Hong & Lin, 2011; Jerrim & Schoon, 2014). The female students between 10 and 15 years old exhibited higher proficiency in mathematics, science, and games. This fact indicates that the adaptation between the elementary and middle phases of education is a key stage and gender stereotypes need to be examined in order to change the students' ATS.

Weinburgh (2000) noted that there has been an increasing trend in terms of measuring students' ATS over the last 30 years. Various dimensions have been published for exploring students' attitudes. Much of this research has studied people from Western countries, while a limited amount of research involved participants from non-western countries, especially in Southeast Asia. Osborne et al. (2003) show that many studies have investigated ATS, and most of them have been conducted in the United States and European countries. More research in non-Western countries could help to determine students' ATS, and help standardize the instruments used for describing students' ATS in different cultural contexts, such as Indonesia.

Generally, each country has different customs, cultures, and education systems, which cause different attitudes and behavior toward the learning process. Nevertheless, not many researchers in Indonesia are currently concerned about students' ATS, especially in Aceh province where the culture is based on religion and the application of Islamic law. This influences daily life, education, and people's perspectives about science. According to the outcomes, Acehese students' achievements in science are still very low. This fact is proven by the ranking in this field: Aceh is ranked 31 out of 33 provinces in Indonesia. Most teachers in Aceh disregard the development of a positive ATS and place more emphasis on learning achievements. However, the achievement of these outcomes does not emphasize any change in the attitude of pupils toward learning science itself. Based on this fact, the current study is eager to investigate the students' attitudes toward science based on their gender and the grade of the schools they attend and any interaction between the dimensions in terms of their attitude. The study of this issue will provide data about the students' sense and confidence toward science. The availability of the findings may make it possible for scholars and teachers to figure out the changes in the students' ATS in Indonesia, especially in Aceh. Therefore, the study of ATS, related to Indonesian students' perspectives, will enrich the literature in the science education field.

Methodology

Research Design

A quantitative research design was utilized in this research. By using a questionnaire, students' attitudes toward science were investigated based on two variables, which are gender and the grade of the schools. The researchers employed TOSRA (Test of Science Related Attitudes) to achieve the aim of the research. The questionnaires include five scales representing different aspects of attitudes toward science learning: they are career interest in science, leisure interest in science, the attitude toward scientific inquiry, the social implications of science, and enjoyment of science lessons. According to Eccles (2007), TOSRA assigns separate scores to several different categories making it easier for educators and researchers to measure students' ATS.

Sample and Data Collection

This study involved 1,023 students that were spread across 8 elementary and 8 junior high schools. The method of stratified random sampling was applied in selecting the participants. Students in elementary and junior high schools are between 11 and 14 years old. The research was conducted in Aceh Province of Indonesia. This province is located in the west of Indonesia. The following Table 1 shows the distribution of samples.

Table 1. The Distribution of the Sample Based on Gender and Grade of School

Gender	Grade of Schools		Total
	Elementary	Junior High	
Male	238	191	429
Female	269	325	594
Total	507	516	N= 1023

Instruments

The basic process of the present study included: the selection of the pupils' attitudes toward science learning as the focus; the review of relevant literature; the identification of the research question; the selection of suitable measuring instruments for the study; the choice of schools for the sample; the choice of the school grade levels for the sample; and the choice of area for the sample. The instrument that was used to collect the data is the TOSRA. The questionnaire was developed by Chaerul (2002) from the original TOSRA which was designed by Fraser (1981). The questionnaire was employed to explore students' attitudes in science lessons. Fraser (1981) designed a TOSRA questionnaire of 70 items which were arranged into seven scales each with 10 statements. TOSRA is a well-constructed questionnaire in exploring ATS (Navarro et al., 2016). This questionnaire was designed to be a short version of the TOSRA. This study adopted five scales of TOSRA that are related to the research. The selected scales are the social implications of science, the normality of scientists, enjoyment of science lessons, leisure interest in science, and interest in a career in science. Squared Multiple Correlation and Alpha If Item Deleted were considered as a means to select five designated items. These scales have an alpha scale from .76 to .89.

In this study, the researchers have adapted the dimensions of attitudes toward science learning created by Fraser which are: (a) students' career interests - a professional interest in the field of science; (b) leisure activity related to science - pupils are interested in being involved outside the school in their spare time in science-related activities; (c) attitude to scientific inquiry - students' preferences regarding scientific inquiry in investigations; (d) the implications of science in social life - the positive and negative attitudes regarding the impact of science in society; (e) students' level of enjoyment of learning about science courses.

