

# The Relationship of Science Knowledge and Decision-Making Based on Gender on Socioscientific Issues

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**Abstract**—The purpose of this study was to investigate the relationship between students' understanding of science and decision-making based gender on socio-scientific issues (SSI), especially on environmental pollution in Indonesia. Science Instruction based SSI was developed and implemented to encourage students to understand and reflect on knowledge and decision making on the issue in the current society. Eighteen students attended the instruction and participated in pre-test and post-test. Data were collected by utilized decision-making and science knowledge test then analyzed by correlation product moment test. Regarding the relationship of the two domains revealed that there was no difference between male and female on decision making whereas the correlation analysis between the understanding of scientific knowledge and decision making did not show a positive and significant correlation, decision making is determined by the understanding of science only 6.978 %. These results highlight there are other variables besides the understanding of sciences concept and gender that have a significant correlation to decision making on SSI.

**Keywords**—*socioscientific issues, decision making, science knowledge*

## I. INTRODUCTION

Science education recently aims to realize the achievement of scientific literacy which is the central area of many curricula such as *Hongkong Curriculum Development Council, National Research Council (NRC), Qualifications and Curriculum Authority (QCA) and American Association for the Advancement of Science (AAAS)* [1]. Based on the curriculum, science education not only acquisition the concept of science, but also requires students to participate in argumentation and making a decision about the technological and societal applications of modern science problems as well as their personal and societal implications. Integration socioscientific issues (SSI) in science instruction is believed the potential to facilitate students to realize it. SSI is a controversial issue that is complex which integrates science, technology, and social dimensions and tends to be generalized to personal level or controversy at a broader level. It is also packaged based on real-life issues with no definite solution [2]. As a result, introducing students to relevant and contentious issues will

assist them to contextualize science ideas and practices toward the resolution of those issues [3].

Studies reveal through science learning with the integration of SSI is the potential to improve the ability to argue, make decisions and critical thinking skills [2][4][5]. Siribunnam et al. [6] argued SSI-based instruction offers learning contexts that include both conceptual connections to science, ill-structured and compelling problems that engage learners in the discussion, critical thinking, and decision-making. In line with the opinion, Klosterman & Sadler [7] and Walker & Zeidler [8] described the activities in socioscientific have been documented to invite students to engage in argumentation dan decision making. However, the most forceful justification for placing socioscientific activities on the agenda is that they epitomize a key goal of science education: Enabling students to make decisions that are informed by science on real-life issues [9]. Decision-making ability can further be a sufficient competence for students to participate as citizens to engage in public discussions that can provide solutions to controversial issues in daily life. In addition, students who have informed and systematic decision-making ability will become students who have critical thinking skills.

Science education literature from broader domains of decision making describes discussions of SSI are frequently accompanied by the assumption that an individual's content knowledge contributes significantly to this ability in the context of SSI or in other words, mastery of the scientific knowledge is crucial to producing high-quality decision making. In this regard, a worthwhile study on decision making to identify the influence of scientific knowledge on individual's high quality of decision making has been conducted, but different results are obtained. Nielsen [10] report that students with better scientific abilities show better reasoning and use various sources supported by evidence in decision making than students with lower abilities. Lewis & Leach [11] confirmed that students' decision making is not related to scientific knowledge. Likewise, Perkins et al. in Hong & Chang [12] conclude that there is no significant relationship between the quality of reasoning and content knowledge. While Sadler & Donnelly [13] explains there are other factors that are essential

compared to scientific knowledge which greatly influences decision making such as emotions and personal experience. Based on the results of these studies, there remains a need for further clarification on the correlation between science knowledge and student decision making.

