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THE DETERMINANT FACTORS ANALYSIS OF INDONESIAN STUDENTS' ENVIRONMENTAL AWARENESS IN PISA 2015

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ABSTRACT

This research intended to reveal the determinant factors which could explain Indonesian students' environmental awareness based on the 2015 PISA; also, to find out the influence of Science Proficiency to Indonesian students' environmental awareness based on PISA 2015. The data were obtained from the 2015 PISA database in which there were 6513 Indonesian students participated in the survey. This research employed the Path Analysis continued to the Structural Equation Modelling (SEM) employing the LISREL 8.30. The research results indicated that the environmental awareness of 15-old Indonesian students directly influenced positively by: (1) students' enjoyment of learning science equal to 0.41; (2) students' self-efficacy in science equal to 0.16 (3) students' instrumental motivation equal to 0.15 ; (4) Inquiry-based instruction in science lesson equal to 0.14; (5) students' science proficiency equal to 0.11; and (6) students' epistemic belief equal to 0.04. The higher the socio-economic status of the students, the lower the environmental awareness. A respectable correlation of >0,5 was obtained from the relationship between those 6 variables and environmental awareness.

Keywords: indonesian students, environmental awareness, PISA 2015

INTRODUCTION

Achieving students' scientific literacy is the foremost objective in science education (Bybee et al., 2009; Roberts, 2013). Further, the essential components of scientific literacy are resource use and environmental quality (Roth & Lee, 2016). Other than that, environmental awareness and pro-environment behaviors are considered as the important outcomes of science education in many countries (Alves et al., 2009). Therefore, science education plays an important role in developing an understanding of scientific principles as a basis for environmental problems.

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A person's ability to interact with the environment especially in facing global challenges such as climate change and biodiversity is influenced by science education. Field research has oriented to the integration of environmental issue into school curriculum as environmental education has been considered as an environmental tool protection since the 1970s (Erbas et al., 2012). Moreover, Hadzigeorgiou & Skoumios (2013) suggested that environmental education is implemented formally in schools. Related to environmental education and sustainable development, Uitto et al. (2011) in his research which included 3626 nine graders recommended the need for students' learning motivation towards environmental issues. Fu-

ture scientific research and environmental education really need interest, attitudes, and values in teaching environmental problems.

Science education, despite its limitation, offers some opportunities to foster environmental awareness (Littledyke, 2008). In the latest two decades, many science educators have discussed either explicitly or implicitly the needs of environmental awareness (Hadzigeorgiou, & Skoumios, 2013; Testa et al., 2016). In today's age, scientific literacy is highly salient for the full participation of citizens. Of course, an important component of scientific literacy includes the use of resources and environmental quality (Bybee,2008). Since the 2006 PISA, environmental awareness has become one of the indicators of scientific literacy (Sadler & Zeidler, 2009; Byebee et al., 2009).

Environmental awareness defines as the state of a person who has the knowledge and is aware of the environment where people live and tends to influence the development of communities with pro-environmental behavior (Harju-Autti & Kokkinen, 2014). The high level of environmental awareness of a society strongly influences their behavior towards the environment (Franzen & Meyer, 2009). Thus, community support for environmental protection is highly dependent on the level of environmental awareness. Environmental awareness is studied in various countries because of the many environmental problems faced by all countries. There are many environmental agreements between countries that call for fundamental changes in energy production and consumption in both industrialized countries and developing countries. Therefore, to ensure public support for these policies, citizens must have high environmental awareness.

By the time being, the topic of environmental awareness is often approached based on the educational point of view. Environmental awareness is considered an education problem since the high level of awareness is expected to result from further environmental education. There are several cases where environmental knowledge is a limiting factor for increasing environmental awareness. However, in many cases, the development of environmental awareness is highly dependent on environmental motivation. Environmental awareness has long been considered to be strongly influenced by motivation, knowledge, and skills (Harju-Autti & Kokkinen, 2014; Maharani & Dewi, 2015).

How an individual's environmental awareness turns into pro-environment behavior is explained by the Environmental Awareness Pro-Environmental Behavior (EAPEB) model (Harju-Autti, 2013). Some aspects of the EAPEB model can be explained by several theories about planned human behavior such as values-beliefs-norms (VBN) theory (Jakovcevic & Steg, 2013). According to Hansla et al. (2008) in the VBN theory, the intention determinant to acquire pro-environment behavior includes the consequence awareness which arises from individual beliefs about the adverse consequences of environmental problems. Kenter et al (2011) described the VBN theory as a process by which values form an ecological worldview. The study from Gifford & Nilsson (2014) and Liem& Martin (2015) showed the important roles of social and personal norms to foster pro-environment behavior. In addition, Lafuente & Sánchez (2010) established a multidimensional definition of environmental awareness. In the model, they broadly integrated environmental awareness theory from a theological perspective with environmental behavior theory taken from environmental psychology. Therefore, environmental awareness consists of four dimensions namely affective, cognitive, disposition, and active.

