



**Abstract.** *Student attitudes toward science have been one of the longstanding topics in science education research. Even though Indonesia has a unique educational system in which cultural, religious, and cognitive aspects are incorporated in the science K-12 curriculum, a limited number of studies have explored Indonesian students' attitudes towards science. This research aimed to examine students' attitudes toward science and the interaction between academic grade level and gender in Indonesian primary and middle school. Thirty items from five components of the BRAINS instrument were administered to 1587 Indonesian students from fourth grade through ninth grade to measure their attitude toward science. Rasch analysis, two-way ANOVA, and structural equation modeling path analysis were used to answer the proposed research questions. The current research found that Indonesian students' attitudes toward science were significantly affected by academic level, however, gender only affected three components of attitude (control belief, attitude toward the behavior, and intention). Female students showed a higher attitude toward science than male students in general. The trends in every component of the students' attitudes decreased from primary school to middle school. The present research provides a deeper discussion by considering the socio-cultural and educational history of Indonesia.*

**Keywords:** *academic level, gender, middle school, primary school, science attitude.*

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## INDONESIAN PRIMARY SCHOOL AND MIDDLE SCHOOL STUDENTS' ATTITUDES TOWARD SCIENCE: FOCUS ON GENDER AND ACADEMIC LEVEL

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### Introduction

Science is an essential part of human life, necessary for understanding the nature of phenomena, inventing new technologies, and optimizing decision-making to improve our lives. Science, technology, engineering, and math (STEM) capabilities and skills, which are fostered in science classes are also in high demand for the future global workforce. According to the Workforce in the Future report (PwC, 2017), resource scarcity and climate change will increase the demand for jobs in areas such as alternative energy, new engineering processes, and waste management. Dramatic changes toward machine-oriented techniques and artificial intelligence will also necessitate the creation of new professions. UNESCO (2017) reported that gender equality in science would promote new solutions, generate diverse innovation, reduce bias, and broaden new research in science. However, the gender gap ratio between science researchers from 2008 to 2014 was reported to be 70% males and only 30% females (UNESCO, 2017). Female interest in STEM is believed to originate in school and the report by UNESCO (2017) also indicated that the gender gap in STEM was apparent in secondary education. Therefore, studies of gender differences have been undertaken for more than 20 years to address this issue.

Given the emergence of the importance of gender equity in science, it is essential to consider educational factors, particularly in the psychological influences on students' attitudes toward science. Several studies have pointed out that one of the personal factors substantially influencing students' choices regarding course and career aspirations was their attitude toward science (Khishfe & Boujaoude, 2016; Masnick, Valenti, Cox, & Osman, 2010; Osborne, Simon, & Collins, 2003; Prieto & Dugar, 2016; Uitto, 2014). UNESCO (2015) also reported that one of the crucial factors predicting STEM career interest itself was attitude toward science in school.

Psychological studies have found a relationship between attitudes, intention, and belief. Theory Reasoned Action and Behavior (TRAPB) proposed by Ajzen and Fishbein (1991, 2005, and 2010) is one of the well-known findings. TRAPB suggests a framework for understanding the specific behavior of a human by considering the interest and perception controlling the behavior. According to this theory, it is possible to access

attitude-relevant information from different types of beliefs. Therefore, exploring students' attitudes toward science is also helpful in identifying prospective approaches to science teaching and learning (Elster, 2007). Previous research indicated that the attitude of male students toward science was more positive than that of female students (Dawson, 2000; Denessen, Hasselman, & Louws, 2015; DeWitt & Archer, 2015; Toma, Greca, & Orozco Gómez, 2019).

Interestingly, 67.5% of the students enrolled in STEM disciplines at Indonesian universities are female and 32.5% are male (UNESCO, 2015). This gender percentage, which is opposite that found in previous research, requires further investigation of the Indonesian students' attitudes toward science and the interaction between each attitude's construct. It is important to investigate this issue to provide insight into gender equity in science education.

## Literature Review

### *Attitude towards Science*

In a psychological context, attitude is defined as the latent variable in an individual's response toward some object, person, or other aspects (Ajzen, 1989). Major research from the 1960s in science education has acknowledged the importance of attitude and its effect on learning science (Jones, Howe, & Rua, 2000; Koballa & Glynn, 2013; Osborne, Simon, & Collins, 2003). Previous research on science attitudes has identified students' interest in science, science-related activities, and enjoyment of science-learning experiences as important factors (Khishfe & Boujaoude, 2016).

A study by Anderhag, Hamza, and Wickman (2015) used the term "taste", rather than attitude, to examine how students come to enjoy science class, see it as a concern in their everyday lives, and choose careers in science. Furthermore, Osborne, Simon, and Collins (2003) described that attitude was different from interest in science, since attitude itself refers to a more general area of an individual relationship with the environment, is more behavioral, and has a relationship between intention. Thus, attitudes toward science also have the attributes of feeling, belief, value, and opinion about science, which distinguishes as scientific attitude (Koballa & Glynn, 2013; Osborne, Simon, & Collins, 2003).

According to Summers and Abd-El-Khalick (2018), the concept of attitude toward science has shifted from individual's preference (like or dislike) and negative or positive feelings about science to a cognitive orientation. TRAPB by Ajzen and Fishbein (1991, 2005, 2010) also put its role in this context. Summers and Abd-El-Khalick (2018, p.12) simplified it by stating that "*the more favorable the attitude and the subjective norm, and the greater the perceived control, the stronger the person's intention is to perform the behavior in question.*" Furthermore, Summers and Abd-El-Khalick (2018) developed an instrument to measure students' attitude toward science called Behaviors, Related Attitudes, and Intentions toward Science (BRAINS), as well as developing the components of attitude toward behavior. They used Ajzen's TRAPB theoretical framework to understand science-related behavior and predict students' attitudes and behavioral intentions. Components of BRAINS relate to five TRAPB's components, which are behavioral belief, normative belief, control belief, attitude toward behavior, and intention.

