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The effect of educational levels and gender on students' reasoning ability and mechanical aptitude

Rita Eka Izzaty [a1], Yogyakarta State University, Yogyakarta, 55281, Indonesia, https://orcid.org/0000-0003-3304-1303
Farida Agus Setiawati [b], Yogyakarta State University, Yogyakarta, 55281, Indonesia, https://orcid.org/0000-0003-0099-9179
Fatonah Istikomah [c], Yogyakarta State University, Yogyakarta, 55281, Indonesia, https://orcid.org/0009-0009-0333-0703

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Abstract

This study aimed to investigate the impact of gender on reasoning ability and mechanical aptitude, considering disparities across different educational levels. The research involved 1,183 students aged 12 to 19 from Yogyakarta, Indonesia. The independent variables were educational levels (junior high school, senior/vocational high school, and higher education) and gender (male and female), while reasoning ability and mechanical aptitude scores were the dependent variables. Data were collected through the Differential Aptitude Test's reasoning and mechanical sub-tests, which demonstrated high-reliability coefficients. Statistical analyses included ANOVA and independent t-tests. The findings show that gender significantly influences reasoning ability and mechanical aptitude, with male students outperforming females. However, no notable differences were observed between senior/vocational high school students and college/university students. This study contributes valuable insights to the existing literature on cognitive skills, particularly concerning the impact of gender and educational levels, which can inform educational strategies and career development initiatives.

Keywords: Educational level; gender; mechanical aptitude; reasoning ability; students

* ADDRESS FOR CORRESPONDENCE: Rita Eka Izzaty, Faculty of Education and Psychology, Yogyakarta State University, Yogyakarta, 55281, Indonesia. *E-mail address*: rita_ekaizzaty@uny.ac.id

1. INTRODUCTION

A person's education may be reflected in their status within society (Chandra & Azimmudin, 2013). Subsequently, success in education - otherwise known as academic success - is often influenced by various factors, one of which is talent (Oyetunde, 2007; Pyari et al., 2016; Salkind & Rasmussen, 2007; Wu et al., 2021). This is supported by numerous studies that have proven that talent is a good predictor of one's academic success (Alnahdi, 2015; Curabay, 2016; Mankar & Chavan, 2013; Stickler & Breland 2007). Talent, also known as potential or ability (Kubiszyn & Borich, 2003) can be defined as a person's ability or potential to acquire specific behavioral patterns as well as perform a task where the individual has little or no prior training in (Barmola, 2013).

Meanwhile, Salkind and Rasmussen (2007) assert that talent is a set of characteristics that are related to one's ability to gain knowledge or skills. This opinion is in line with Aiken (1988) who defines talent as a person's capacity to acquire skills from training or experience in a job. Talent shown by participating in extracurriculars has a significant relationship with academic growth (Wai & Allen 2019; Kuykendall, 2023). Measurement of talent is critical because talent can be used to generate a diagnosis and prediction. Through the process of diagnosing someone's talent, the potential that exists within a person can be understood; whereas through the prediction process, the possibility of someone's future success or failure in a particular field can be seen (Kiss, 2009; Metz & Jones, 2012; Milton & Alexiou, 2006).

An instrument that is often used to measure individual talent is the DAT or Differential Aptitude Test (Mahakud, 2013). The DAT instrument was constructed by Bennet et al., 1947, and developed based on the Primary Mental Ability of Thurstone, a theory regarding the grouping of intelligence factors (Bennett et al., 1948; D'Oliveira, 2004). In a DAT instrument, seven subtests can be presented as a whole (1 series) or separate from each sub-test (Ernst, 1951; Macklem, 1989; Mankar & Chavan, 2013). The seven sub-tests are verbal reasoning (VR), numerical ability, abstract reasoning (AR), logical speed and accuracy (CSA), mechanical reasoning (MR), space relations (SR), and language usage which consists of spelling and sentences (Bennett et al., 1947; Gregory, 2011; Kaczmarek & Packer, 1997; Mankar & Chavan, 2013). However, in this research, the study of individual talents will be more focused on the realm of abstract reasoning ability (hereinafter referred to as reasoning ability) which is measured through abstract reasoning and mechanical reasoning abilities (hereinafter referred to as mechanical aptitude) which are measured through the subtest mechanical reasoning.