Other factors that need to be taken into account are regarding gender-based decision making. A Considerable number of SSI-related research has been carried out starting from the development of learning models with SSI integration, the development of teaching materials and training for teachers in teaching SSI in the classroom, however, the assessment of the quality of decision making based gender is still quite rare. There is a stereotype widespread in the community about the differences between male and female in making a decision. Female is considered as emotional, soulful, while the male is not affected by emotions, feelings and tend to be more logical. This stereotype is worthwhile and pervasive on our culture Shields in Fleming [14]. Thus, the female is often stereotyped as low-quality in making decisions than male. This stereotype needs to be proven with empirical data by assessing the decision-making ability and science knowledge between male and female when faced with SSI.

Given the theoretical backdrop just presented, the researchers designed and conducted a study with the purpose of investigating the relationship of scientific knowledge and decision-making based gender contributes to the quality of decision making demonstrated in the context of SSI for junior high school students. In terms of the SSI, the researchers focused on environmental pollution. The selection of environmental problems in this study is based on the fact that there are currently many reports about environmental problems that occur in Indonesia, such as forest fires, floods, pollution, damage to ecosystems and problems related to fossil fuels, thus it is hoped that with contextual problems and happening in Indonesia will be able to trigger students to show their arguments and make decisions by considering various aspects related to the problem owing to the fact that goals of science education is students can understand and be able to act on personal issues and social issues [15].

## II. RESEARCH METHODOLOGY

This study was conducted in Junior High School located in Sidenreng Rappang province of South Sulawesi, Indonesia. The research design that implemented is one group pretest-posttest. In the design of one group pretest-posttest, single-subject groups were given a pretest (T1), treatment (X), and posttest (O). The sample is eighteen students grade seventh that consist of nine males and nine females. The research starts by given pretest to student and implementation of SSI instruction for 4 days to discuss environmental issues with worksheet as a guide for student, and in the last meeting, students were given posttest.

### A. Instrument test

The instrument used in this study consist of decision making test and science knowledge test. The decision-making test used in the form of essay questions with three issues (fish bombing in south Sulawesi, pollution of motor oil, increasing of vehicles in Makassar, South Sulawesi) which each issue comprises of five indicators according to Fraenkel et al. [16]. The issues were presented with a brief

article that sparked the curiosity of students and contains six questions that lead students to make a decision. The total questions for decision making tests contains 18 number that intended to explore students' ability to identify problem-based on the article and collect information to more understand about the issue and main problem, determine alternative solution of the main problem and then weigh pros and cons, advantage and disadvantage of the alternatives for the environment, society, human health. In the final questions, students were asked to give their decision based on the analysis in the previous steps. The science knowledge test consists of fifteen multiple choice questions related to environmental pollution subject and relevant to the issues which presented in decision-making test.

### B. Data analyze

Decision-making instrument and science knowledge test were tested to determine the validity and reliability by used anates application before it was implemented in this study. Validity is the measure that indicates the level of validity of an instrument [17]. Regarding decision-making ability and science knowledge of male and female was tested using an independent t-test for a small sample and the correlation of decision-making ability and science knowledge was analyzed using product moment (Pearson). If the result  $r_s = -1$  or near  $-1$ , the correlation of two variables was very strong and negative, if  $r_s = 0$  or near  $0$ , the correlation of the two variables was very weak, or there was no correlation and if the  $r_s = 1$  or near  $1$ , the correlation of two variables was very strong and positive. In order to know how science knowledgeable to explain decision-making ability between male and female students, it was calculated by using coefficient determination. The coefficient determination obtained from Pearson correlation test was converted to  $t$  to obtain the correlation of two domains (decision making and science knowledge).

## III. RESULT AND DISCUSSION

### A. Decision-making ability and science knowledge of male and female

Decision-making ability of students was measured by using an instrument that represented 5 indicators of decision-making ability by [16]. The result showed in Table 1.