### *Gender Issue in Science and Attitude towards Science*

Research in science education indicates that gender has an essential role in influencing attitudes toward science. In the 1960s, gender inequality in science education was acknowledged and studies on gender and science education began (Brootman & Moore, 2008). Baker (2002) pointed out that the gender issue in science education was recognized as a crucial problem in the late 1980s, when the number of scholarly articles about gender began to increase. This was also supported by the finding by Osborne, Simon, and Collins (2003) that gender was one of the factors that influenced students' science attitudes in general. According to Weinburgh (1995), who conducted a meta-analysis study between 1970 and 1991 by examining gender differences in attitudes toward science and their correlation with achievement in science, the attitude of male students in science was more positive than female students. A similar result was found by a meta-analysis study conducted by Becker (1989). Because of these issues, several authors have attempted to identify gender discrimination in the teaching and practice of science (Brotman & Moore, 2008; Brickhouse & Potter, 2001; Howes, 2002).

Early studies indicated that female students had less science attitude than male students (Catsambis, 1995;



Simpson & Oliver, 1990). A more current report by several authors (Jones, Howe, & Rua, 2000; Miller, Blessing, & Schwartz, 2006) also indicated that male students had a higher science attitude than females, even though there were also big gaps of in certain subjects, such as physics and biology. Contrasting results have also been found in several studies, indicating that female students had more positive attitudes or equal proportions of positive attitudes toward science as male students (Boone, 1997; Harwell, 2000; Murphy & Beggs, 2003; Said, Summers, Abd-El-Khalick, & Wang, 2016). According to Koballa and Glynn (2013), sociological reasons for gender inequality in science students might be the result of different cultural expectations of the genders by people close to the students (i.e., parents, peers, and teachers) and their experiences in science. According to Baker (2002 p. 662), gender and equity issues in science education need to be addressed by examining the gender, class, cultural, religious ethnicity to answer where the gender and equity in science education are.

### *Gender, Culture, and Educational Issue in Indonesia*

Indonesia is the largest Muslim country in the world, about 87% of its population is Muslim (Statistics Indonesia, 2018). In the colonial era (beginning in the 16th century), a woman's role was as a mother and wife, and at that time, only women from elite backgrounds attended formal school (Rinaldo, 2011). That was also impacted by the role of gender in Indonesian culture. For example, Javanese culture, the most prominent ethnic group in Indonesia, had three prominent Java beliefs about women. The first was in the saying 'konco wingking' (literally meaning "a companion whose place is in the back part of the house"), the second was 'suargo nunut neraka katut' (meaning "a wife will go wherever her husband goes, to hell or heaven, making her a mere follower of the husband's deed"), and the third said women's roles are 'manak, masak, macak' (meaning "to breed, to cook, and to adorn herself for her husband") (Arimbi, 2010 p.61). Thus, women's roles in Javanese culture were to manage the household and be obedient to their husbands.

In the 1880s, support for Indonesian education for girls and women gained momentum from the actions of the Indonesian national heroine for women's emancipation, Raden Adjeng Kartini. She began to read many books and wrote famous pieces about Indonesian women at that time, which commenced the Indonesian literacy culture campaign for women. The reformation of women's rights in Islam started in the mid-1990s when political subjectivities were shaped (Rinaldo, 2011). The period in the 1990s after Indonesian independence was a vital period for Muslims in Indonesia where the Indonesian constitution guaranteed equal rights for both genders and a women's independent organization was founded (Arimbi, 2010; Rinaldo, 2011). The words "gender quality" and "feminism" were famous among students because of the network of women's NGO in Indonesia in the mid-1990s, even though the stereotypical female activists were from elite backgrounds. Over the last decade, the gender quality issue has been raised again by Muslim women.

Regarding the current situation for women in Indonesia, their participation in decision-making roles is still low, with 18% of women's participating in the Indonesian parliament in 2009-2014 (UNDP Indonesia, 2017; JICA report, 2011). Women still accounted for a bigger proportion of the unemployment rate in 2014, when 6.2% of females and 5.7% of the males were unemployed (JICA report, 2011; UNDP Indonesia, 2017). In general, women are also paid less than men, even though it depends on their academic level (UNDP Indonesia, 2017; Purnastuti, Miller, & Salim, 2013). The stereotype of "women's place is in the house" contributes to the female unemployment rate in Indonesia.

As mentioned previously, in Indonesia, female students still accounted for a larger proportion of students enrolled in STEM disciplines in 2014 in selected universities, where females and males comprised 68% and 32.5% of the enrollment, respectively. However, the data reported that the female students enrolled in STEM fields in higher education were concentrated in biology or health fields and a bigger proportion of students in the engineering field were comprised of males (UNESCO, 2015). Based on the UNESCO report, prospective female students chose the health field and prospective male students chose the engineering field as their career aspirations starting from 15 years old.

### *Indonesian K-4 to 9 Science Curriculums*

Another factor that influences students' attitudes toward science is the curriculum. Osborne, Simon, and Collins (2003) described curriculum as variables that influenced students' attitudes toward science, even though the more significant effect on attitude was the teacher him/herself. In addition, it has been hard to generalize



which attitude or curriculum impacted attitudes toward science. Evidence by Osborne, Simon, and Collins (2003, p.1070) highlighted that effective science teaching could be the main reason for negative attitudes toward school science.