The reasoning ability along with problem-solving ability and decision-making ability represent different but overlapping aspects of human intelligence (Lohman & Lakin, 2011; Plotnik, 2006). Problem-solving is a problem-solving skill needed to solve problems that arise. Reasoning ability itself refers to the cognitive processes that are considered key to scientific thinking, comprising induction, deduction, analogy, problem-solving, and causal relationships (Dunbar & Klahr, 2012). In a more straightforward context, reasoning ability can be interpreted as the critical ability to understand delicate materials (Lohman, 2005), and this ability will increasingly become more evident as the mind develops (Gunhan, 2014). It is therefore essential to understand the thinking process of students for educators to provide meaningful education (Battista, 2007).

In regards to mechanical aptitude, this ability is considered an essential modality for students who hold an interest in building a career in the field of mechanics, such as pilots, military personnel, engineers, technicians, machine and computer operators, carpenters, electricians (Pearson Assessment, 2009, 2014; Damos et al., 2011; Matton et al., 2013). An individual who has a high mechanical aptitude can be considered as a person who correspondingly has proficient skills; hence the potential to learn principles of operation and repairing of sophisticated devices tends to be honed faster (Pearson Assessment, 2014; Dye, 2000; Kaczmarek & Packer, 1997; Metz & Jones, 2012).

Due to the many fields of work that require mechanical aptitude, besides being one of the components of DAT, mechanical sub-tests are also included as a component of the Career Ability

Placement Survey (CAPS) instrument, The Armed Services Vocational Aptitude Test Battery (ASVAB), Aviation Selection Test Battery (ASTB), Wiesen Test of Mechanical Aptitude (WTMA), and Bennett Mechanical Comprehension Test (BMTC) (Pearson Assessment, 2014; Byers et al., 2010; Denton, 2011; Klenk et al., 2011; Knapp et al., 2003; Meisenberg, 2010).

1.1. Literature review

1.1.1. Reasoning ability

Reasoning ability refers to the cognitive processes that are considered key to scientific thinking, comprising induction, deduction, analogy, problem-solving, and causal relationships (Dunbar & Klahr, 2012). Furthermore, Lohman and Lakin (2011) state that in general, reasoning ability can be defined as the process of concluding information. Individuals who have high-level reasoning ability fulfill logical structures or can think logically (Basir & Waluya 2022; McGeown & Warhurst 2020). Reasoning involves both conscious processes (explicit or intentional) and unconscious or tacit processes (Evans & Over, 1996). Reasoning through explicit processes is often described as a (rule-based) strategy that requires effort by transferring formal and structured or systematic, managed, and scientific principles (Lohman & Lakin, 2011). This reasoning process is indeed easy and flexible to do but is generally relatively slow compared to the tacit reasoning process (Lohman & Lakin, 2011). Meanwhile, the tacit process is commonly utilized when an individual needs to make quick or intuitive decisions, hence the tendency to reason based on perception or personal belief and not based on clear reasoning (Koskinen et al., 2003; Lohman & Lakin, 2011; Nash & Collins, 2006; Okolia et al., 2013).

In a more straightforward context, reasoning ability can be interpreted as the critical ability to understand delicate materials (Lohman, 2005), and this ability will increasingly become more evident as the mind develops (Gunhan, 2014). The research conducted by Tong et al., (2022) explains that good math academic skills indicate that they can understand real-life situations. It is therefore essential to understand the thinking process of students for educators to provide meaningful education (Battista, 2007). Academic teaching significantly affects students' reasoning abilities (Peng & Kievit 2020). In regards to the measurement of one's reasoning ability, Carrol (1993) states that three domains can be measured as a representation of reasoning ability, namely deductive reasoning, inductive reasoning, and quantitative reasoning. Deductive reasoning is a process of logical thinking done to draw specific conclusions from general information (premise) that is known, believed, or observed based on rules of formal logic (Ayalon & Even, 2008; Monti et al., 2007; Prado et al., 2011). This type of reasoning is often referred to as mathematical thinking (Ayalon & Even, 2008).