Overall, the ability to make a decision was increased significantly for each indicator. The highest improvement revealed in determining an alternative solution for both male and female students. This is because the issue given is closely related to the student's environment. In addition, during the learning process students will face several issues which asked them to make a decision. As a result, the student will be able to determine various alternatives to make decisions from the issues given. This is in line with the concept of long-term memory that it is important to give training in several stages where information or ability used in short-term memory must be raised and repeated so that the skill is firmly stored in long-term memory [18]. The lowest improvement showed in analyze pros and cons indicator for both male and female. The student needs to consider the alternative effects on various aspects such as the environment, social, health as well as able to predict the

possibilities that will happen when implemented in society. This is more complex and required the ability of students to conduct deep analyses as well as reasoning. Therefore, the intensity to practice in long period is crucial.

TABLE I. THE COMPARISON OF DECISION MAKING BETWEEN MALE AND FEMALE

Indicator	Pre-test Average (%)		Post-test Average (%)		N-gain	
	Male	Female	Male	Female	Male	Female
1 <sup>a</sup>	44.44	41.97	64.19	74.07	0.33	0.57
	43.21	40.74	65.43	74.07		
	38.27	58.02	45.32	82.72		
	41.97	46.91	61.31	76.95		
3 <sup>b</sup>	41.97	60.49	74.07	83.95	0.55	0.59
4 <sup>c</sup>	25.92	40.74	49.38	65.43	0.32	0.42
5 <sup>d</sup>	32.09	40.74	64.20	75.31	0.47	0.58
Highest	41.97	46.91	74.07	83.95		
Lowest	25.92	40.74	49.38	65.43		
Average	<b>35.49</b>	<b>47.22</b>	<b>62.24</b>	<b>75.41</b>	<b>0.42</b>	<b>0.54</b>
<sup>a</sup> Identify problem						
<sup>b</sup> Determine alternatives solution						
<sup>c</sup> Analyse pros and cons						
<sup>d</sup> Making decision						

Based on Table 1, the level of decision-making ability in both male and female groups differed by 11% which the pre-test of the male group showed the average 35.49% and female 47.22 %. After implementation of SSI based instruction in class, the decision-making ability was inclined in both groups of students. This can be seen from the average post-test score in the male group at 62.24% and the female group at 75.41%, n-gain value showed both groups in medium category respectively 0.42 for male and 0.54 for female. This result is in line with the opinion that implementation of SSI able to empower students to consider how science-based issues and the decision made concerning them reflect in part, the moral principles and qualities of virtue that encompass their own lives, as well as the physical and social world around them [19]. It is also supported according to Siribunnam [6] that involving students to learn socioscientific issues which require the involvement of student, presented challenge to students to explore the controversial issue, integrate social aspects based on their investigation potential to improve decision-making ability of students.

TABLE II. RECAPITULATION OF COLLECTING INFORMATION INDICATOR

No	Group	Average
1	Female	76.39
2	Male	70.83

Indicators of collecting information were assessed during the learning process by using observation sheets. Based on Table 2, the average score of females was higher than male. The average score for the female was 76.39 while males were 68.06. Collecting information related to problems that have been identified beforehand, as a result, if the problem identified is inappropriate or not in accordance with the issues presented, it will affect the information collected by students. In addition, in collecting information, it is necessary to be able to consider relevant or irrelevant information and the reliability of information sources. The working group also influences the information obtained by

students. Good collaboration between group members can improve the ability of student groups to collect information.

TABLE III. COMPARISON OF PRE-TEST, POST-TEST, AND N-GAIN OF SCIENCE KNOWLEDGE MALE AND FEMALE STUDENT.