Current Indonesian curriculum (K-2013) has four core competencies which are covered using a student-centered scientific approach. Science subject begins in the fourth grade in primary school until ninth grade of middle school level where it is taught as one integrated science subject. At the high school level, science subjects are separated into biology, chemistry, and physics. The general principles of the Indonesian curriculum are comprehensive and continuous (Dharma, 2008), where the content in all grades is the same but the depth and scope are different. The subjects are presented continuously at all educational grade levels. This indicates that Indonesia follows the spiral curriculum, where the difficulty construct level increases in every grade. The students learn the same topics or sub-subjects at every grade level with different degrees of difficulty, starting from a concrete concept to an abstract concept and from general to specific concepts. Science teaching and learning also follows a continuum from surface knowledge to constructed knowledge (Biggs & Collin, 2014).

### *Research Focus*

The current research examined Indonesian students' attitudes toward science with the following research questions:

1. What is the extent of the effect of gender, academic grade level, and the interaction between gender and academic grade level on Indonesian students' attitude toward science?
2. What are the aspects of attitude toward science that influence Indonesian students' attitudes toward science?

## **Research Methodology**

### *General Background*

Quantitative research was performed, and the data were collected in August 2017. The researcher asked the school officer to inform the teacher and students about this research and the school administrators arranged the classes and students who were willing to participate in the research. Before completing the questionnaire, the students read the conditions of research involvement. An IRT-Rasch analysis was performed for data validation and the person measure of IRT-Rasch was used in further analyses. Subsequently, two-way ANOVA, the correlation of gender and grade to students' attitudes toward science, and structural equation modeling (SEM) were examined.

### *Participants*

The data of the current research were gathered from 1587 Indonesian students from fourth grade through ninth grade in primary and middle schools located on the western Java Island. According to Decile (2010), many researchers from educational studies consider that 30-500 subjects are appropriate enough for a parametric test. Furthermore, sample size also considered as enough criterion for statistical significance and meaningful to represent the population. The participants were gathered from four schools, with both public schools and private schools at each grade level. From the 1587 total participants, 806 (51%) were female, 764 (49%) were male, and 17 did not indicate gender information (missing). Ninety-seven percent of the total participants were Muslim, and some were of another religion (Christian, Catholic, and Hindu). Regarding the frequencies of participants at the primary level, 148 students were in the fourth grade, 128 were in the fifth grade, and 103 were in the sixth grade. In the middle school level, 361 students were in the seventh grade, 380 were in the eighth grade, and 450 were in the ninth grade.

### *Research Instrument and Instrument Validation*

The BRAINS Instrument developed by Summers and Abd-El-Khalick (2018) and measured on a 5-point Likert-scale (from strongly disagree to strongly agree) was used in this research. The main reason that the BRAINS



instrument was used is because it standardizes attitude measurements and removes gaps between grades and ages from the internal consistency. The BRAINS instrument also has a strong theoretical framework built on Ajzen's TRAPB (1991, 2005, 2010).

The BRAINS Instrument has five dimensions (constructs) with a total of 30 items translated into the Indonesian language. The *Behavioral Beliefs* dimension works to control positive or negative attitudes toward behavior (Ajzen & Dasgupta, 2015). The behavioral belief dimension is a belief about the effects of learning science or becoming a scientist as measured by nine items such as "We live in a better world because of science" or "Scientists usually like to go to work, even when they have a day off." The *Normative Beliefs* dimension refers to individual or group approval for performing the behavior. This belief stems from social (for example, family or friends) approval or disapproval of engagement in science (Ajzen & Fishberin, 2005; Summers & Abd-El-Khalick, 2018). It has three items, including "My family encourages my interest in science." The *Control Beliefs* dimension refers to the basic perception of behavioral control. This belief is perceived to stem from self-efficacy or effort and that this belief and actual control (i.e., skills or abilities) can facilitate performance (Ajzen & Fishberin, 2005). In this context, an individual's perceived ability to learn science or the effort put forth affects science learning (Summers & Abd-El-Khalick, 2018). The Control Beliefs dimension has six items about perceived self-efficacy, such as "Science is easy for me." The *Attitude toward Behavior* dimension refers to the control of responding favorably or unfavorably toward science (Ajzen & Fishbein, 2005). The attitude refers to different aspects of science and connects with individuals' lives. This attitude toward behavior serves as the connection between belief factors and an individual's intention. Examples of items in this dimension are "I really like science," and "Science is one of the most interesting school subjects." The *Intention* dimension involves motivational factors of an individual's choice or conscious plan which are reflected in the performance of an individual's behavior. It is also an indicator of how much effort individuals are willing to put forth in order to perform their behavior (Ajzen, 1991). The intention dimension includes students' intention to pursue science, such as a career in science. One of the samples from the six items of intention is "I would enjoy working in a science-related career."

The responses to the item in the BRAIN Instrument were examined in terms of dimensionality, item fit, and reliability. To determine which was the better way to interpret the instrument, dimensional analyses were conducted using Rasch analysis. As a result, the five-dimension model was used, in which the Akaike Information Criterion (AIC), final deviance, and chi-squared analyses met the benchmark after being compared with the one-dimensional analyses. Criteria from Adams and Wu (2010) was used to select the dimensionality model by choosing the lowest AIC and final deviance (Table 1).