Inductive reasoning is the opposite of deductive reasoning (Prado et al., 2011; Zalaghi & Khazaei, 2016). A conclusion is said to be an inductive inference when it passes from a single statement (of limited and specific evidence) towards a more universal and orderly statement (Barbey & Barsalou, 2009; Khan & Ullah, 2010; Klauer et al., 2002; Tomic, 1995). Inductive reasoning results in generalizations (Zalaghi & Khazaei, 2016). Meanwhile, quantitative reasoning is defined as reasoning that involves quantity to identify a relationship (Johnson, 2012; Moore et al., 2009). Although quantitative reasoning cannot be equated with mathematical abilities, this reasoning requires the use of mathematical content to solve a problem (Dwyer et al., 2003; Shavelson, 2008). Mathematical proficiency can be used for conceptual understanding, procedural fluency, strategic competency, adaptive reasoning, and productive disposition in problem-solving (Rahman et al., 2022).

1.1.2. Mechanical aptitude

Mechanical aptitude refers to the ability to understand the principles of physics, tools, and mechanical devices, as well as the mechanisms in which they work (Learning Express, 2011). Prada and Urzua (2017) further state that mechanical aptitude also includes motor skills and visual integration. Meanwhile, Cronbach (1984) as well as Hegarty et al., (1988) describe mechanical aptitude as abilities that include general reasoning and specialized knowledge about machines. Based on these definitions, mechanical reasoning tests are designed to assess the subject's knowledge of physical and mechanical principles, such as pulleys, levers, and simple electrical circuits (Kaczmarek & Packer, 1997; Newton, 2007).

In a subtest of mechanical reasoning, questions take the form of multiple-choice formats and are presented as images (Learning Express, 2011; Sutton & Williams, 2007). At higher test levels, the content in mechanical sub-tests is usually in the form of common tasks encountered in everyday life, for example, reading texts and diagram descriptions of how a machine works, operating complex machines, diagnosing faults in a machine, and designing new machines (Hegarty & Just, 1993; Kieras & Bovair, 1984; Rouse & Morris, 1986; Williams et al., 1983). Because it is considered an entity of talent, which is, in turn, a type of individual difference (Jung et al., 2014; Nazimuddin, 2015; Robinson, 2012), reasoning ability and mechanical aptitude can grow, improve, and be transferred along with the advancement of educational level or experience (Bao et al., 2009; Darwish, 2014; Newton, 2007).

There is very little research that studies the correlation of educational levels with reasoning ability and mechanical aptitude. An example of past research that examines the effect of students' educational level on reasoning ability is those conducted by Mwamwenda (1999) and Medhi et al., (2013). In addition to examining potential differences in reasoning ability across different students' educational levels, the study conducted by Mwamwenda (1999) also tested the existence of differences in reasoning ability across different student ages. The study sample involved undergraduate and postgraduate students in Africa, in which the data was collected using a questionnaire consisting of various combinations of inquiry questions and supplemented with the subjects' biographical information. The study concluded that educational level and age influences a person's ability to reason.

A similar study was also conducted by Medhi et al., (2013) in Canada, who specifically studied primary school students in grades I, III, V, and VII. The results showed that the proposed hypothesis was proven ($p < 0.01$) with a moment product correlation coefficient of 0.68. A similar conclusion was also drawn from the study conducted by Susac et al. (2014) involving elementary school students (ages 13-14 years) and junior high school students (ages 16-17 years).

Meanwhile, research on the influence of educational level on students' mechanical aptitude had previously been done by Miller et al., (2011), Maier (1993), as well as Willis & Rosen (1979). A report written by Maier (1993) from the U.S. Department of Defense's Manpower Data Center states that the U.S. Department of Defense uses educational level as an indicator to recruit qualified applicants (armed forces or officers). This is because the educational level affects the scores obtained on the ASVAB test which ultimately impacts the candidate's performance. Based on the results of the analysis, approximately 40% of non-graduate categories fail to complete their first term. This figure is 20% higher than the commissioned officers who graduated from senior high school and tertiary education levels; and 10% higher than commissioned officers who have had a history of some form of other education, such as home-schooling or self-development (courses).