Science lessons in schools are very supportive of developing students' attitudes, awareness, and responsibility for the environment. Their scientific skills and knowledge could be used to assess environmental conditions and increase awareness and understanding to be involved in active participation for environmental sustainability. To measure students' environmental awareness, they were asked to respond to seven environmental issues and show how their information about the problems was related: (1) the increase of greenhouse gases in the atmosphere,(2) the use of genetically modified organisms (GMO),(3) nuclear waste, (4) the consequences of clearing forests/other land use, (5) air pollution, (6) extinction of plants and animals , (7) water shortage. The environmental awareness questionnaire of the 2015 PISA appears in Table 1.

Table 1. The Environmental Awareness Questionnaire of the 2015 PISA

No	How informed are you about the following environmental issues?	I have never heard of this	I have heard about this but I would not be able to explain what it is really about	I know something about this and could explain the general issue	I am familiar with this and I would be able to explain this well
1	Increased greenhouse gases in the atmosphere				
2	The use of genetically modified organisms				
3	Nuclear waste				
4	The consequences of clearing forests for other land use				
5	Air pollution				
6	Extinction of plants and animals				
7	Water shortage				

(OECD , 2016c)

Environmental awareness is considered quite important in the science learning aspect by PISA; thus, it seems to have an influence on the Science Proficiency as described in the following figure.

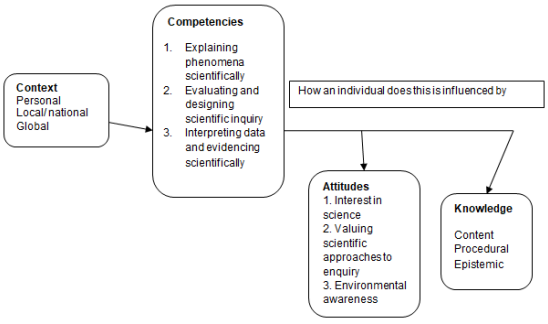

Figure 1. Inter-relation between the Four Aspects in PISA Framework (OECD , 2016c)

Several studies of PISA results have proven the theoretical framework as described in Figure 1. Alves et al. (2009) examined factors that impact environmental awareness and science proficiency as well as the relationship between the two using the 2006 PISA data comprising 300 cases from 22,0000 Canadian students and 9,000 Brazilian students who participated in the PISA survey. The results of the study showed that (1) the students' self-study, science- value, learning experience, economic index, social and cultural status (ESCS) had a significant effect on the proficiency of science; and (2) there was a significant direct influence of proficiency science on environmental awareness. Coertjens et al. (2010) conducted a study of the effects of sex, socio-economy status, immigration status on attitudes of environmental awareness of 15-year-old students. The research used the 2006 PISA data consisting of 4999 students from Flemish, Belgium. The results of the study indicated that there were effects of sex, socio-economy status, and immigration status towards environmental awareness.

Erbas et al. (2012) also conducted a study of factors influencing environmental awareness by utilizing 2006 PISA data which involved a sample of 4942 students from 160 schools. The findings of this study indicated that the interest of 15-year-old Turkish students on the environment varied according to socio-demographic variables such as gender, economy, social and cultural status. The study also showed the interest of Turkish students in school activities related to environmental topics, also, the interest and optimism of parents about environmental problems. Although the relationship of parents' interest and optimism with the students' caring was negative, the level of parents' optimism about environmental issues explained the greatest variation in the students' environmental caring followed by parents' interest in environmental problems. In other words, a

sense of caring and optimistic parents about environmental issues had a relatively strong impact on children's caring, level of awareness and optimism about environmental issues.

Zecha (2010) conducted a study of several factors considered influential on environmental awareness by involving 900 German and 182 Spanish students aged 14 and 15. The results of his research informed that children's culture influenced knowledge, attitudes, and actions related to environmental awareness. The research on factors impacting the scale of attitude to the environment was carried out by Le Hebel et al. (2014). His research required 2124 French students and concluded that (1) there was a connection between environmental awareness and students' interest in learning environmental topics; (2) environmental awareness and extra-curricular activities have relationships; (3) there was a correlation between the environmental awareness and students' personal value. Uitto et al. (2011) conducted a study of the relationship between student interest in environmental issues, attitudes to the environment and biocentric values in school science learning. The survey was conducted using the ROSE (Relevance of Science Education) questionnaire on 3626 ninth graders. The results of the study show that: (1) the attitudes and value factors have a significant correlation; (2) the interests and attitudes were uncorrelated; and (3) girls had a stronger positive attitude than men in the environmental and biocentric values.

Saricam & Sahin (2015) examined the relationship between environmental awareness, environmental attitude, curiosity and exploration at the 13 or 14-year-old students using structural equation modeling (SEM). The results showed that high-ability children scored higher on environmental awareness, environmental attitude, curiosity and exploration than low-ability children. The SEM analysis also proved that the better the curiosity and exploration of high-ability children the higher the environmental awareness and attitude. Employing the 2006 PISA data for the European Union, Duarte et al. (2017) examined family influences, school characteristics, and social interplay or peer group attitudes to the environment. The main object of the research is the existence of social interactions, such as the important role of a family's characters and school's characters. The importance of the social context of adolescents as a strategy for environmental education is the finding of the study.