**Table 1. Dimensionality test.**

	Final Deviance	AIC
One-Dimension	117287	117529
Five-Dimension	115783	116053

The IRT-based Rasch analysis and Classical Test Theory (CTT) were used to determine reliability. Cronbach's alpha coefficient was determined using the CTT methods. Cronbach's alpha coefficient was above .663, which suggests acceptable use of the instrument (Behavioral Beliefs, .769; Control Beliefs, .648; Normative Beliefs, .663; Attitude towards Behavior, .790; and Intention, .735). Based on the IRT-based Rasch analysis, the coefficient obtained from Separation Reliability to indicate how fit the parameter separated from the analysis was .993. Furthermore, all coefficients of EAP (Expected A Posteriori) indicating item reliability were above .752 (Behavioral Belief, .798; Control Beliefs, .787; Normative Beliefs, .752; Attitude towards Behavior, .878; and Intention .845).

The amount of unexpected variation in the response items was also analyzed by the item fit by the range of MNSQ and the items were fit into the range of .50-1.50, as recommended by Wright and Linacre (1994). The miss fitting is found in BRAIN30 item by outfit MNSQ 1.56, but it was still considered acceptable to use (Wright and Linacre, 1994). Differential item functioning (DIF) was used to identify any items biased in terms of gender or grade (Table 2). Based on criteria by Zwirk, Thayer, and Lewis (1999), the range of DIF was below .5. However, the DIF result for BRAIN item 8 was considerable, since the gap from benchmark is not a huge difference.



**Table 2. Psychometrical properties based on Rasch Modeling in the BRAINS instrument.**

Dimension	Item	Estimate	Outfit MNSQ	Infit MNSQ	Cronbach's $\alpha$ if Item Deleted	DIF Gender	DIF Grade
Behavioral Beliefs	BRAIN02	-.459	1.07	1.07	.754	.08	.03
	BRAIN03	-.164	1.03	1.02	.751	.28	.06
	BRAIN08	.182	1.25	1.16	.765	.00	.66
	BRAIN19	-.032	.92	.92	.736	.00	.22
	BRAIN21	-.138	.98	.97	.741	.00	.10
	BRAIN25	.484	1.13	1.11	.759	.14	.18
	BRAIN26	-.196	.90	.91	.734	.05	.14
	BRAIN27	-.198	0.87	.87	.727	.02	.02
Control Beliefs	BRAIN29	.521	1.12	1.11	.756	.21	.16
	BRAIN05	-.364	.97	.98	.597	.07	.36
	BRAIN06	-.184	1.18	1.15	.620	.25	.18
	BRAIN10	.643	.94	.94	.590	.00	.07
	BRAIN12	-.131	1.24	1.19	.641	.17	.38
	BRAIN14	.303	.94	.94	.599	.08	.13
Normative Beliefs	BRAIN18	-.267	.89	.90	.586	.14	.04
	BRAIN09	.147	1.20	1.17	.742	.03	.39
	BRAIN17	-.055	.91	.91	.482	.11	.36
Attitude towards Behavior	BRAIN22	-.092	.91	.91	.472	.06	.00
	BRAIN01	-.271	.93	.94	.756	.13	.16
	BRAIN07	-.048	.88	.89	.749	.00	.07
	BRAIN15	-.149	.81	.82	.739	.00	.16
	BRAIN23	.207	1.23	1.22	.787	.03	.13
	BRAIN24	.149	.79	.80	.717	.05	.06
Intention	BRAIN30	.112	1.56	1.32	.797	.20	.43
	BRAIN04	.019	.95	.94	.680	.08	.09
	BRAIN11	.044	1.36	1.30	.741	.00	.32
	BRAIN13	-.049	1.12	1.10	.707	.12	.16
	BRAIN16	-.382	.88	.89	.688	.15	.05
	BRAIN20	.055	.87	.87	.675	.00	.12
	BRAIN28	.314	.98	.98	.695	.13	.12

### Data Analysis

Dimensionality analysis was performed using ACER ConQuest version 4.5.0, whereas the item fit and IRT-based Rasch analyses used WINSTEP version 4.0.1. Furthermore, to examine the interaction and correlation between academic levels and gender on students' attitudes toward science, two-way ANOVA and Pearson's Correlation were performed using SPSS version 22. Following the analysis of dimensionality, the five-dimensional Rasch model was applied to every person. The five attitudes toward science constructs and path analyses were conducted using SEM to evaluate the students' attitude toward the science model fit construct. SEM analysis was performed with AMOS version 2.4.



## Research Results

Two-way ANOVA was used to examine the effect of academic level and gender for each attitude toward the behavior subscale, as shown in Table 3. The mean difference between every academic level and gender are shown in Table 3. The significant results in the Attitude toward Science variable on grade and gender are discussed.

**Table 3. The results from two-way ANOVA test of gender and grade.**

Variable	Grade			Gender			Grade x Gender		
	<i>F</i>	<i>p</i> -value	$\eta_p^2$	<i>F</i>	<i>p</i> -value	$\eta_p^2$	<i>F</i>	<i>p</i> -value	$\eta_p^2$
Overall	11.09	<.001	.034	5.93	.015	.004	.20	.961	.001
Behavioral Beliefs	4.79	<.001	.015	2.39	.122	.002	.32	.904	.001
Normative Beliefs	5.95	<.001	.019	0.09	.768	.000	1.67	.138	.005
Control Beliefs	17.44	<.001	.053	4.13	.042	.003	1.16	.327	.004
Attitude towards Behavior	11.53	<.001	.036	6.13	.013	.004	1.67	.138	.005
Intention	8.16	<.001	.026	7.29	.007	.005	0.90	.480	.003

### *Relationship of Academic Level and Gender on Students' Attitudes toward Science*

**Behavioral beliefs.** A significant effect of academic level was found on the student's behavioral beliefs ( $F [5, 1558] = 4.79, p < .001, \eta_p^2 = .015$ ). In contrast, not significant on gender on behavioral beliefs ( $F [5, 1558] = 2.39, p < .122, \eta_p^2 = .002$ ) was found. The combined analyses also found no significant interaction between academic level and gender ( $F [5, 1558] = .32, p < .904, \eta_p^2 = .001$ ). The significant result on academic level indicated that the differences between the students' behavioral beliefs were affected on an academic level. The mean differences are shown in Figure 1, where the means in primary school increased but fell sharply at the middle school level.