Table 2. Dimensions of the Test of Science Related Attitudes (TOSRA)

Dimensions	Description	Item
Career interest in science	Students' future interest in science	1, 2, 3, 4, 5
Leisure interest in science	Students are interested in being involved outside the school in their spare time in science-related activities	6, 7, 8, 9, 10
Attitude to scientific inquiry	Students' preference toward using scientific inquiry in investigations	11, 12, 13, 14, 15
Social implications of science	The positive and negative attitudes regarding the impact of science on society	16, 17, 18, 19, 20
Enjoyment of science lessons	The level of students' enjoyment of science learning	21, 22, 23, 24, 25
Total		25 items

The internal consistency reliability was estimated for TOSRA scales by using the Cronbach a coefficient. The Cronbach's Alpha Reliability Coefficients for the attitude toward science inquiry .82, enjoyment of science lessons .75, leisure interest in science .80, the social implications of science .83, and career interest in science .80. By using this questionnaire, students were asked to indicate whether they strongly agree (SA), agree (A), undecided or neutral (N), disagree (DA), or strongly disagree (SD) with each statement of the instrument by using the Likert scale.

Interviews were used to ascertain students' ATS. The questions were: *Do you enjoy science lessons in the classroom? Are you interested in attending science activities outside of school? Do you want to pursue a science-related career in the future?, and Does science have a positive effect on society?.* After the questionnaire was distributed, 88 students (42 males; 45 females) were invited for an interview session. They were selected based on their attitude scores; low, medium, and high. Individual interviews took approximately 10 minutes. Their opinions were used to support the quantitative findings.

Data Analysis

Descriptive statistics were applied to describe students' ATS. After fulfilling the assumption tests, i.e., normality ($p > 0.05$) and homogeneity ($p > 0.05$), t-test and two-way ANOVA were employed. The t-test was applied to determine whether any significant relationship existed among students' ATS in different categories of respondents, such as gender and school grades. Using the ANOVA, mean scores resulting from the TOSRA questionnaire were compared based on gender and grades. Applying a two-way ANOVA technique, the main effect of both gender and grade level of schools, as well as the interaction effect of those two variables were examined.

Results

Attitudes Toward Science Related to Gender

By applying the statistical method of t-test, the researchers investigated gender-based differences toward students' ATS. The data revealed a statistically different SATS between male and female students. Females' attitudes were more positive than those of males. Table 3 illustrates the difference in students' ATS based on gender. Females' attitudes ($M = 3.78$; SD

= 0.46) were more positive than male ($M = 3.52$; $SD = 0.54$) with a medium effect size ($d = 0.52$) according to the criteria of Cohen (1988).

Table 3. *t*-test for ATS Based on Gender

Gender	N	Mean	SD	Df	t-value	Effect Size
Male	429	3.52	0.54	1021	14.75**	0.52
Female	594	3.78	0.46			

Note: ** $p < .001$

Table 4 shows the students' ATS based on gender differences among the five scales of TOSRA. Overall, Table 4 shows the scales of TOSRA indicate a statistical difference between males and females ($p < 0.001$).

Table 4. Performance of ATS Based on Gender for Each Scale

Scale	Male (N=429)		Female (N=594)		Mean Difference	t-test
	Mean	SD	Mean	SD		
Career Interest in Science	3.35	0.85	3.77	0.76	0.42	8.26**
Leisure Interest in Science	3.59	0.76	3.93	0.59	0.35	8.21**
Attitude to Scientific Inquiry	3.28	0.52	3.37	0.48	0.83	8.08*
Social Implications of Science	3.84	0.70	4.05	0.56	0.21	5.36**
Enjoyment of Science Lessons	3.55	0.81	3.77	0.74	0.22	4.42**

Note: ** $p < .001$; * $p < .01$

The data revealed the mean score of social implications of science as the highest score from others. The mean score of female students' ($M=4.05$; $SD=0.56$) is higher than that of males ($M=3.84$; $SD=0.70$). For both genders, the lowest score among the scales is the attitude of scientific inquiry. The mean score of female students on that scale is ($M=3.37$; $SD=0.48$) and ($M=3.28$; $SD=0.52$) for male students. Table 4 shows that females' score for career interest in science is higher than that of males. There is a significant difference between males ($M=3.35$; $SD=0.85$) and females ($M=3.77$; $SD=0.76$) on this scale. This indicates that female students prefer to choose scientist as their career in the future. A significant difference between males ($M=3.59$; $SD=0.85$) and females ($M=3.77$; $SD=0.76$) is also indicated in the scale of leisure activity in the field of science.