Since participating in the 2000 PISA, science education in Indonesia has undergone a tremendous transformation to create a foundation for prosperity and sustainable development. Between 2012 and 2015, science performance among 15-year-old Indonesian students increased by 21 points. This makes the education system in Indonesia considered the fifth fastest among the 72 countries participating in the PISA study (OECD, 2016d). Indonesian high school students (grade 10 or higher) performed better in science, with an average difference of 45 points from their peers who were in grade 9 or below (OECD, 2016d).

The 2015 PISA results for Indonesian students in Science Proficiency was 403 or ranked 62 of 72 participants. These results were better than in 2006, which scored 393 while seen from the level of proficiency, Indonesian students were at the level 2 of the 6 levels of ability measured in the PISA study (OECD, 2016a). In the attitude aspect, the acquisition of Indonesian students' environmental awareness score was -0.5 (WLE score). Therefore, it concluded that Indonesian students' environmental awareness was below the average of all students participating in the 2015 PISA survey. The PISA 2015 also asked the students about their beliefs about the nature of scientific knowledge and the validity of Epistemological beliefs. Indonesian students, on the other hand, were far below the students in OECD countries to agree on the current view of the nature of science, especially about how scientific ideas develop. For instance, about six out of ten students in Indonesia reported that ideas in science or science books sometimes change, compared to eight out of ten students in all OECD countries (OECD, 2016d).

Science education at schools ideally influences students' environmental awareness. Nevertheless, there has been no research that studies the relationship between Science Proficiency in schools and Indonesian students' environmental awareness. Similarly, there has been no study on factors impacting the environmental awareness of Indonesian students that are connected simultaneously to the Science Proficiency at schools. Research is necessarily carried out to find out the extent of the Science Proficiency effect on Indonesian students' environmental awareness; also, to examine the dominant factors influencing the environmental awareness of Indonesian students. These factors are beneficial for further development of science learning model to enhance Indonesia students' environmental awareness. The search of determinant factors from Science Proficiency and awareness of Indonesian students based on the PISA data is a more complex study that may even lead to the design of a model. This

is due to the large number of variables affecting the Science Proficiency in the PISA survey such as the students' background, parents' background, school background, teachers' background, and learning process.

From several previous studies, either those using the PISA data (Alves et al., 2009; Coertjens et al., 2010; Erbas et al., 2012; Duarte et al., 2017) and primary data (Zecha, 2010; Le Hebel et al., 2014; Saricam & Sahin, 2015) showed that there have not been many studies on the influence of science learning aspects on students' environmental awareness. In accordance with the framework of PISA 2015 as described in Figure 1, this study limited the identification of factors affecting the environmental awareness and the influence of Science Proficiency on Indonesian students' environmental awareness. In this regard, this study was limited to several variables that were directly involved in science learning and socioeconomic status. The research objectives were described as follows: (1) to find the determinant factors explaining the environmental awareness of Indonesian students based on the 2015 PISA data; and (2) to reveal the influence of Science Proficiency on environmental awareness of Indonesian students based on the 2015 PISA data.

METHODS

The research data were taken from the PISA database accessible via the OECD page at http://www.oecd.org/pisa/data/2015database/, the data code is PUF_COMBINED_CMB_STU_QQQ_Zip. There were 519,334 students responded from 72 countries and 921 variables related to students. The number of Indonesian students involved in the PISA survey was 6513 and more than half of the sample was in grade 9 (OECD, 2016d: 2).

According to the OECD standards, the desired population in each education system consists of 15-year-old children who attend school in grade 9 or higher. To provide a valid estimate of student achievement and characteristics, the sample of PISA students must be chosen in a way that represents the full population of 15-year-old students in each education system. The sample design for the 2015 PISA was a stratified systematic sample. There are two types of stratification samples used, namely explicit and implicit. Explicit stratification is done by grouping schools into separate strata. The example of explicit stratification variables is state or territories of a country. For Indonesia, this explicit stratification referred to the results of the National Examination which were divided into three criteria; high, medium, and low (OECD, 2015). The National Examination is formulated for all schools throughout Indonesia and regulated by standard policy assessments and evaluations issued by the Ministry of Education and Culture. In these policies, the ministry regulates the materials and subjects to be tested, as well as how the National Examination is implemented, and the thresholds that must be achieved by students as graduation requirements. The implicit stratification is basically the unique sorting of the schools in each explicit layer by a set of stratification variables implicitly designated. Type of school, urbanization, and minority composition are examples of implicit stratification variables. The implicit stratification is a way to ensure the allocation of school samples that are rigorous and proportionate so as to ensure the representative samples. This can lead to an increase in the reliability of survey variable estimates as long as the stratification variable is implicitly related to PISA proficiency at the school level. For Indonesia, the adopted implicit stratification was the criteria for school funders, school types, and regions (OECD, 2015).