**Normative beliefs.** A significant effect of academic level was found on the student's normative beliefs ( $F [5, 1558] = 5.95, p < .001, \eta_p^2 = .019$ ) and gender was not significant ( $F [5, 1558] = .09, p < .768, \eta_p^2 = .000$ ). No interaction between academic level and gender was found in normative beliefs ( $F [5, 1558] = 1.67, p < .138, \eta_p^2 = .005$ ). This result was similar to the behavioral beliefs, where only an effect of the academic level was seen. The same trend of a dramatic decrease from sixth grade to seventh grade seen in the behavioral beliefs was also seen in the normative beliefs.

**Control Beliefs.** Academic level significantly affected the student's control beliefs ( $F [5, 1558] = 17.44, p < .001, \eta_p^2 = .053$ ), as did gender ( $F [5, 1558] = 4.13, p < .042, \eta_p^2 = .003$ ). However, no significant interaction between academic level and gender was found ( $F [5, 1558] = 1.16, p < .327, \eta_p^2 = .004$ ). The results indicate that students' control beliefs were affected by academic level and gender. The mean differences are shown in Figure 1, where relatively higher control beliefs in females than males were seen at every academic level and both the female and male values decreased steadily from fourth to ninth grade.

**Attitude towards Behavior.** Academic level had a significant effect on students' attitude toward behavior ( $F [5, 1558] = 11.53, p < .001, \eta_p^2 = .036$ ), as did gender ( $F [5, 1558] = 6.13, p < .013, \eta_p^2 = .004$ ). In contrast, no significant interaction between academic level and gender was found in attitude toward behavior ( $F [5, 1558] = 1.67, p < .138, \eta_p^2 = .005$ ). Similar trends in the mean differences of attitude toward behavior and control beliefs were found, where females had a higher attitude toward behavior, and it decreased over the grades (Figure 1).

**Intention.** Significant effects of academic level regarding the student's intention in academic level ( $F [5, 1558] = 8.16, p < .001, \eta_p^2 = 0.026$ ) and gender ( $F [5, 1558] = 7.29, p < .007, \eta_p^2 = .005$ ) on the students' intentions were found. However, no significant interaction between academic level and gender was found ( $F [5, 1558] = .90, p < .480, \eta_p^2 = .003$ ). This result indicates that academic level and gender affected students' intention. A significant two-way interaction was seen between the academic level and gender. The similar trend is also found in the mean of difference in overall academic level. Interestingly, female students' intention in 9<sup>th</sup> grade was higher than in 7<sup>th</sup> grade.



The mean differences of person measures between students' attitude toward science according to academic level and gender are presented in Figure 1. Except for the control belief and attitude toward behavior components, the results showed a trend of increasing attitude by primary grade. Interestingly all components decreased from sixth grade in the primary school level to seventh grade in the middle school. Regarding gender, at the end of primary and middle school (sixth grade and ninth grade, respectively), female students' attitudes toward science were relatively higher than male. Students' attitudes toward science in each construct will be discussed further.