The next scale of TOSRA in the questionnaire is the students' enjoyment of science courses. Likewise, level of leisure activity related to science: this scale shows a significant difference between males and females as well. Thus, the female students' score ($M=3.77$; $SD=0.74$) is higher than that of males ($M=3.55$; $SD=0.81$).

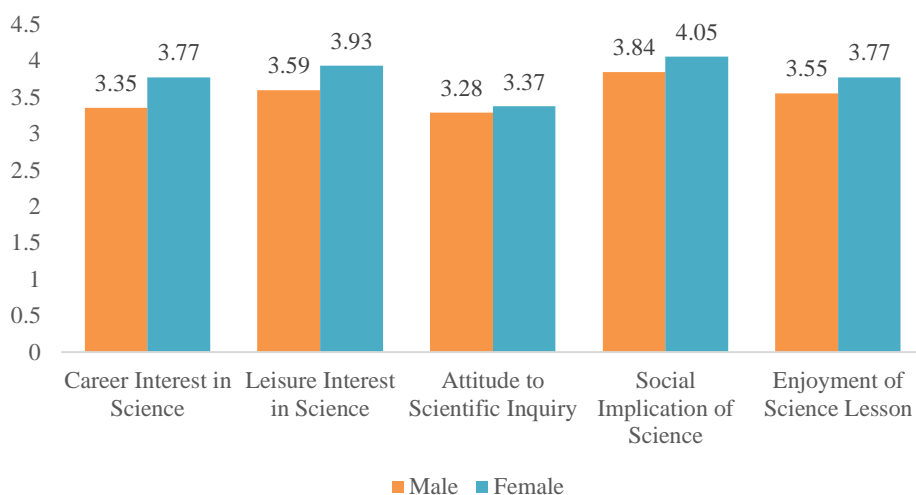


Figure 1. Mean score per each scale of TOSRA based on gender

SATS Related to Grade of School

As for examining SATS in different grades, Table 5 shows SATS in elementary and junior high schools. The data reveals there is no significant difference in the SATS between the sixth grade of primary school and the eighth grade of secondary school.

Table 5. Performance of SATS Based on Different Grades of School

Level of school	N	Mean	SD	df	t-value	Effect Size
Elementary School (ES)	507	3.70	0.52	1021	1.85	0.12
Junior High School (JHS)	516	3.64	0.50			

Although this result indicates the difference was very slight, the data show that the mean score of the students' attitudes in elementary school (M = 3.70; SD = 0.52) is more positive than in junior high school (M = 3.64; SD = 0.50).

Table 6. The Differences of SATS Based on Grade for Each Scale

Scale	Elementary (N=429)		Junior High (N=594)		Mean Difference	t-test
	Mean	SD	Mean	SD		
Interest in a career in science	3.64	0.84	3.54	0.81	0.11	1.94
Leisure interest in science	3.77	0.71	3.81	0.66	0.36	0.83
Attitude to scientific inquiry	3.31	0.51	3.35	0.49	0.38	1.22
Social implications of science	3.94	0.66	3.99	0.61	0.51	1.29
Enjoyment of science lessons	3.84	0.76	3.52	0.76	0.32	6.72**

** $p < .001$

Table 6 illustrates the level of difference between the schools among the TOSRA scales. It can be interpreted that four out of five dimensions of TOSRA show no significant difference between elementary and junior high schools. However, one of them reveals significant differences: the scale of students' enjoyment of learning science.