The previous studies using the PISA data have emerged at least five variables involved in science learning and one socio-economic status variable that sufficiently affected the Environment Awareness (ENVAWARE) and Science Proficiency (PVSCIE). The five variables are: (1) students' epistemic beliefs or so-called the Epistemological beliefs (EPIST); (2) students' enjoyment of learning science or called Enjoyment of Science (JOYSCIE) variables; (3) students' instrumental motivation or variables (INSTSCIE); (4) students' self-efficacy in science or the Science Self-Efficacy (SCIEEFF) variable; and (5) Inquiry-based instruction in science lesson (IBTEACH). Some variables related to family background such as parental education, parental work, number of houses owned, learning facilities, availability of books, etc. are summarized in one variable called the student's economic, social and cultural index (ESCS) (Alves et al., 2009; Coertjens et al., 2010; Erbas et al., 2012; Duarte et al., 2017). Research using primary data involving 1182 to 3600 students showed that there were several variables that influenced environmental awareness, namely: (1) attitudes and interests in the environment, (2) knowledge about the environment, (3) curiosity, (4) gender and (5) intelligence (Zecha, 2010; Le Hebel, 2014; Uitto et al., 2011; Saricam & Sahin, 2015).

Students' epistemic beliefs are individual representations of the nature, structure, and sour-

ce of science, for example, what is considered as "true" and how the validity of an argument is formed. Such beliefs have been proven in direct contact with the student's ability to acquire new knowledge in science and science learning achievement in school. (Mason et al., 2013). Epistemological beliefs (EPIST) were measured by a questionnaire of 6 items arranged in a Likert scale with four categories: strongly disagree, disagree, agree and strongly agree (OECD, 2016a).

Students' enjoyment of learning science in the 2015 PISA study is called the Enjoyment of Science (JOYSCIE) variable. Enjoyment of Science measured the students' learning enjoyment of science through their responses ("strongly agree", "agree", "disagree" or "strongly disagree") with five items consisting of the following statements: (1) pleasure in learning science topics; (2) reading preferences about science; (3) pleasure in doing scientific topics; (4) enjoyment in acquiring new knowledge from science; and (5) interest to learn about science. The science enjoyment index was built to summarize the students' answers (OECD, 2016c).

Students' instrumental motivation (INSTSCIE) for learning science is an impetus for learning science because students consider science to be very useful for them, their future studies, and careers (OECD, 2016a). This variable assesses whether students feel that science is relevant to their own needs and career prospects through their responses ("strongly agree", "agree", "disagree" or "strongly disagree") with four statements: (1) working on science at school is very useful as it will help your future occupation; (2) what is learned in science subjects is very useful since it is needed for your future occupation; (3) learning science in school is very valuable because it will enhance your career prospects, (4) knowing a lot of things in science will help get a job (OECD, 2016c).

The term "self-efficacy" is used to explain students' beliefs that their actions can produce something desired such as solving difficult problems or achieving goals. Self Efficacy refers to the assessment of future-oriented competence in achieving certain goals within a specific context, which requires scientific capabilities such as explaining phenomena scientifically, evaluating and designing a scientific investigation, or interpreting scientific data and evidence (Mason et al., 2013). In the 2015 PISA, self-efficacy was called the Science Self-Efficacy (SCIEEFF) variable. This Science Self-Efficacy asked the students to state how easily they carry out the following tasks: (1) identifying science questions underlying the newspaper reports about health problems; (2) explaining the frequency of earthquakes is more common in some regions than elsewhere; (3) explained that the treatment of disease can be done by giving antibiotics; (4) identifying science questions related to waste disposal; (5) predicting how environmental changes will affect the sustainability living of certain species; (6) interpreting scientific information given to food labels; (7) discussing new evidence about the possibility of life on Mars; and (8) identifying a better explanation of two explanations about acid rain formation (OECD, 2016c: 155). The student responses categorized as: (1) I can do it easily; (2) I can do this with little effort; (3) I will struggle to do this; and (4) I cannot do this.

Inquiry-based instruction level in science lesson is the extents to students' experience the inquiry-based science learning (investigation). In the 2015 PISA, the Inquiry-based level instruction in science lesson was abbreviated as IBTEACH. Inquiry-based instruction in science learning refers to how to involve students in experiments, direct activities, and challenge students and support them to expand conceptual understanding of scientific ideas. The best students are expected to understand, explain, debate scientific ideas, design, experiment and communicate. In the PISA study, this was performed by asking the students the frequency ("never or almost never", "in some lessons", "in most lessons" and in all lessons ") of the following statements: (1) Giving-students the opportunity to explain their ideas; (2) Giving students the opportunity to spend time in the laboratory doing practical experiments; (3) Students are invited to debate science questions; (4) Students are involved in drawing conclusions from experiments that they have done; (5) The teacher explains how scientific ideas can be applied to a number of different phenomena; (6) Giving students the opportunity to design their own experiments; (7) Involving students and teachers in debates about investigations; (8) Teachers discuss the relevance of real-life science concepts; and (9) Students are involved in investigations to test ideas (OECD, 2016c). An inquiry-based science learning index combines these nine statements.

Socioeconomic status variables (ESCS) are one of the variables that are not directly related to science learning, yet it is suggested by many researchers to be strongly related to science proficiency and environmental awareness (Schmidt et al., 2015). Socioeconomic status is a broad concept summarizing various aspects of students, schools, or school systems. In the PISA survey, a student's socio-economic status was estimated

by an index of economic, social and cultural status (ESCS). Some variables that correlate with students' family backgrounds such as parental education, parental work, number of household items that are considered material wealth, and the number of books or other educational resources available at home are elements of the ESCS variable. The Principal Component Analysis (PCA) is used to combine several economic, social and cultural status variables in the ESCS. This was done for international comparison purpose. For the reporting aim, the scale value of the ESCS was standardized to have a zero average and one standard deviation for the student population in OECD countries, given the same weight for each country.