Willis & Rosen (1979) also conducted a study that analyzed scores of mechanical and manual agility tests. The results concluded that the two factors examined in the study reduced the possibility of pursuing an educational degree. This means that someone who has high mechanical aptitude tends to work rather than continue education. The level of mechanical skills a person has is directly proportional to the wages the person receives. Meanwhile, Miller et al., (2011) found a correlation of knowledge scores to mechanical aptitude test scores at the beginning of all education levels (junior and senior high school). The results showed that although the mechanical aptitude scores of senior high school students were not always higher than the mechanical aptitude scores of junior high school students on each aspect of mechanical talent measured, it was seen that the correlation showed a positive and significant relationship ($p < 0.05$).

In addition to the educational level or history of education factor, other factors such as gender, age, interests, learning environment (especially those supported by learning media and information technology), family background and father's occupation, as well as language and cultural background, are also suspected to be factors causes of differences in students' reasoning and mechanical aptitude (Jin et al., 2024; Bao et al., 2009; Chandra & Azimmudin, 2013; Mankar & Chavan, 2013; McKenna & Agogino, 2004; Kube et al., 2024; Newton, 2007; Yang, 2004). In regards to gender issues, several studies indicate that there are no gender differences especially in students' reasoning abilities (Al-Zoubi & Al-Salam 2009; Mankar & Chavan, 2013; Piraksa et al., 2014), yet several other studies have shown the influence of gender on students' reasoning ability and mechanical aptitude (Halpern et al., 2007; Lohman & Lakin, 2008; Miller et al., 2011; Preckel & Freund, 2005). In essence, research that demonstrates the existence of gender influences informs that reasoning ability and mechanical aptitude in male students tend to be higher than that of female students (Kurti et al., 2024).

1.2. Purpose of study

Based on the explanation above, this study aims to enrich the results of previous studies, more explicitly examining whether or not there are differences in reasoning ability and mechanical aptitude between students of different educational levels and genders. The "educational level" factor comprises junior high school, senior/vocational high school, and higher education (college/university); while the "gender" factor consists of male and female. Four hypotheses were proposed in this study as follows:

H1: Educational level influences students' reasoning ability
H2: Gender influences students' reasoning ability
H3: Educational level influences students' mechanical aptitude, and
H4: Gender influences students' mechanical aptitude

2. METHODS AND MATERIALS

2.1. Participants

This research adopts a quantitative approach. This research involved 1,183 students in the Special Province of Yogyakarta, Indonesia with an age range between 12 to 19 years old. The sample was selected using a multi-stage random sampling technique. This sampling technique was chosen because it utilizes more than one probability sampling technique. More specifically, cluster sampling was used in the first and third stages, while stratified sampling was used in the second stage. The first random sampling was done based on districts and municipalities within the Special Region of Yogyakarta, the second random sampling was based on schools identified in the first randomization, and the last random sampling was based on the class of the schools selected on the second randomization.

In terms of educational levels, the participants comprised 77 junior high school students, 1,022 senior/vocational high school students, and 84 college/university students. According to gender, there were 790 male students and 393 female students who participated in filling out the instrument. The participants, who were all adolescents, were still in search of their talents and skills, particularly related to reasoning abilities and mechanical aptitude. This study has been approved by researchers' institutions for involving groups of participants. The participants have stated their agreement to participate in this study.

2.2. Data collection instrument

The instrument used in the study was instruments of reasoning and mechanical ability which is part of the Differential Aptitude Test constructed by Bennet et al., (1947). The instrument used to measure reasoning and mechanical ability takes the form of multiple-choice questions. There were 50 items for the reasoning subtest and 68 items for the mechanic subtest. The time allocation for each subtest was 25 minutes for the reasoning subtest and 30 minutes for the mechanic subtest. Regarding the reliability of the test, the reasoning and mechanical sub-tests of the Differential Aptitude Test had an alpha reliability coefficient of 0.858 and 0.737, respectively.

2.3. Data analysis

The variables in this study consist of independent and dependent variables. Educational level serves as the first independent variable and consists of junior high school (SMP), senior/vocational high school (SMA/SMK), and higher education (college/university); gender as the second independent variable consists of male and female. Whereas the dependent variable was measured based on the score of students' reasoning and mechanical ability. Because the analysis was based on the educational level and gender of students, two data analysis techniques were performed, namely analysis of variance (ANOVA) and difference analysis.