Concept	Pre-test Average		Post-test Average		N-gain	
	Male	Female	Male	Female	Male	Female
1	48.16	55.57	76.56	81.48	0.55	0.58
2	44.22	59.23	81.50	85.19	0.67	0.64
3	66.71	66.74	81.48	85.22	0.44	0.56
4	62.96	62.96	81.48	77.78	0.50	0.40
5	40.74	48.15	70.37	74.07	0.50	0.50
<b>Average</b>	<b>52.56</b>	<b>58.53</b>	<b>78.28</b>	<b>80.75</b>	<b>0.53</b>	<b>0.54</b>

- Concept 1: Definition of environment
- Concept 2: Physical and Chemical properties of environmental pollution
- Concept 3: Activity cause environmental pollution
- Concept 4: Impact of environmental pollution on humans and ecosystems
- Concept 5: How to manage the environment to overcome pollution

In the implementation of SSI instruction, concepts are trained by presenting phenomena in everyday life. Students answer questions given by the teacher by connecting their knowledge and the results of seeking information. Increasing students' mastery of science knowledge in the implementation of SSI is because, in the learning process, students are invited to understand concepts through everyday phenomena that are close to students. As a result, students more easily understand the concept, apply their knowledge, as well as more meaningful for them.

Generally, female students get higher result compared with male students, but the difference was not too significant. Based on the analysis, the improvement science knowledge of male is 0.53 and female is 0.54. It can be concluded that the mastery of scientific knowledge of male student groups and a female student is the same as the medium category. According to Gallagher in Zeidler et al. [20], although male and female have differences in physical, emotional, and intellectual development, there is no evidence related to academic achievement. Academic achievement cannot be explained through biological differences. Social and cultural factors are the main reason that causes differences in academic achievement.

### B. Relationship of science knowledge and decision making

The relationship between science knowledge and decision-making ability is obtained from the value of concepts understanding and decision-making abilities that have been analyzed previously then sought for correlation.

**TABLE IV. RECAPITULATION OF SCIENCE KNOWLEDGE AND DECISION MAKING**

Average of Science Knowledge pre-test		Average of science knowledge post-test	
Male	Female	Male	Female
52.56	58.53	78.28	80.75
N-gain Male = 0.53		N-gain Female = 0.54	
Average of decision-making pre-test		Average of decision-making post-test	
Male	Female	Male	Female
35.49	47.22	62.24	75.41
N-gain Male = 0.42		N-gain Female = 0.54	

Based on the science knowledge data, it is shown the average pre-test and post-test of the female is higher than male students respectively 58.53 and 80.75. In the decision-making ability, both pre-test and post-test female students are higher than male students. The results of correlation analysis revealed the value of the correlation between science knowledge and decision making is 0.264 which means the relationship between science knowledge and decision-making is in a low category, while the  $r$  value is positive, meaning the higher science knowledge of students, the better decision-making ability or unidirectional correlation. The results of coefficient of determination between science knowledge and decision making obtained 6.978% which indicates decision-making ability is determined by science knowledge 6.978%, the remaining 93.22% is determined by other variables which are not examined.

Knowledge is not significantly correlated to make a decision, but students' attitudes toward socioscientific issues are given significantly with student decision making [21]. In addition, other factors that can affect learning ability are teachers, intuition, personal experience, students' trust in information and personal values. In line with this opinion, Lewis & Leach [11] reveal, student decision making is not related to scientific knowledge. Another factor which strongly influences decision making to scientific knowledge is emotion and personal experience [13]. Based on these opinions and the results obtained in this study, it can be concluded that there are other factors besides mastering science knowledge which more influence the ability of students to make decisions.

#### IV. CONCLUSION

Based on the results of research and discussion that have been described we cannot assume that increases in content knowledge necessarily improve the quality of decision making among students. The analysis showed there is no difference between student decision making based on gender and improvement in decision-making ability. Increased decision-making ability of male and female is included in the medium category (male 0.42 and female 0.54) after the implementation of SSI instruction and in scientific knowledge both experience an increase in the medium category (male 0.53 and female 0.54). The correlation between the two domains shows that there is no significant positive correlation between the increase in scientific knowledge and the improvement of students' decision-making abilities. Decision-making ability is determined by

science knowledge 6.978% and the remaining 93.22% is not examined in this study. Other variables can be in the form of intuition, emotion, personal experience, moral, belief, etc.

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