Environmental awareness (ENVAWARE) in the 2015 PISA study was measured by knowing the condition of students whether or not they knew information related to environmental issues. ENVAWARE were used from the questionnaire. ENVAWARE is a score calculated from the student responses to a question that asks about various environmental issues (see Table 1). The environmental issues raised in the 2015 PISA survey included: (1) the increased greenhouse gases in the atmosphere; (2) the use of genetically modified organisms; (3) nuclear waste; (4) the consequences of deforestation for land; (5) air pollution; (6) the extinction of plants and animals; and (7) the lack of water. The students' responses were divided into four categories: (1) I have never heard of this; (2) I have heard of this but I cannot explain what really happened; (3) I know something about this and can explain the problem in general; (4) I know this and I can explain it well (OECD, 2016c)

This study employed the path analysis (Loehlin, 1998) and continued to the structural equation modeling (SEM) (Bowen & Guo,2011) with the help of LISREL 8.30 software (Jöreskog & Sörbom, 1996). The path analysis aimed at finding both the direct or indirect effect of the variable on environmental awareness while the SEM was to confirm the hypothesized theoretical model. Furthermore, the path analysis was employed to analyze the relationship within the complex variables; thus, it cannot be done by multiple regression. There are many dependent variables in complex models so that a series of regression equations are needed (Gudono, 2011). Each variable was not tested for validity because all items used in the PISA study were validated beforehand using the Item Response Theory (Hambleton et al, 1991).

RESULTS AND DISCUSSION

The results of the 2015 PISA study for several Indonesian student attitudes variables related to science are informed in Table 2.

Table 2. The Attitude variable Scores Related to Science Learning, Environmental Awareness, and Socio-Economic Status of Indonesian Students based on the 2015 PISA Results

No	Variables	Score in WLE (Warm's weighted Mean Likelihood Estimation)
1	Epistemological beliefs	-0,3
2	Enjoyment of Science	0,65
3	Instrumental motivation	0,81
4	Science Self-Efficacy	-0,51
5	Inquiry-based instruction in science lesson.	0,26
6	Environmental Awareness	-0,5
7	ESCS	-1,87

(OECD, 2016 a ; OECD, 2016b)

The scores presented in WLE ranged from -2 to +2 with the mean of 0. Table 1 informs that the Environmental Awareness of Indonesian students was 0.5 digit below the average of all students involved in the 2015 PISA study. Similarly, both the Epistemological Beliefs and Science Self-Efficacy were under the average acquisition of all students. In addition, the ESCS of Indonesian students was very low; almost 2 digits under all students' ESCS in the 2015 PISA. These results reaffirmed that the economic, social and cultural status of Indonesian students was indeed very low compared to other countries. For the level of Science Enjoyment, Instrumental motivation, Inquiry-based instruction in a science lesson, the Indonesian students were above the average achievement of students from all countries participating in the 2015 PISA survey. Indonesian students' Science Proficiency scored 403, ranked 62 of 72 participating countries. This was an improved achievement compared to 2012.

To facilitate the SEM analysis, the Environmental Awareness variable was abbreviated as ENVAWARE, the Science Proficiency as PVSCIE, Epistemological beliefs as EPIST, Enjoyment of Science as JOYSCIE, Instrumental motivation as INSTSCIE, Science Self-Efficacy as SCIEEFF, Inquiry-based instruction in science lesson as IBTEACH, also, social, economic, and cultural status as ESCS. The results of SEM analysis with the LISREL 8.30 software are presented in Figure 2. The criteria for goodness of fit test (GFT) of the model are informed in Table 3.