ANOVA was used to determine the difference in reasoning and mechanical ability scores based on the educational level of students, while the difference analysis was done using an independent t-test and determined the difference in reasoning and mechanical ability scores based on students' gender. The analysis was carried out with the help of IBM SPSS 16. The output of both ANOVA and independent t-tests indicates levels of significance, which then inform whether there were differences in scores of reasoning and mechanical abilities across students with different education levels and gender.

3. RESULTS

The results of quantitative descriptive analysis on students' reasoning ability are shown in Table 1. The table consists of mean, standard deviation, minimum, and maximum values based on the education and gender of the participating students. In terms of the student's education level, it can be concluded that the highest mean score of the reasoning subtest belonged to the senior/vocational high school students at 37.6356 (SD= 6.83807), and the lowest mean of the reasoning subtest score belonged to junior high school students at 32.5952 (SD= 9.02857). On the other hand, based on the gender of students, it can be concluded that male students had a higher mean reasoning score than female students.

Table 1
Descriptive Statistics of Reasoning Ability Based on Educational Level and Gender

Variable	Category	Mean	Standard Deviation	Minimum	Maximum
Educational Level	Junior High School	32.5952	9.02857	8.00	48.00
	Senior/ Vocational High School	37.6356	6.83807	11.00	50.00
	College/ University	37.3140	6.83246	6.00	49.00
Gender	Male	38.1211	7.00465	8.00	49.00
	Female	36.6098	7.03788	6.00	50.00

Results of the analysis of variance indicate significant results (0.000) due to it being smaller than alpha (0.05); hence it can be concluded that there are differences in reasoning ability across students' education levels. As a result of the ANOVA test indicating differences in reasoning ability in terms of the educational level, it is necessary to do further post-hoc (Multiple Comparisons) testing to see which level of education most influences students' reasoning ability. Based on the results of the post-hoc test in Table 2, it can be seen that there are no differences in reasoning ability between senior/vocational high school students and college/university students. This is interpreted from the significance of the test results (0.831) which is higher than alpha (0.05).

Table 2

Summary of Follow-up Tests on Students' Reasoning Ability

(I) Educational Level	(J) Educational Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Junior High School	Senior/ Vocational High School	-5.04036	1.13840	0.000	-7.8325	-2.2482
	College/ University	-4.71872	1.14015	0.000	-7.5152	-1.9222
Senior/ Vocational High School	Junior High School	5.04036	1.13840	0.000	2.2482	7.8325
	College/ University	.32164	0.52810	0.831	-0.9737	1.6169
College/ University	Junior High School	4.71872	1.14015	0.000	1.9222	7.5152
	Senior/ Vocational High School	-.32164	0.52810	0.831	-1.6169	.9737

Table 3 illustrates the analysis of differences in results of reasoning ability between genders, tested through an independent t-test. The test result shows that the significance value obtained is smaller than alpha (0.05); so it can be concluded that there are differences in reasoning ability between different genders. Based on the descriptive analysis (Table 1), it can be seen that regarding reasoning ability, male students have a higher mean score than female students.

Table 3

The Results of Independent T-Test of Students' Reasoning Ability

	t-test for Equality of Means				
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Reasoning	0.004	1.51135	0.52932	0.47219	2.55051

Table 4 describes the mechanical aptitude data, consisting of mean, standard deviation, minimum value, and maximum value grouped based on the educational level and gender of the students. Based on the educational level of the students, it can be concluded that the highest mean score of the mechanical subtest was found in the senior/ vocational high school category at 37.4716 (SD= 6.45080) and the lowest mean score of the mechanical subtest was found in the junior high school category at 28.6234 (SD= 8.35565). On the other hand, based on the gender of students, it can be concluded that male students have a higher mean score in the mechanical subtest than female students.