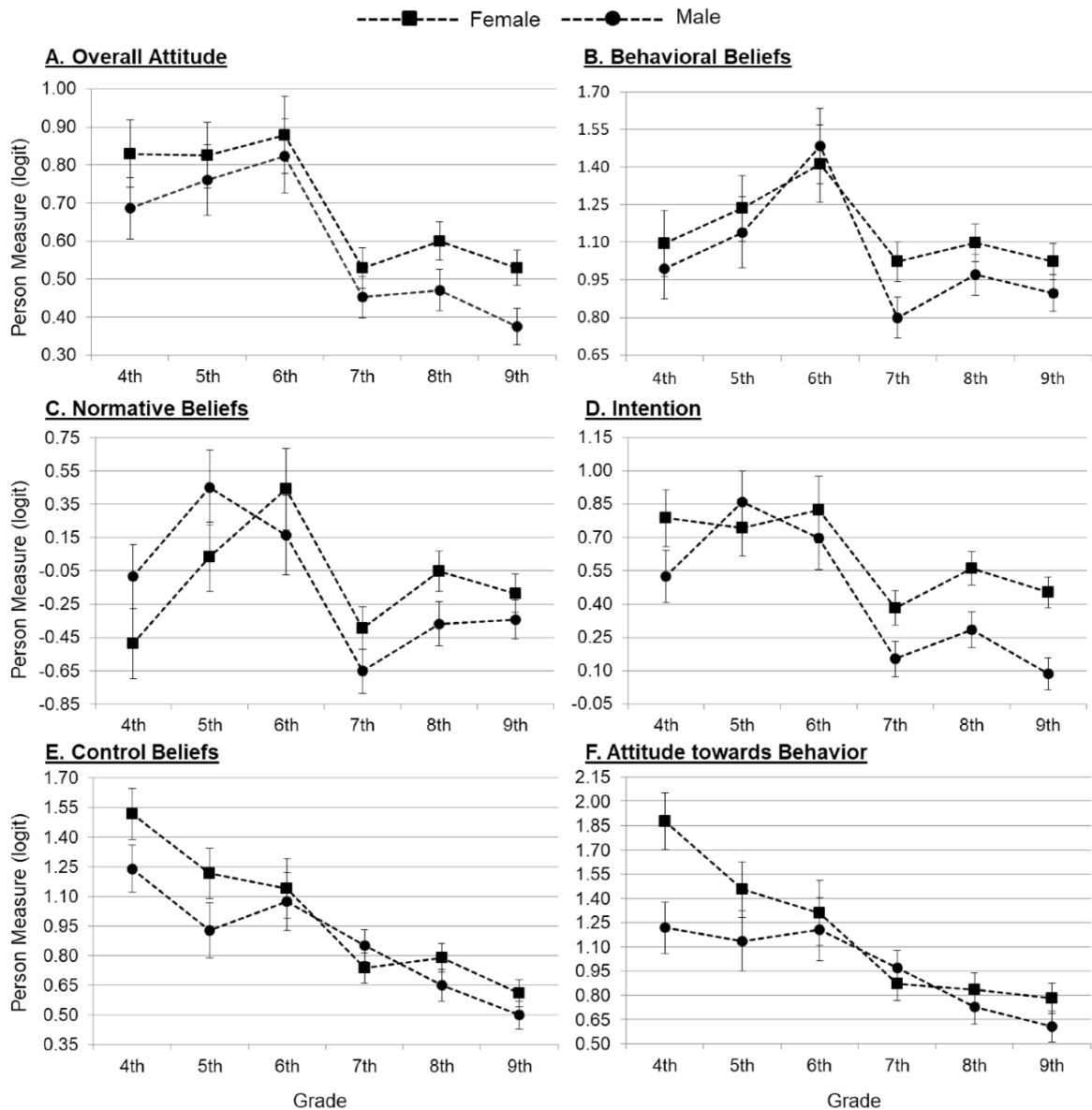


Figure 1. The interaction between academic level and gender on students' attitude toward science.

Correlations between the Five Constructs of Attitude toward Science according to Academic Level and Gender  
Correlation coefficients were examined to determine the association of each construct. All attitude constructs toward science were significantly correlated ( $p < .05$ ) with samples from every grade level in primary and middle school and gender (Table 4).



**Table 4. The correlation coefficients (r) for every variable.**(Notes: \*\* *p*-value < .01; \* *p*-value < .05)

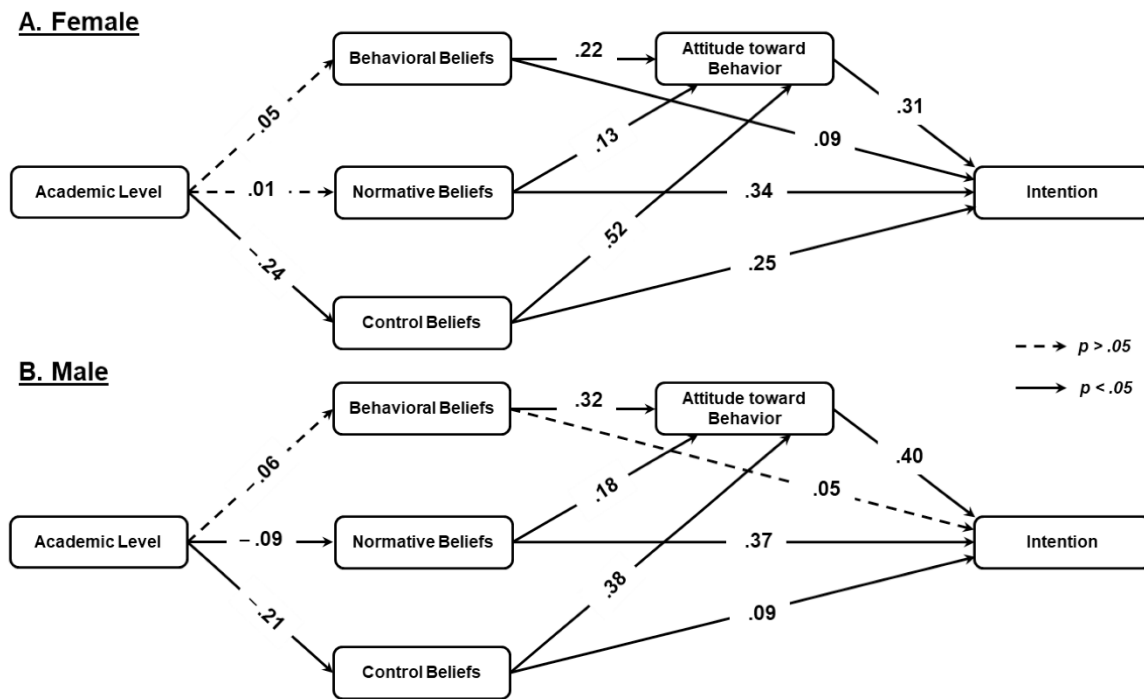
Component I	Component II	Academic x Gender			
		Primary		Middle	
		Female	Male	Female	Male
Behavioral Beliefs	Normative Beliefs	.528**	.405**	.458**	.454**
	Control Beliefs	.409**	.425**	.391**	.329**
	Attitude toward Behavior	.524**	.587**	.525**	.527**
	Intention	.560**	.435**	.471**	.440**
Normative Beliefs	Control Beliefs	.254**	.245**	.317**	.221**
	Attitude toward Behavior	.649**	.534**	.640**	.566**
	Intention	.608**	.298**	.576**	.471**
Control Beliefs	Attitude toward Behavior	.318**	.456**	.397**	.342**
	Intention	.570**	.618**	.561**	.523**
Attitude toward Behavior	Intention	.648**	.590**	.639**	.623**