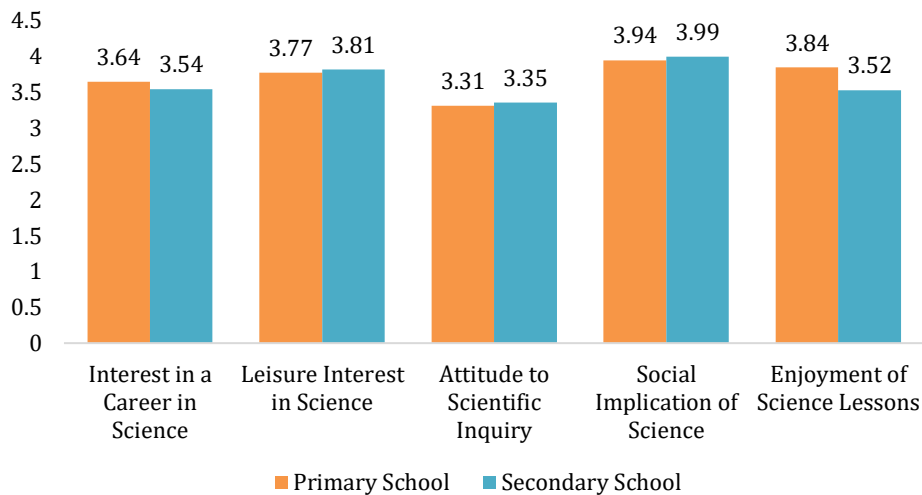


Figure 2. Mean score for each scale of TOSRA based on the grade levels

Attitudes toward Science Related to Gender and The Grade of The School

Using a two-way ANOVA technique, the interaction and main effect of gender and the grade level were analyzed statistically. The result of students' attitudes toward science with the TOSRA questionnaire was shown in table 7.

Table 7. Analysis of the Interaction toward SATS by Gender and Grade Levels

Source	SS	Df	MS	F
Gender	17.12	1	17.12	70.20**
Grade	1.77	1	1.764	7.23*
Gender * Grade	0.002	1	0.002	0.008

Note: ** $p < 0.001$; * $p < 0.05$

This study found males and females exhibit considerable differences in their enthusiasm toward science. Table 7 shows that females in elementary grades have a more enthusiastic attitude than males ($F = 35.71$; $p < 0.001$). This is also seen in junior high schools; females have a more enthusiastic attitude than males ($F = 34.52$; $p < 0.001$).

Table 8. Analysis of the Simple Main Effect toward SATS by Gender and Grade of School

Source	SS	Df	MS	F	Sig	Post-hoc
Gender						
Male	0.71	1	0.71	2.41	0.12	
Female	1.12	1	1.12	5.42*	0.02	E>S
Grade						
Primary	8.96	1	8.96	35.71***	0.000	F>M
Secondary	8.18	1	8.18	34.52***	0.000	F>M

*** $p < 0.001$; * < 0.05

Table 8 shows that female students in elementary grades have a more positive attitude than male students. This condition continues until junior high school. The data revealed that female students in secondary schools have more positive attitudes than males. According to the grade level of the school, the female students' ATS at the elementary level are more positive than in junior high schools.

Discussion

According to the student's gender, the data from the interviews conducted by the researchers to support the questionnaire's items revealed that girls are more fascinated by science activities than boys are. This fact is indicated by most of the female students saying they would prefer to have a career in science. This important fact differs from those of previous studies. Many researchers have reported that boys exhibit significantly more enthusiastic attitudes toward science than girls do (Toma et al., 2019; Weinburgh, 2000). Findings from the interviews conducted by the researchers provide evidence that boys are less hard-working than girls. Female students are shown to be hard-working in doing tasks and conducting science activities. Generally, students' ATS tend to be positive. Since the majority of students in Indonesia's Aceh Province are Muslim, Islamic culture might influence students' understanding of the nature of science (Safkolam et al., 2021), and in turn, lead to positive ATS.

The students' ATS, based on their gender differences among the five TOSRA scales, showed that the average score of the girls was better than boys. This indicates that the females are more sensible of the meaning of science in daily life. Most of the females realize that the application of science would make their lives better. Many educators believe students' attitudes toward the social implications of science may contribute to their decision in selecting a future career in science (Toma et al., 2019). Students' attitudes toward the social implications of science were crucial in determining their science elective decisions, especially among female students (Jerrim & Schoon, 2014).

The result reveal that students are unfamiliar with how to conduct experiments, and they are not used to working independently when learning, especially in science activities. Related to the interview data, female students want to conduct experiments; however, they are less confident in interpreting their findings. This is also found among male students. According to this result, teachers are supposed to facilitate students when conducting experiments. They should encourage the students to feel convinced about their results, and satisfied with their attempts at scientific exploration (Al-Araimi et al., 2018). The science teachers are supposed to improve the students' attitudes toward science by conducting experiments. This activity could be an alternative method for helping the students to feel more enthusiastic in science class. The data reflect those female students are more interested in the profession of science; this fact is revealed by interview data which show female students prefer to be scientists. The research conducted by Aini et al., (2019) revealed that Indonesian female pupils have a better ATS than males do. In line with the interview data, female students want to have careers as doctors, work in a laboratory, be a science lecturer, or an architect or similar, while male students express aspirations to be police officers, soldiers, soccer players, or athletes, etc. This fact reveals male students are more interested in physical activities than other activities. In addition, several studies confirm that female students consider science to be more useful to them than other subjects (Hong & Lin, 2011; Jerrim & Schoon, 2014), hence female students tend to select the former instead of the latter. In other words, students who perceive science as being useful or relevant to them, both now and in the future, are more likely to decide to make the field of science their profession in the future.

