Implementation of Socioscientific Issues Instruction to Fostering Students’ Decision Making Based Gender on Environmental Pollution

H P Rizal¹, P Siahaan² and G Yuliani³

¹ Science Education, Postgraduate Student, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
² Department of Physics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
³ Department of Chemistry Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
Email: parsoransiahaan@upi.edu

Abstract. The purpose of this study was to investigate the implementation socioscientific issues (SSI) instruction to examine students’ decision making based gender. Selection of environmental problem based on the consideration this issue has potential to evaluate from various scientific disciplines and may initiate to make decision. The participant was students grade VII in South Sulawesi. Pre experiment method was utilized in study with one group pre-test and post-test design. The instrument used in this study comprised of open-ended question, observation sheets for group discussion, sheet for interview and observation sheet of implementation instruction in class. The result indicated that instruction has been implemented successfully. It was found that pre-test and post-test was fostered with N-gain for male and female in medium category. Based on independent t test was found there was no difference improvement of decision making between male and female students. The group showed there was no difference between male group and female group, but a significant difference was noted in mix group. Students and teacher give positive response to the implementation of instruction. It is concluded that science instruction based SSI can be implemented to foster male and female decision making by forming group discussion.

1. Introduction

Scientific literacy is worthy of note in education because become an indicator of quality education in a country. In addition, prepare students who literate science is the main purpose of learning curriculum of science in some western countries such as Hong Kong Curriculum Development Council, National Research Council (NRC), Qualifications and Curriculum Authority (QCA) and the American Association for the Advancement of Science (AAAS) [1].

According to Jho, Gyoung and Kim scientific literacy includes positive attitude towards science, understanding of scientific knowledge in everyday life such as science knowledge associated with the ideas contained in paper, media, internet and make informed decisions [2]. In other words, scientific literacy summarizes the relationship between the understanding of science, attitudes toward science and decision making in the context of everyday life. Thus, provided students’ decision making ability related phenomena and social science become one of the specific objectives of science and important
to developed not only to improve scientific literacy of students, but also to improve students’ critical thinking skills to participate as citizens who provide solution of various issues encountered.

Tawil & Liliasari suggested that decision-making is the process of thinking to identify and decide choice of various options [3]. The ability to make decisions leading to the ability to systematically evaluate the possibility of factual and ethical action on complex situation of the phenomenon as well as existing issues and systematically make the final decision. One effort to fostering decision making ability of students is by integrate a variety of issues related to the phenomena that occur in community into science lessons. Issues that integrated science, technology and social dimensions. The issue is known as Socioscientific Issues (SSI). SSI term is mostly used for designing real world scenarios in which not only focuses on the facts related to science, but also normative values (Sadler in Botcher and Meisert) [4]. One of SSI that can trigger student to use their ability to make decisions is issue about environment. Environmental issues often contain values, ill structure and controversial [5]. This issue can lead student to making decision.

Lewis and Leach explained that students with better science knowledge shows better reasoning and use the resources that are supported by the evidence in making decisions [6]. Contrary, Hong and Hong and Chang reveals that students’ decision-making is not related to its scientific knowledge [7]. While Fleming explains that there are other factors that are very strong compared to the science knowledge that greatly affects decision making such as emotions and personal experiences. These factors need to be considered because it’s varying for each individual primarily between male and female. In SSI discussion differences of individuals or group can build a different perspective. Therefore, in SSI discussion gender differences may become factor that distinguishes students’ ability to make decisions beside science knowledge. In addition, with regard to gender stereotypes which are developed in community about the differences between male and female in decision making. Female are considered as a highly emotional, full of feeling and male are not affected by emotional feelings and tend to be more logical. This stereotype is very strong and pervasive impression on our culture [8]. The stereotype judged female less able to make decision than male, however this stereotype still need to prove because research about gender still unable to show consistent result. According to Dagun male known to be more able and responsive in recognizing a problem when starts entering adulthood than female [9]. Differences in the ability possessed by male and female influenced by the thinking male and female are different, that male are more analytical and flexible than female. Contrary, Halpern explains that in general there is no difference between males and female in the overall IQ, learning, memory, problem solving, and concept formation [10].

Based on the description, this study examine junior high school students and divide student and group discussion not only based on the knowledge level or characteristic, but also gender of student to find out how the difference of improvement decision making ability between female and male and how the difference of decision making ability between group based gender by implementation of socioscientific issues instruction.