A weaker association between each component was found in the correlation coefficients between the samples. At the primary school level, the lowest correlation was found between normative beliefs and control beliefs ( $r = .245$ ) for both males and females, whereas the highest correlation was found between normative beliefs and attitude toward behavior ( $r = .649$ ) for females and between control beliefs and intention ( $r = .618$ ) for males. Regarding the middle school level, the lowest coefficient was found between normative beliefs and control beliefs for both females ( $r = .317$ ) and males ( $r = .221$ ). For females in middle school, the highest coefficient was found between normative beliefs and attitude toward behavior ( $r = .640$ ). For males in middle school, the highest coefficient was found between attitude toward behavior and intention ( $r = .623$ ). Overall, the correlation coefficients of male students were much lower than those in the female students in both primary and middle school.

#### SEM (Structural Equation Modeling)

Path analysis was conducted (Figure 2) based on SEM. The chi-squared value for males and females was examined ( $p < .05$ ). RMSEA, CFI, TLI, NFI, AGFI, sRMR, and CMIN/DF were also examined as fitness indices. The RMSEA value (.051) was considered to fit the data well because it was below .08. The CFI (.995), GFI (.996), and TLI (.960) values were also more than .09 and considered acceptable. The value for sRMR (.0185) was considered a good fit because it was below .05. The path values are shown in Figure 2.





**Figure 2. Structure Equation Modeling of attitude toward science by gender**

CMIN/DF = 5.044, sRMR = .0185, GFI = .996, AGFI = .956, NFI = .993, TLI = .960, CFI = .995, RMSEA = .051 (CI90 = .03 - .074)

Following the benchmark by Keith (1933), a small influence is a value between .05–.10, a moderate influence is a value between .11–.25, and a large influence is a value of more than .25. Following those benchmarks in females, the largest influences were found in control beliefs on attitude toward behavior (.52) and normative beliefs on intention (.34). Interestingly, the influence of behavior beliefs on intention was not significant (.05). However, the largest influence was found in control beliefs on attitude toward behavior (.38), followed by normative beliefs on intention (.37). Of note, the influence of control beliefs in females was higher than in males.

**Table 5. Standardized β values for each path compared by gender.**

Path	Female		Male		z-score
	β	p-value	β	p-value	
Academic Level → Control Beliefs	-.24	<.001	-.21	<.001	.625
Academic Level → Normative Beliefs	.01	.782	-.09	.014	-1.957*
Academic Level → Behavioral Beliefs	-.05	.164	-.06	.095	-.208
Behavioral Beliefs → Attitude towards Behavior	.22	<.001	.32	<.001	2.231**
Control Beliefs → Attitude towards Behavior	.52	<.001	.38	<.001	-3.173***
Normative Beliefs → Attitude towards Behavior	.13	<.001	.18	<.001	1.228
Normative Beliefs → Intention	.34	<.001	.37	<.001	.923
Attitude towards Behavior → Intention	.31	<.001	.40	<.001	1.983**
Control Beliefs → Intention	.25	<.001	.09	.004	-3.322***
Behavioral Beliefs → Intention	.09	.001	.05	.130	-.962

(Notes: \*\*\* p-value < .01; \*\* p-value < .05; \* p-value < .10)



Further analysis using z-scores to compare the standardized  $\beta$  values for both genders found that the five paths were significantly different in both genders, as shown in Table 5. First, male students ( $\beta = .32$ ) had significantly higher  $\beta$  values than female students ( $\beta = .22$ ) in the path from behavioral beliefs to attitude towards behavior ( $p$ -value  $< .05$ ). A similar significant difference was also found between male and female ( $\beta = .40$  and  $\beta = .31$ , respectively) paths from attitude toward behavior to intention. However, the female students ( $\beta = .01$ ) had a significantly higher  $\beta$  value than the male students ( $\beta = -.09$ ) in the path from academic level to normative beliefs ( $p < .10$ ). In addition, a significantly higher  $\beta$  value in females than males ( $\beta = .52$  and  $\beta = .38$ , respectively) was found in the path of control beliefs to attitude toward behavior and in the path from control beliefs to intention ( $\beta = .25$  and  $\beta = .09$ , respectively) with a  $p$ -value  $< .05$ . No significant effects were found in the rest of the full sample.

## Discussion

The results of this research on Indonesian students' attitudes toward science and its effect on educational level and gender were consistent with previous results from Murphy and Beggs (2003) and Said, Summers, Abd-El-Khalick, and Wang (2016), where attitude toward science declined along with academic grade level. Thus, from the five BRAIN constructs, the overall trend of attitude toward science plunged from primary school to middle school. Collectively, behavioral beliefs and normative beliefs had the same trend, where they first increased in primary school, then dropped in middle school. Control beliefs and attitude toward behavior decreased in every grade, starting from the fourth primary grade until the ninth grade in middle school. The intention scores fluctuated but also decreased between primary and middle school. In the study by Said, Summers, Abd-El-Khalick, and Wang (2016), the students' attitudes toward science also decreased with age. Based on two-way ANOVA, the effect of academic level was significant in every component of attitude toward science. Even if the school, teacher, and learning experience between each academic grade level is considered, the subject difficulty by grade is more obvious to discuss because it is directly related to the Indonesian curriculum. From the aspect of subject difficulty, students might feel burdened and perceive science to be difficult. Moreover, according to Murphy and Beggs (2003), interest in science could become a consequence of repetition of topic and national test assessment. Regarding religion, a study by Koul (2016) described students' attitudes toward school science and religious outlook and reported that students' personal beliefs could affect their attitude toward science, as well as their ability to learn science. This belief also needs to be discussed, since personal beliefs toward science and religion could lead to conflict and contrast (Koul, 2016), where the two frameworks could become opposing and lead to unacceptance.