The aspect of the leisure interest in science also shows that females show more interest than males do. This finding corroborates previous studies. For example, Daher et al. (2021) reported that female students had significantly higher scores in all the components of motivation towards science. Chumbley et al. (2015) and Glynn et al. (2011) also found that females had higher motivation and self-determination than males. This indicates the students' desire to participate in out-of-school science-related activities. In addition, female students are interested in exploring science by watching programs on television such as those on the Discovery Channel, or science fiction programs, programs about animals' lives, etc (Jones et al., 2000). Most of the female students are enthusiastic when talking with friends about science after

school. They enjoy discussing scientific material after they learn about it. In contrast to female students, male students get bored when watching science programs on TV, listening to talk about science on the radio, and talking to friends about science after school. However, according to the interviews, both the male and female students expressed their willingness to visit a science museum on a weekend. Briefly, this result gives important feedback for science teachers to help them increase students' positive attitudes toward science. It is suggested that the teachers could arrange field trips to help motivate their students to learn about science.

Along with the above explanation, data on the students' enjoyment in science learning show that females have more interest in science than male students do. This finding is in line with previous studies, i.e., Chumbley et al. (2015) and Jones et al. (2000). Female students relish science materials such as information about animals' lives, the characteristics of an organism, natural phenomena, etc. Therefore, they enjoy going to science classes and they agree with the statement that science classes are fun. This is in contrast to the male students. Male students find science lessons boring, and they do not enjoy attending them. Male students do not agree with the statement "Science is one of the most fascinating subjects." They consider physical classes and art classes to be the most interesting. Because of this, science teachers should try to apply teaching methods that are suitable for this point of view. The teachers have to employ constructivist teaching methods that can improve the male ATS. The data reflect the interaction between gender and grade level with various components of the ATS. These findings are in line with prior studies that the attitude toward science has different components and has different interactions between the components (Jerrim & Schoon, 2014; Osborne et al., 2003; Townsend, 2012; Wan & Lee, 2017).

According to the students' ATS in different grades of schools, the results show no statistical difference between the students' attitudes in elementary school and junior high school. It is interesting to note, unlike with other prior studies, this result reveals students in elementary and junior high schools have the same response toward their ATS. The prior research reported that ATS had declined between the ages of 10 and 14, as they move from elementary schools to junior high schools (Aini et al., 2019; DeWitt & Archer, 2015). The findings of this study indicate the equality of students' ATS between elementary and junior high school. The results are meaningful feedback for science teachers, who should continue to maintain their students' positive ATS in the different grades of school.

The TOSRA scales revealed no significant difference between elementary and junior high schools for the scale of interest in a career in science, leisure interest in science, the attitude to scientific inquiry, and the social implications of science. The findings indicate that the students in the sixth and eighth grades have the same ATS. This condition is supported by the fact that students show a great desire to participate in science classes. Related to the dimension of the pursuing a career in science, the data show students in both grades of school desire to have a career as a scientist. They consider such a profession to be interesting. The result interprets those students in both grades as having a more favorable feeling toward statements such as "my ambition in the future is to be a scientist".

The positive attitude toward a career in science is affected by their leisure interest in science. Similarly, this dimension reveals that students at both levels tend to have the same attitude to studying science. They enjoy visiting a science museum on the weekend (Anderson et al., 2003), they relish spending their spare time watching science programs on TV or reading science articles. The equality of the students' ATS is also expressed by their attitude toward scientific inquiry. This condition is reinforced by the students' explanations from both grades, which reveal they are more intensely curious about exploring science and to experiencing laboratory activities. Students at both school levels are aware of the implications of science in their lives. They trust that knowledge of science will allow them a better life. This finding is consistent with the study of Sheldrake et al. (2017). However, the data show that the scale of enjoying science lessons has a statistical difference between elementary and junior high school. The average score of elementary students for their enjoyment of science lessons is higher than that for junior high school students. This fact is indicated by the students' perceptions of science being changeable over time. They find science classes more complicated and challenging, especially for some science topics, such as the characteristics of life or physics formulas. Students have stated that science lessons were taught using conventional methods; because of that, the subject is boring and frustrating. Eventually, this condition leads to them disliking science. Most of the students in junior high schools seem to have more inclination to agree with the statement "Science classes bore me" and disagree with expressions such as "Science classes are fun," or "Science is a fascinating course in school".