2. Research methodology
Research design used in this study is a one group pretest-posttest design [11]. With these designs, the research subject is an experimental class without comparison. In the design of one group pretest-posttest, single-subject groups were given a pretest (T1), treatment (X), and posttest (O). Instruments on the pretest and posttest at same time, but given at different times. This study was conducted in Junior High School, Sidenreng Rappang province of South Sulawesi with a population students grade seventh. Study throughout to students with second semester who have five classes with the composition of 25-30 students in a class. The sample in this research is student class VIIa Academic Year 2015-2016. The research start by given pretest to student and learning process for 4 days to discuss environmental issues with worksheet as a guide for student and in the last meeting with post test.
2.1. Instrument test
The instrument used in this study is pre test and post test instrument consist of five indicators according to Tawil & Liliasari [3]: a) identify the problem, b) collect information, c) Determine alternative solution, d) Analyze pros and cons, e) Make Decision. Instrument used in the form of essay question with three issues (fish bombing in south Sulawesi, pollution of motor oil, increasing of vehicles in Makassar, south Sulawesi), each issue consists of a brief article that sparked the curiosity of students and contains six questions that lead students to make decision with the total questions for all issues contains 18 number. The instrument asked student 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. Based on that, students asked to make decision with the reasons. Beside pre test and post test of decision making instrument, student worksheet in classroom based on decision making indicators was prepared to assist students in group to discuss and make decision related environment issues. Group discussion divided into 3 groups; male group, female group, mix group (consist of female and male student) with formation six students each group. The second indicator, collect information assessed during the learning process by using observation sheets, sheet for teacher and student interview to know the response about implementation of instruction in class.

2.2. Data analyze
Decision making instrument was tested to determine the validity and reliability by used anates application before used in this study. Validity is the measure that indicates the level of validity of an instrument [12]. Reliability test used in this study is the product moment correlation while to interpreting the value of reliability each item problems, the value was consulted to table of r product moment critical value, with the provision that if r calculate > r table at N = 34 and the significant level α = 0.05 means the item problem was reliable [12]. The improvement of decision-making ability of students each indicator, each item and in generally was calculated used Normalized Gain (%). In this study, the first hypothesis about how the difference improvement of decision making ability between female and male was tested using Independent Sample t-test for small sample and the second hypothesis about the differences improvement of ability of decision-making among male group, female group and mix group were tested using ANOVA. If the result of ANOVA reject the null hypothesis means that there are differences in average of decision making ability between group of male, female and mix, then carried across the Tukey test to compare the average male group, female group and mix group and determine which groups differed significantly. If each group obtained p value < 0.05 means that there is a statistically significant difference among the three groups, if p values > 0.05 means that there is no statistically significant difference among the three groups [13].

3. Result and discussion
3.1. Decision making between male and female students
Decision-making ability of students was measured by using instrument that represented of 5 indicator of the ability of decision-making by Tawil & Liliasari [3]. At the First meeting, students are given pretest to represent the ability of students in decision making. In the implementation of SSI instruction students are given issue or phenomena then discussed and in the end students are given posttest. The recapitulation result showed in Table 1.
Table 1. The comparison of pretest, posttest and n-gain of decision making male and female students.

| Indicator | Number of problem | Pretest Average (%) | Posttest Average (%) | N-gain |
|-----------|-------------------|---------------------|----------------------|--------|
|           |                   | Male | Female | Male | Female | Male | Female |
| 1         | 1,7,13            | 44.44 | 41.97 | 64.19 | 74.07 | 0.33 | 0.57 |
|           | 2,8,14            | 43.21 | 40.74 | 65.43 | 74.07 |       |       |
|           | 3,9,15            | 38.27 | 58.02 | 54.32 | 82.72 |       |       |
| 2         | 4,10,16           | 41.97 | 60.49 | 74.07 | 83.95 | 0.55 | 0.59 |
| 3         | 5,11,17           | 25.92 | 40.74 | 49.38 | 65.43 | 0.32 | 0.42 |
| 4         | 6,12,18           | 32.09 | 40.74 | 64.20 | 75.31 | 0.47 | 0.58 |
| Highest score | 41.97 | 46.91 | 74.07 | 83.95 |       |       |
| Lowest score | 25.92 | 40.74 | 49.38 | 65.43 |       |       |
| Average   |                   | 35.49 | 47.22 | 62.24 | 75.41 | 0.42 | 0.54 |