The second point of note from the academic grade level results is that the students' control beliefs and attitudes toward behavior were the two lowest components among all of the attitudes toward science components. This is necessary because the control belief perceived from themselves, as their ability about themselves toward learning science. Examples of BRAINS items in this component are "I cannot understand science even if I try hard" and "Science is easy for me." Improving students' self-efficacy would help the students to believe in themselves. Several ways have been suggested to foster students' self-efficacy. Artino (2010) recommended explicit feedback from the teacher to shape students' self-monitoring and activate metacognition. Teachers can also use Bandura's (1997) four principal strategies to foster students' self-efficacy by an inactive approach to students' mastery experiences, vicarious (observational) experiences, social persuasions, and physiological and psychological states. Furthermore, science learning in the previous class could impact this result and the academic results need to be seriously considered. A previous study of Indonesian participants by Kristiani, Susilo, and Aloysius (2015) showed that attitude toward science and cognitive learning were correlated. By considering students' control beliefs and attitude toward behavior, we might better understand their impact on students' cognitive learning in the classroom.

Regarding gender influence, the attitude of female students toward science was relatively higher than males, as shown in Figure 1. This result was consistent with previous research by Khishfe and BouJaoude (2016) that examined Lebanese students' attitudes toward behavior by considering gender and religion. That study reported that female students took science-related jobs because the subject was seen as a prestigious one, it was a good future career, and because of their interest in science. This result was also supported by a study by Najafi, Ebrahimitabass, Dehghani, and Rezaei (2012) on attitudes related to science in Iran, where female students more highly favored the study of environmental issues. The major two findings were that students were aware that science could have beneficial, as well as harmful effects on the environment and their interest in a science and technology career was aimed at overcoming those issues. A previous study by (Rohaeti, & Prodjosantoso, 2018) that examined Indonesian science processing skills showed a significant gap, where female undergraduate students had higher



scores than males. Furthermore, in this study, the positive attitude of female students toward science might have come from the social perception of science-related careers and their salary in a particular industry. Based on the two-way ANOVA results, gender only significantly affected control beliefs, attitude toward behavior, and intention. Gender had no interaction with normative beliefs, suggesting that the individual belief that came from social approval to engage in a behavior was not significant. Hence, behavioral beliefs, where the individual belief regarding the consequences of science learning, becoming a scientist, and the relevance of science, was also not significantly associated with gender. As mentioned earlier, the gender role in Indonesia has been moving forward and education has become more accessible for women, indicated by the fact that female students accounted for a greater proportion of STEM-enrolled students in 2014 in the selected university. Furthermore, an older study by Steinkamp (1982) reported male students' attitudes toward science in developed countries such as Japan, the USA, Australia, and New Zealand. This finding emphasized that the role of women in a science-related career in a developed country in Indonesia was higher and might also come from their attitude toward science in school.

This research found differences in behavioral beliefs on intention between females and males, where, for females, the influence was significant. This evidence is important because female students believe in science, as well as its benefits, and the consequences of becoming scientists more than males. For instance, they have a substantial belief that science makes a better world to live in and that science is important for their future success.

### Conclusions and Implications

This research aimed to explore Indonesian students' attitude toward science based on empirical evidence. The results showed two important elements that must be considered. First of all, regarding the academic grade level, the students' attitude toward science declined from the fourth grade to the ninth grade. Specifically, the decline occurred between the sixth primary grade and the seventh middle school grade. Although the results showed that academic grade level was significant in all components of attitude toward science, according to the structure equation modeling, the component of control belief had large influence on attitude toward behavior and impacted on their intention. Along with component attitude toward behavior, the trend of control belief component was gradually decreasing from the 4th grade to 9th grade. Control belief component is defined about students' belief in their capabilities to do science-related tasks. This highlights the importance of facilitating classroom teaching strategies to enhance students' self-efficacy and help them believe in themselves.

Secondly, this research also found the interaction of gender and the Indonesian students' attitudes toward science. In this case, gender was the only significant influence on control beliefs, attitude toward behavior, and intention components. Moreover, Indonesian female students had a significantly higher overall attitude toward science than males. The result might indicate that gender roles in Indonesia have moved forward to where education is more accessible for women and provides a model of attitudes toward science in each gender. It also provides more insight into why a greater proportion of female students are enrolled in STEM disciplines in Indonesia. Moreover, this research was also helpful in identifying prospective approaches in science teaching and learning in the future.

Science education researchers have been aware of gender inequality issues since 1960. Given the fact that future jobs in science demand gender equality to promote diverse innovation, science teachers also need to be aware of the essential role science classrooms play in this issue. Interestingly, the results of this study showed that Indonesia has the potential to reduce the gender gap in science. However, the research also revealed the next challenge, which is the declining student attitudes toward science with academic grade level. Middle school is a crucial period for students to shape and establish their attitudes. It also means the science teachers should try to exert positive effects on students' attitudes in science. Further research on the Indonesian learning environment is also needed, since how science is taught can be one of the solutions to increasing students' science attitude.

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