Briefly, students in elementary and junior schools express similar positive attitudes toward science. This fact is illustrated by the TOSRA scales: they are interested in careers in science, they have a leisure interest in science, a positive attitude to scientific inquiry, and understand the social implications of science. Nevertheless, when elementary school students enter junior high schools, their enjoyment of science declines significantly. This finding is in line with Potvin and Hasni (2014) whose findings reported a decrease in interest in school science and technology from grades 5 through 11. Therefore, our findings provide substantial feedback for science teachers. The teachers should make a greater effort to encourage students to enjoy science classes, especially when they enter the higher school levels. The teachers should apply teaching methods that are appropriate to create a more vivid and stimulating classroom. This hopefully helps the students to feel great positivity about attending science courses.

Related to the level of schools, female students' ATS in elementary schools are better than in junior high schools. However, when they enter junior high school their attitude toward science declines slightly. As a result, the practical significance of this difference seems dubious. Moreover, even though the male students' attitudes are less positive than those of the female students, their attitudes tend to be the same between elementary and junior high school. This study shows that female students in elementary schools feel more enthusiastic in science class. Similarly, female students exhibit more enthusiasm than males do in junior high schools.

Related to the grade levels of the schools, female students' ATS in elementary schools are better than in junior high schools. This result corresponds with some studies that found females had a more positive attitude than males (Aini et al., 2019; Chaerul, 2002). Some previous studies reported ATS declines from the ages of 10 to 14, as they move from elementary schools to junior high schools (Aini et al., 2019; DeWitt & Archer, 2015).

Conclusion

The result shows that female students have a more positive ATS than male students, at both levels of schooling. Specifically, female students have more positive ATS than males across the scale. Students in higher grades show lower attitude scores than students in lower grades. This condition reflects the general phenomenon happening to the teaching of science in Aceh Province. It implies that females show more enthusiasm in science classes than boys do. This surprising finding contrasts with previous studies. Many studies found that males consistently hold more positive attitudes toward science than females. According to the interviews, however, female students are more interested in science activities than males are. Female students are consistently more hard-working than male students and thus are more able to cope with the learning processes than their male peers are.

According to the grade of the schools, the data reveals that there is no significant difference in students' ATS between the sixth grade of elementary school and the eighth grade of junior high school. Although this result indicates the difference are very slight, the data show that the mean score of the students' attitude in primary schools is higher than in secondary schools. It is worth noting that, unlike in prior research, Acehnese students reveal that their ATS is the same in elementary and junior high schools in the province. Nevertheless, when elementary school students enter junior high school, their enjoyment of science declines significantly. This result is meaningful feedback for science teachers, who must try to continue to maintain the students' positive attitude toward science.

Recommendations

This research identifies five implications for future research. The first is the need to explore the causes of the decline in positive ATS. The second is to examine practical and appropriate strategies to improve students' ATS, especially in the early years of junior high school. The teachers should make a greater effort to encourage students to enjoy science lessons, especially when they enter higher levels of school. The teachers should apply teaching methods that are appropriate to create more vivid classrooms. By this strategy, eventually, students can build a more positive attitude toward their science classes. The existence of a difference between the ATS of females and males cannot be ignored. The third is that scholars need to explore gender stereotypes based on ethnic backgrounds. The fourth is the need to construct a strategy for developing a positive attitude toward science without a gender gap. This will assist curriculum designers in designing materials that encourage students' enthusiasm and interest in learning science without gender differences. Lastly, these results suggest that a survey needs to be conducted to cover the complexity of students' attitudes toward learning science. Therefore, qualitative research in this area is needed.

Limitations

This study has investigated how students' ATS correlate to gender and grade of schools. However, the research has a limited area of study which causes a lack of representativeness of the sample. This research should also be combined with qualitative methods to obtain more comprehensive data.

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Authorship Contribution Statement

Susilawati: Contributed to writing the manuscript, collecting the data, analyzing and interpreting the data. Aznam: Supervising the research process from the beginning until the end of the research, critical revision of the manuscript. Paidi: Assisting in constructing the theoretical concepts and data analysis, reviewing the final manuscript.

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