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THE DIFFERENCES IN MALE AND FEMALE STUDENT'S PROBLEM-SOLVING ABILITIES IN ENVIRONMENTAL CHANGE TOPICS BASED ON EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD

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ABSTRACT

This study aims to determine the differences between male and female students's problem solving abilities in environmental change topic based on ESD. This study used pre-experimental method with one group pretest – post test design. This study located at MA Darul Muqorrobin with subjects 30 students of class X who selected using a purposive sampling technique. Generally, female students's problem solving ability is higher than male student's, with a final value of 77.7 for male students and 82.3 for female students. Male students have an average total score higher than female students on the problem understanding indicator, namely 7.7 for male students and 7.4 for female students. In the problem-solving design indicator, female students have a higher average total score than male students, namely 6.1 for male students and 6.5 for female students. Female students have an average total score higher than male students on the indicator of carrying out problem solving, namely 5.8 for male students and 6.4 for female students. In the indicators evaluating problem solving, female students have an average total score higher than male students, namely 5.3 for male students and 5.9 for female students. The high female students's problem solving ability due to the structure of woman's corpus collasum which thicker than the men's. Testosterone hormone causes men prefer learning that hands-on. The preoptic region in the men's hypothalamus is larger than women's so men can understand problem better than women. The interpretation of the N-Gain value is sufficient, so the learning of environmental change topic based on ESD is effective to improve problem solving ability in both students.

INTRODUCTION

There are four categories in 21st century skills, namely ways of thinking (creativity and innovation, critical thinking, problem solving, making decisions and learning), ways of working (communicating and working together), tools for working (knowledge and information technology and communication skills, career, personal and social responsibility), as well as awareness of culture and competence (Blyznyuk, 2018). Problem solving skills are the one of skills that students must have in the 21st century (Sari & Trisnawati, 2019). Problem solving ability is the process of seeking and finding the best answer to something that is not yet known and becomes an obstacle by combining the knowledge and abilities that already owned to be applied to the problem (Supiyati et al., 2019).

Problem solving ability is the one of competencies that students must hold in Education for Sustainable Development (ESD) learning. ESD is a transformative learning paradigm towards sustainability, which is based on innovative teaching and learning practices, diversity of methods, problem-based learning, critical reflection, assessment and clarification of self-values and existing conceptions, context and action-based learning (Cebri et al., 2020). ESD can be applied in curricular activities, by integrating ESD concepts in learning processes or methods (project-based learning, inquiry, story-based, values, problems and learning outside the classroom) in the curriculum and also through extracurricular activities (scouts, youth scientific groups and so on) (Fatiyah et al., 2020; Perkasa et al., 2020; Saragih et al., 2021). One of the applications of ESD in learning is through ESD-based learning. Appliying ESD-based learning has been proved to improve students' problem solving abilities (Fatiyah et al., 2020; Pradipta & Hariyono, 2021; Saragih et al., 2021).

The study shown that the problem solving abilities of students at MA Darul Muqorrobin are still low criterion with a percentage 39% (Budianti et al., 2022). The lowest problem-solving ability indicator is implementing a problem-solving strategy, namely 32%. It is because of the learning at MA Darul Muqorrobin has not focused on improving problem solving. Most of the learning process is not fully student-centered. The results of an interview with the biology teacher on March 25 2023 showed that the teacher did not know the concept of ESD, so they had never done ESD-based learning.

In the context of ESD, gender is the one aspects that discussed in social perspective. Men and women have several differences. One of the differences is biological differences in men and women. These biological differences lead to differences in knowledge, attitudes, behaviors and abilities possessed by women and men (Barnas & Ridwan, 2019). Gender can be a differentiator in the problem solving ability (Lestari et al., 2021). There are significant differences between men and women in problem solving (Fitriani et al., 2015). The research of Dorisno (2019) show that there are differences between men and women in problem-solving ability. MA Darul Muqorrobin is a school that separate classes between male and female students, so it is very interesting to conduct the research of problem-solving ability based on gender. The study was conducted on differences problem-solving abilities of male and female students in environmental change topic based on ESD. This study aims to determine differences problem solving abilities of male and female students in enviromental change topic based ESD.