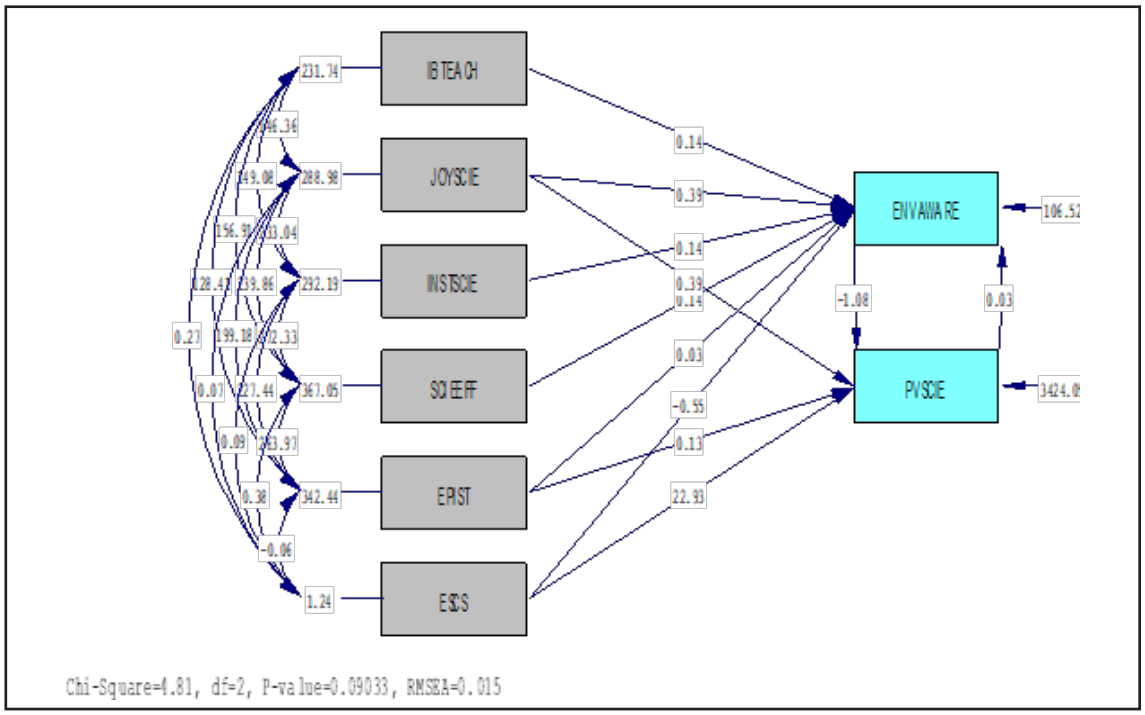

Figure 2. The Determinat Factors of Environmental Awareness of Indonesian Students based on the 2015 PISA Results

Table 3. The Criteria of Goodness of Fit Test (GFT) in SEM

GFT Size	Criteria	Results	Conclusion
P value	≥ 0.05	0.09	very good
λ^2 /df	≤ 5	2.4	very good
Root Mean Square Error of Approximation (RMSEA)	≤ 0.08	0.015	very good
Goodness of fit index (GFI)	≥ 0.9	1	very good
Adjusted Goodness of fit index (AGFI)	≥ 0.9	1	very good
Comparative fit index (CFI)	≥ 0.9	1	very good
Normal fit index (NFI)	≥ 0.9	1	very good
Icremental fit index (IFI)	≥ 0.9	1	very good
Non Normed fit index (NNFI)	≥ 0.9	1	very good

(Kusnendi, 2008; Ghozali & Fuad, 2005)

Of all the parameters explained in Table 2, it shows that out of ten criteria, the results of SEM analysis can be declared acceptable. One of the characters of the Likelihood Ratio Test (λ^2) is that the higher the value, the lower the relative P-count value, and vice versa. It was desirable that the Likelihood Ratio Test be as small as possible so that the P value turned larger. Another characteristic of λ^2 statistics is its sensitivity to sample size (Lomax & Schumaker, 2012; Hair

et al., 1998). The larger the sample size, the obtained λ^2 statistics tend to be greater with smaller P-values. Thus, for large statistical samples, the λ^2 tends to reject the model (Joreskog & Sorbom, 1996). However, it turned out that this did not occur in the SEM analysis conducted in this study. Having the sample size of 6513, the value of λ^2 was 4.81 and the P value met the requirements of 0.09. This indicated that the model produced in this study had a high absolute fit measure (AFM). The AFM informs the ability of the model to estimate in absolute terms the population covariance matrix based on the sample covariance matrix. Two measures of absolute suitability that are the most important LISREL version are the Likelihood Ratio Test (λ^2) and the Root means Square Error of Approximation (RMSEA) (Joreskog & Sorbom, 1996). All relationships within the variables presented in Figure 1 were significant at the 95% confidence level as shown in Table 4 and Figure 3.

Table 4. The Estimate and Test: The Determinant Factors of Indonesian Students' Environmental Awareness based on the 2015 PISA Results

Path	Path Coefficient	Standar Eror	Standardized Path Coefficient	t	R^2 Determinant
IBTEACH → ENVAWARE	0.14	0.011	0.14	13.48	0.59
JOYSCIE → ENVAWARE	0.39	0.013	0.41	29.73	
INSTSCIE → ENVAWARE	0.33	0.016	0.15	8.57	
SCIEEF → ENVAWARE	0.14	0.013	0.16	10.20	
EPIST → ENVAWARE	0.031	0.011	0.04	2.91	
ESCS → ENVAWARE	-0.55	0.210	-0.04	-2.64	
PVSCIE → ENVAWARE	0.029	0.0075	0.11	3.79	0.15
JOYSCIE → PVSCIE	0.39	0.15	0.10	2.61	
EPIST → PVSCIE	0.13	0.063	0.04	2.07	
ESCS → PVSCIE	22.93	0.65	0.40	35.15	
ENVAWARE → PVSCIE	-1.08	0.23	-0.28	-4.67	

Note: the t-table value at 95% and n> 150 is ± 1.95 (Ghozali & Fuad, 2005: 81)