- Identify problem
- Determine alternatives solution
- Analyze pros and cons
- Make decision

Table 1 shows level of decision making ability of male and female differ by 11%. It is seen from the results of pretest two groups for male gain 35.49% from 100 ideal value and female 47.22% from 100 ideal values. Decision making ability was improved in general and each indicator after implementation of SSI instruction. The average of N-gain was increased with 0.42 for male (medium category) and 0.54 for female (medium category). This result in line with Klosterman and Sadler opinion that learning with socioscientific issues requires involvement of student, presented challenge to students to explore the controversial issue, integrate social aspects based on their investigation that can improve decision-making ability of students [14].

The first indicator identify problems requires student's ability to create questions and answers with regard to the issues with the aim to identify the main problem of issue. The ability of students to identify problems obtained through the average in make question, make a temporary answer and determine the problem. Determines an alternative solution is an indicator of the highest achievements in both groups of students. This is because the issue given close to student. In addition, during the learning process students are also trained to make decisions by providing socioscientific issues, so that students can specify a range of alternative solutions to make decisions on a given issue. The last indicator makes decision students are assigned to select the most appropriate alternatives to solve problem of environmental pollution and enclosing the reasons for selecting the alternatives. Based on the results in this study, it can be seen that students are able to write good problem solving alternatives, but still difficult to analyze pros and cons of issue. The second indicator that collects information assessed during the learning process by using observation sheet.

Based on the test results of the difference in average improvement of decision making ability showed that there is no difference average of improvement decision making ability between male and female to the implementation of socioscientific issues instruction. These mean that generally the abilities of male and female equally in decision-making. In line with the opinion of Halpern & Lamay that on the average, male and female showed the same results on general intelligence tests [15]. According to Halpern in general there is no difference between male and female in the overall IQ, learning, memory, problem solving, and concept formation [10]. Fraine, Damme and Onghena explained a weak correlation between gender and academic achievement, gender factor is unable to become the only aspect of the benchmarking of student achievement [16]. The difference between male and female is due to social and cultural factors.
3.2. Decision making between male group, female group and mix group
Sadler suggested that characterizes the SSI is a discussion group to discuss the issue or phenomenon presented [17]. Discussion group consisting of members of heterogeneous enables a variety of different perspectives on the issues. In addition, a heterogeneous group with different abilities of students can help low-ability students to master the concepts included in the issue because students with high ability guide students who have low capacity. Recapitulation of the assessment of the group discussions illustrated in Table 2.

**Table 2. The comparison average difference of group discussion.**

| Indicators          | No. Problem | Pretest Average | Posttest Average | N-gain |
|---------------------|-------------|-----------------|------------------|--------|
|                     |             | Male            | Female           | Mix    | Male  | Female | Mix    |
| 1                   |             | 48.15           | 68.52            | 50.00  | 62.96 | 90.74  | 66.67  |
| 2                   |             | 38.89           | 61.11            | 35.18  | 59.26 | 85.19  | 42.60  | 0.37  | 0.65  | 0.27  |
| 3                   |             | 25.93           | 33.33            | 12.96  | 59.26 | 75.93  | 42.59  |
| 4                   |             | 37.65           | 54.32            | 32.71  | 60.49 | 83.92  | 50.62  |
| 5                   |             | 53.70           | 72.22            | 55.56  | 83.33 | 88.89  | 70.37  | 0.64  | 0.60  | 0.33  |
| Highest             |             | 44.44           | 61.11            | 25.93  | 77.78 | 88.89  | 57.41  | 0.60  | 0.71  | 0.43  |
| Lowest              |             | 38.89           | 33.33            | 18.52  | 53.70 | 77.78  | 42.59  | 0.24  | 0.67  | 0.30  |
| Average             |             | 53.70           | 72.22            | 55.56  | 83.33 | 88.89  | 70.37  |

a. Identify problem  
b. Determine alternative solution  
c. Analyze pros and cons  
d. Make decision

Table 2 shows the mix group obtains lower results than male and female group, but N-gain category for each group equal in medium category. The highest result of each group showed in determine alternative solution indicator. The second indicator collect information assessed during the learning process by using observation sheet with the average of collect information for female group gain 76.39, male group gain 70.83 and mix group gain 65.28. Calculation with ANOVA showed difference average in ability of decision-making between groups on the implementation of SSI. Further testing to compare the entire pair-group average between male, female and mix group that differed significantly by using Tukey test. The result showed in Table 3.