Table 4

Descriptive Statistics of Mechanical Aptitude Based on Educational Level and Gender

Variable	Category	Mean	Standard Deviation	Minimum	Maximum
Educational Level	Junior High School	28.6234	8.35565	10.00	46.00

	Senior/ Vocational High School	37.4716	6.45080	16.00	55.00
	College/ University	36.9048	7.13825	14.00	53.00
Gender	Male	38.9633	6.11155	19.00	55.00
	Female	32.6183	6.69921	10.00	48.00

Similar to reasoning, the analysis of variance results in mechanical aptitude also indicated significant results due to the value (0.000) being smaller than alpha (0.05); thus, it can be concluded that there are differences in mechanical aptitude between students of different educational levels. Subsequently, it is also necessary to carry out a post-hoc test to see which level of education most influences students' mechanical aptitude. Based on the results of the post-hoc test shown in Table 5, there appear to be no differences in mechanical aptitude between senior/vocational high school students and college/university students. This is interpreted from the significance level of the test results (0.754) which is higher than alpha (0.05).

Table 5

Summary of Follow-up Tests on Students' Mechanical Aptitude

(I) Educational Level	(J) Educational Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Junior High School	Senior/ Vocational High School	-8.84825	0.78466	0.000	-10.7713	-6.9252
	College/ University	-8.28139	1.04756	0.000	-10.8488	-5.7140
Senior/ Vocational High School	Junior High School	8.84825	0.78466	0.000	6.9252	10.7713
	College/ University	0.56686	0.75364	0.754	-1.2802	2.4139
College/ University	Junior High School	8.28139	1.04756	0.000	5.7140	10.8488
	Senior/ Vocational High School	-0.56686	0.75364	0.754	-2.4139	1.2802

Table 6 illustrates the results obtained from the analysis of differences between genders in mechanical aptitude, tested through an independent t-test. The test result shows that the significance value obtained is smaller than alpha (0.05); thus, it can be concluded that there are differences in mechanical aptitude between genders. Based on the descriptive analysis (Table 4), it can be seen that regarding mechanical aptitude, male students have a higher mean score than female students.

Table 6

The Results of Independent T-Test of Students' Mechanical Aptitude

	t-test for Equality of Means				
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
Mechanic	0.000	6.34497	0.38967	5.58045	7.10949

Based on the analysis, it can be concluded that there are no differences in reasoning ability and mechanical aptitude between senior/vocational high school and college students. Meanwhile, in terms of genders, there are differences in reasoning ability and mechanical aptitude between male and female students that is male students have higher reasoning ability as well as higher mechanical aptitude than female students.

4. DISCUSSION

Based on the results of the analysis of variance, this study supports the findings of previous research conducted by Mwamwenda (1999), Miller et al., (2011), Medhi et al., (2013), and Susac et al., (2014); that is to say that there was a significant difference in students' reasoning ability and mechanical aptitude across different educational levels. Descriptive statistics for both the student's reasoning ability and mechanical aptitude in terms of educational level indicate that the educational level that had the lowest to highest mean is junior high school, higher education (college/university), followed by senior/vocational high school, respectively. This means that there was an increase in reasoning ability and mechanical aptitude since the students were in junior high school. Even so, it turns out that follow-up testing indicates that there are no differences in reasoning ability and mechanical aptitude between senior high school students and college/university students. This indicates that there is not much of a development in reasoning ability both in terms of abstract and mechanical reasoning from senior high school to college/university.

The findings in this study are in line with previous research which stated that differences in ability will tend to increase only during adolescence period or until middle school age, subsequently decreasing in the following years as they age (Baltes et al., 2006; De Neys & Everaerts, 2008). The discussion of individual differences in reasoning ability (both abstract and mechanical) began with the assumption that rational standards need to be used as a reference in reasoning (Wilhelm, 2005). This is because humans can be rational in principle, but may fail in various life practices. According to the principle governing rationality, conclusions drawn from true premises are regarded as valid when they do not conflict with mental representations therein, which are related to perceptions influenced by cognitive abilities (Johnson-Laird, 2010; Wilson & Sperber, 2006). Therefore, it can be said that the construction of reasoning is also related to the theory of cognitive development initiated by Piaget (Baltes et al., 1999; Bastable & Dart, 2008; Pascual-Leone, 1983).

In Piaget's theory, the ability for logical thinking (including solving mathematical operations), abstract and rational thinking, and inductive and deductive reasoning begin to develop rapidly when entering the concrete operational stage and peak during the formal operational stage (Darwish, 2014; Ghazi et al., 2016; Khalid, 2015; Susac et al., 2014). Elkind (1984) further argues that at this stage, children are generally able to use syllogistic reasoning by drawing logical conclusions based on the consideration of two existing premises.