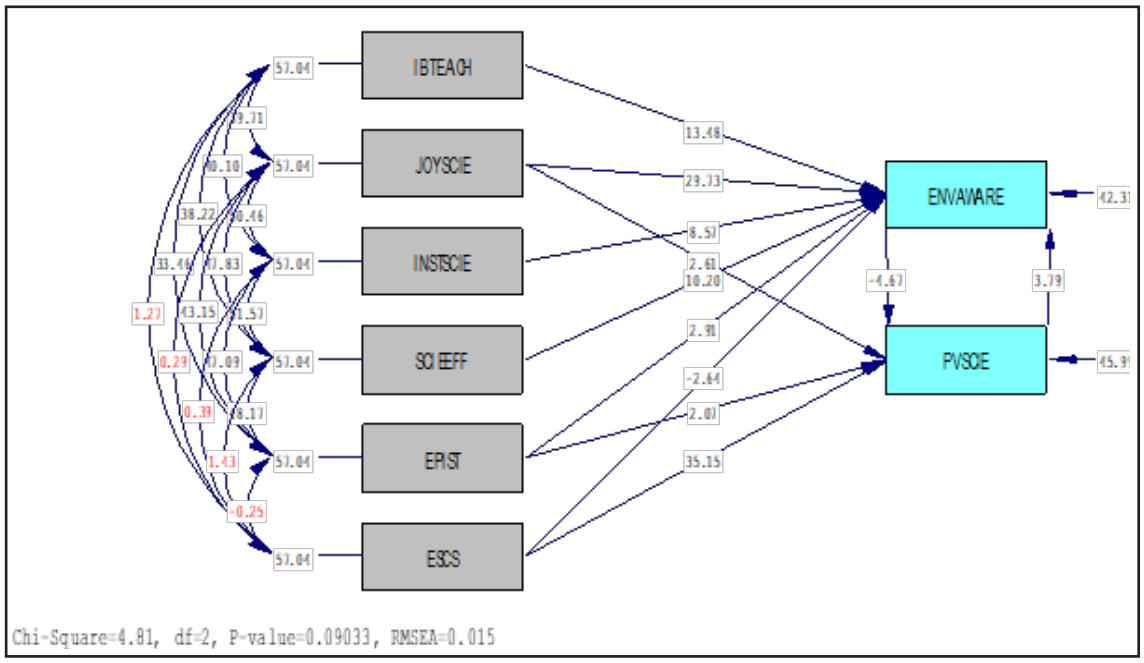

Figure 3. The Significance Test of the Determinant Factor Effect on Indonesian Students' Environmental Awareness

On the basis of Table 3, the seven variables influencing the environmental awareness of Indonesian students gave 59% of determination coefficient, this means that the seven variables were able to explain variations in environmental awareness scores by 59% while the other 41% was explained by other variables. With standardized path coefficients, it appeared that the students' enjoyment of learning science had a positive effect on environmental awareness of 0.41, followed by the students' self-efficacy in science of 0.16, the students' instrumental motivation of 0.15, the inquiry-based instruction in science lesson of 0.14, the students' science proficiency of 0.11 and the students' epistemic beliefs of 0.04. The economic, social and cultural index of Indonesian students had a negative effect of 0.04 on environmental awareness but had a positive effect of 0.40 on the students' science proficiency. This means that the higher the economic, social and cultural index of Indonesian students, the lower their environmental awareness. Similarly, it was known that environmental awareness had a negative effect of 0.28 on the students' science proficiency. Moreover, Figure 3 shows that the variable of students' enjoyment of learning science, students' self -efficacy in science, students' instrumental motivation, students' Inquiry-based instruction in science lesson, students'epistemic beliefs correlated each other yet the five variables did not correlate with the economic, social and cultural index of the students.

The influence of students' enjoyment of learning science, students' self-efficacy in science and Students' epistemic beliefs on students' environmental awareness was consistent with the results of previous studies (Le Hebel et al., 2014). For Indonesian students, it was seen that the Students' epistemic beliefs had less influence on environmental awareness than students' enjoyment of learning science and students' self-efficacy in science. The research results showed that motivation had a strong influence on environmental awareness as shown by previous research (Hansla et al., (2008), Harju-Autti, 2013). The inquiry-based instruction in a science lesson on Indonesian students also contributed a strong influence on environmental awareness. This was in line with several previous studies that inquiry-based learning gave a positive effect on students' environmental awareness (Saricam & Sahin, 2015). Referring to the previous studies (Alves et al., 2009), the science proficiency of Indonesian students have proven to possess a strong direct influence on environmental awareness.

Previous studies have proven that socioeconomic status encouraged environmental awareness, but this could not be found in Indonesian students where the economic, social and cultural index had a negative effect of 0.04 on environmental awareness (Coertjens et al., 2010; Erbas et al., 2012). The results of this study indicated that Indonesian children of higher socioeconomic status possessed lower environmental awareness. This was supported by several studies which showed that environmental awareness is strongly influenced by children's culture, family, school characteristics, and social interaction (Zecha, 2010; Duarte, 2017). For Indonesian students, it concluded that community culture, school culture, and social interaction were likely to have a stronger influence on students' environmental awareness than socioeconomic status. It means that the community culture, school culture and social interaction of Indonesian students did not support the development of an environmental awareness attitude. However, the economic, social and cultural index of Indonesian students turned out to be very greatly impacted the science proficiency of 0.04%. The relationship between environmental awareness and science proficiency of Indonesian students is presented in Table 5.