**Table 3. The comparison tukey test of group discussion.**

| Group   | Sig  | α   | Interpretation         |
|---------|------|-----|------------------------|
| 1       | 0.352| 0.05| Not Significantly different |
| 2       | 0.352| 0.002| Significantly different |
| 3       | 0.038| 0.002| Significantly different |

a. Male Group  
b. Female Group  
c. Mix Group

Table 3 shows female and male group not significantly different based on the sig number that higher than α, but mix group with female and male group significantly different (sig < α). In group discussion, differences in environmental characteristics of students, student background, values in society also influence the interaction of students in group. According Ormrod the distribution group that is too heterogeneous make differences in ability among students more clearly [15]. High ability students may dominate the discussion and make low-ability students less participates. Low-ability students may be embarrassed to ask for help when they do not understand and give other members do most or all of the work. Further Ormrod explains that the group would be more effective if all group
members are female or all male because female students are more likely to express their opinions in small groups or all of its members are female [15]. In line with these opinions, this study dividing groups based on gender differences and cognitive abilities caused the mix group too heterogeneous, so that cooperation within the group was not optimal when compared to group of all male or female and when given test to make independent decision, the result vary between members of group.

4. Conclusion
Based on the results of research and discussion that has been described can be concluded that students’ decision making ability was fostered with the implementation socioscientific issues instruction. The result showed no difference in improving of decision making ability between male and female in generally although in some indicators female student get higher score than male, but generally no significant difference. In socioscientific issues group discussion showed that female and male group no significant difference, but mix group was noted. The male and female group more active and make informed decision than mix group. This result may occur because the formation of group too heterogeneous and students difficult to cooperate each other. According to result in this study, in making decision individually, gender does not really give a significant influence, but when asked to make decision as a group, gender different affect decision making student. Suggestion for other researchers who are interested to doing similar research, important to take into account about the allocation of time because to discuss about controversial issues need more time to express the opinion. The other factor that can influence students’ decision making such as ethnic, cultures and the environment condition should be more attention.

5. References
[1] Lee C Y and Grace M 2012 Science Education Journal 96 pp 787-807
[2] Jho H, Gyoung H and Kim M 2013 Science & Education Journal 23 1131-51
[3] Tawil M and Liliwasari 2013 Berpikir Kompleks dan Implementasinya dalam Pembelajaran IPA (Makassar: Badan Penerbit UNM) pp 125-40
[4] Bottcher F and Meisert 2011 Research in Science Education 43 479-506
[5] Weinberger Y and Dreyfus A 2013 International Journal of Environment & Science Education 8 627-643
[6] Lewis J and Leach J 2006 International Journal of Science Education 28 pp 1267- 87
[7] Hong J L and Chang N 2004 Research is Science Education 34 97-111
[8] Santrock J W 2003 Adolescence Perkembangan Remaja (Jakarta: Erlangga) p 376
[9] Dagun S 1992 Maskulun dan Feminim: Perbedaan Pria dan Wanita dalam Fisioologi (Jakarta: Rineka Cipta) p 68
[10] Feldman R 2011 Pengantar Psikologi Understanding Psychology (Jakarta: Salemba Humanika) p 56
[11]Fraenkel J R et al 1993 How to Design and Evaluate Research in Education (New York: McGraw-Hill)
[12] Arikunto S 2012 Prosedur Penelitian Suatu Pendekatan Praktek (Jakarta: Rineka Cipta)
[13] Sarwono J 2006 Analisis Data Penelitian Menggunakan SPSS (Yogyakarta: Andi) p 88
[14] Klosterman M L and Sadler T D 2010 International Journal of Science Education 32 pp 1017-043
[15] Ormrod J E 2008 Educational Psychology (United States of America: Pearson Education) pp 118-88
[16] Fraine B D, Ramme J V and Onghena P 2007 Contemporary Educational Psychology 32 132-50
[17] Sadler T D, Barab S A and Scott B 2007 Research in Science Education 37 371-91