In addition to the common cognitive development factors that take place in an individual's lifespan, the influence of educational level on abstract and mechanical reasoning can also be caused by linguistic factors. This is because reasoning involves abstract principles through a notational system, so language is needed as a tool to interpret it (Hiebert, 1980; Ji et al., 2004; Landy et al., 2014; Logan, 1980). Many experts agree that the higher the educational level of a person, the more vocabulary he or she will master due to the demands of applying higher forms of communication, namely the four linguistic skills which include reading, writing, speaking, and listening (Alqahtani, 2015; Asemota, 2015; Carranza et al., 2015; Cole & Feng, 2015; Kacani & Cyfeku, 2015). Consequently, it can be concluded that language is a contributing factor to the influence of the educational level on reasoning ability within a person.

In regards to the gender variable, the results of this study also reinforce research by Miller et al., (2011), Lohman and Lakin (2008), Halpern et al., (2007), Strand et al., (2006), Parsons et al., (2005), Preckel and Freund (2005), McKenna and Agogino (2004), Yang (2004), Casey et al., (2001), Halpern

(2000), Kaczmarek and Packer (1997), and Benbow and Stanley (1980), which states that differences in reasoning ability and mechanical aptitude are due to gender differences, where male students' reasoning ability and mechanical aptitude tend to be higher than female students' reasoning ability and mechanical aptitude. The superiority of male students, particularly in terms of mastery of mechanical skills is proven by Miller et al., (2011). The study revealed that in 2009 in the United States, only 11.4% of women had mechanical engineering degrees and only 1.6% of women worked as mechanics; 1.5% as carpenters; and 6.9% as machinists.

As with the educational level factor, the influence of the gender factor cannot be separated from the existence of cognitive developmental aspects that must be traversed by humans (Halpern et al., 2007; Spelke, 2005). The study of the human brain produces much information about brain structures that relate to gender differences. From the study, differences in cerebral morphology were found to develop in the uterus and became permanent after the fetus turned 26 weeks old (Achiron et al., 2001). That is, from the beginning of life, baby boys and girls tend to learn different things; where baby boys focus on objects and mechanical relationships, while baby girls focus on people, emotions, and personal relationships (Baron-Cohen, 2003; Eliot, 2009). From the beginning, boys are physically stronger but less resilient, see the world in terms of objects, ideas, and theories, and have higher spatial, numerical, and mechanical aptitude. Thus, boys tend to develop knowledge and skills related to mathematics and science. On the other hand, girls are physically and psychologically more mature, are caring, see the world from a personal-centered view, emphasize aesthetics, and morality, and have higher verbal ability (Ardila et al., 2011; Baron-Cohen, 2003; Spelke, 2005; Vassiliou, 2010).

5. CONCLUSION

Based on the analysis and discussion, the conclusions can be drawn as follows: there are no differences in reasoning ability and mechanical aptitude between senior/vocational high school and college students and there are differences in students' reasoning ability and mechanical aptitude between genders with male students have higher reasoning ability as well as higher mechanical aptitude than female students.

The research findings have practical implications for educators and school psychologists in designing learning programs. Our study implies that in designing a learning program for students, the school and college/university should provide their students, especially female students with experiences that improve female students' reasoning and mechanical ability. While the senior high school and college/university may not need to pay attention to educational levels in designing such programs.

The results of this research have shown that there are no differences in reasoning ability and mechanical aptitude between senior/vocational high school and college students and there are differences in students' reasoning ability and mechanical aptitude between genders. Despite the insightful findings, this study also has limitation that needs to be acknowledged. Despite the use of randomization by researchers in obtaining the sample, the majority of participants or students were senior/high school students with 1,022 people, while the number of participating students from junior high school and college/university was smaller with only 77 and 84 people, respectively. Future research needs to make an effort to ensure the balance of the number of participants in those three educational levels (junior high school, senior/vocational high school, college/university) to gain more accurate results.

Ethics Approval: All procedures performed in studies involving human participants have followed the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The University Ethics Committee has approved the research that involves the participants. The participants have stated their agreement to participate in this research.

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