Table 5. The Relationship between Environmental Awareness and Science Proficiency of Indonesian Students Referring to the 2015 PISA

No	Influence (standardized)	Direct	Indirect	Total
1	PVSCIE ENVAWARE	0.11	0.00	0.11
2	ENVAWARE PVSCIE	-0.28	0.01	-0.27

The above Table 5 informs that the direct influence of science proficiency on environmental awareness was 0.11. This means that the higher the science proficiency of Indonesian students, the higher the environmental awareness. Therefore, the research results concluded that science learning in Indonesia emerged a positive impact on the students' environmental awareness. Meanwhile, the effect of environmental awareness on science proficiency was -0.27 which means that the higher the environmental awareness, the lower the students' science proficiency. However, on its indirect influence, the environmental awareness gave a positive effect of 0.01 on Indonesian students' science proficiency. This was due to the strong correlation between ESCS and science proficiency, as well as the negative correlation

between ESCS and environmental awareness. In addition, this research provides a recommendation for implementing the environmental education intensively as a separate subject to reach a parallel increase of environmental awareness and science proficiency.

The correlation level within the variables involved in this study is presented in Table 6. It appeared that there was a fairly strong correlation between the Inquiry-based instruction in a science lesson with the students' enjoyment of learning science, students' self –efficacy in science, students' instrumental motivation, and students' epistemic beliefs. Also, there was a strong correlation between the students' enjoyment of learning science with the students' self–efficacy in science, students' instrumental motivation, and students' epistemic beliefs. Similarly, a strong correlation was shown between the students' instrumental motivation with the students' self –efficacy in science and students 'epistemic beliefs. In addition, there was also a strong correlation between the students' self–efficacy in science and the students' epistemic beliefs.

Table 6. The Correlation between the Variables Influencing Environmental Awareness

	ENVAWARE	**PVSCIE**	**IBTEACH**	**JOYSCIE**	**INSTSCIE**	**SCIEEF**	**EPIST**	**ESCS**
ENVAWARE	1							
PVSCIE	-0.08	1						
IBTEACH	0.55	-0.07	1					
JOYSCIE	0.74	-0.07	0.57	1				
INSTSCIE	0.71	-0.08	0.57	0.8	1			
SCIEEF	0.68	-0.07	0.54	0.74	0.83	1		
EPIST	0.58	-0.06	0.46	0.63	0.72	0.74	1	
ESCS	0.01	0.4	0.02	0.00	0.00	0.02	0.00	1

There were several weaknesses of this research both methodologically and substantially. The use of path analysis is basically referred to the correlational analysis. Furthermore, the disadvantage of statistical correlation analysis is its dependence on sample size. If the sample size is too large, the correlation coefficient decreases, while if the sample is small, the correlation coefficient rises. This study employed a sample size up to 6513 students so that the actual correlation would be higher than the correlation coefficient appeared in the analysis results.

Environmental awareness measurements in the 2015 PISA study were carried out by analyzing the students' condition whether or not they knew the information related to environmental issues. The environmental issues used in the 2015 PISA Survey included: (1) the increased greenhouse gases in the atmosphere; (2) the use of genetically modified organisms; (3) nuclear waste; (4) the consequences of deforestation for land; (5) air pollution; (6) the extinction of plants and animals; and (7) the lack of water. This is certainly less comprehensive to see the students' environmental awareness aspects since it contains not only cognitive aspects but also other dimensions like affective, cognitive, disposition, and active (Lafuente & Sánchez, 2010).

There is something interesting from the results of this study that socio-economic had a negative effect of -0.28 on the environmental awareness of Indonesian students. This means that the higher the socioeconomic status of Indonesian students, the lower their environmental awareness. There needs to be further research related to this because in general the higher the socioeconomic status the higher the level of environmental awareness as in Australia (Thomson et al., 2017), Turkey (Öztürk, 2018) and in most PISA 2015 participating countries (OECD, 2016a). This is reinforced by research using primary data in Malaysia that students with a more complete background of facilities and learning resources will have higher attitudes, knowledge and environmental awareness (Aminrad et al., 2013).

CONCLUSION

The 15-year-old Indonesian students' environmental awareness based on the 2015 PISA results was positively influenced directly by (1) the students' enjoyment of learning science; (2) the students'self -efficacy in science; (3) the students' instrumental motivation; (4) the inquiry-based instruction in science lesson; (5) the students' science proficiency; and (6) the students'

epistemic beliefs. Science learning in Indonesia has proven effective in increasing the students 'environmental awareness as evidenced by the research results showing that Indonesian students' science proficiency contributed a positive influence of 0.11 on environmental awareness. Meanwhile, Indonesian students with higher socioeconomic status possessed lower environmental awareness. There was a quite large correlation of >0.5 between the students 'enjoyment of learning science, students' self-efficacy in science, students 'instrumental motivation, Inquiry-based instruction in science lessons, students' epistemic beliefs with the environmental awareness.

Indonesian science learning requires to strengthen those six aspects to increase their environmental awareness. Further, it is necessary to strengthen the environmental education materials so that Indonesian students' increase in environmental awareness will be in line with science learning achievements at school. Further research is needed as several studies indicated that environmental awareness is strongly influenced by children's culture, family, school characteristics, and social interaction (Zecha, 2010; Duarte et al., 2017; Lee & Shi, 2014).

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