MATERIALS AND METHODS

This study used pre-experimental method with one group pretest – post test design. This study is located at MA Darul Muqorrobin Kendal with subjects 30 class X students of MA Darul Muqorrobin for 2022/2023 academic year (15 male students and 15 female students) who were selected used purposive sampling technique. Purposive sampling is a sampling that carried out certain considerations (Hermawan, 2019). The technique of collecting data is done by testing. The data in this study are problem-solving abilities data and the effectiveness of learning on environmental change topic based ESD to improve problem-solving abilities based on gender data. The data was collected using an essay test instrument on students' problem solving ability on the topic of environmental change, totaling 8 questions. The indicator of problem-solving ability that use is the indicator according to Polya (1973). The indicator of problem-solving ability and the number of questions can be seen in the **Table 1**.

Table 1. The Indicator of Problem-Solving Ability and The Number of Questions

The Indicator of Problem-Solving Ability	The Number of Questions
Understanding Problems	2
Designing Problem Solving	2
Implementing Problem Solving	2
Evaluating Problem Solving	2

Before being used, the problem-solving ability essay questions were tested on grade XII MIPA students who had obtained environmental change material. Based on the results of trials, problem-solving skills have validity, reliability and difficulty levels that are worthy of being used for research.

Problem-solving ability data based on gender then searched for the final value. Meanwhile, to analyze problem-solving ability data based on gender per indicator, an average calculation of the number of student scores for each problem-solving ability indicator was calculated. Effectiveness data were analyzed using the calculation of Normalized Gain (N-Gain), namely by calculating the post test score minus the pretest score divided by the result of subtracting 100 minus the pretest score.

RESULTS AND DISCUSSION

Result

Based on the results of the study, there is the difference in the average pretest and post test scores in male students and female students. The average pretest and post test scores of gender-based problem-solving skills can be seen in **Figure 1**.

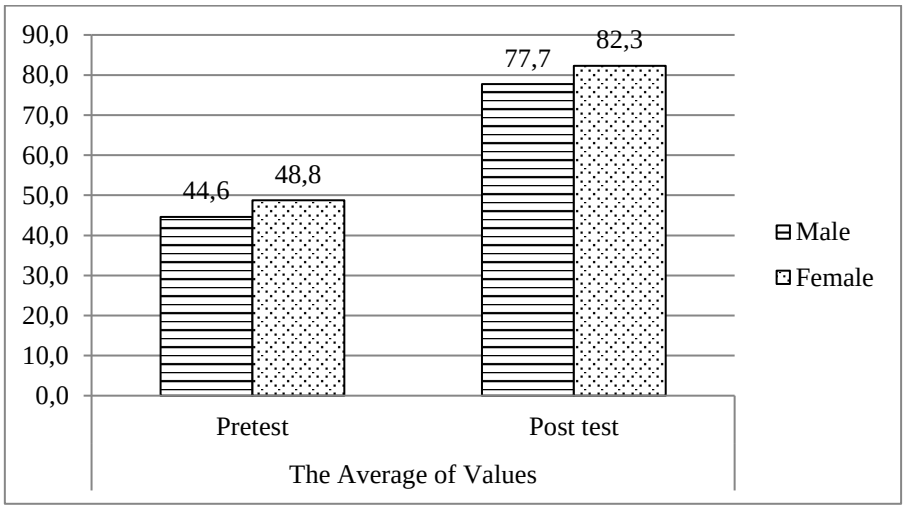

Figure 1. The Average of Values in Pretest and Post Test Based on Gender

Based on **Figure 1**, the average of pretest and post test values of female students are higher compared to male students. The average pretest values of male students is 44.6 and female students are 48.8 out of a maximum of 100. The average post-test values of male students is 77.7 and female students are 82.3 out of a maximum of 100.

Problem solving questions are developed with the number of 2 questions each indicator out of 4 indicators of problem solving ability. The maximum scores for each indicator is 8. The problem-solving ability indicator used is an indicator of problem-solving ability according to Polya (1973), namely understanding problems, designing problem solving, implementing problem solving and evaluating problem solving. The average number of pretest and post test scores per indicator based on gender can be seen in Figure 2.

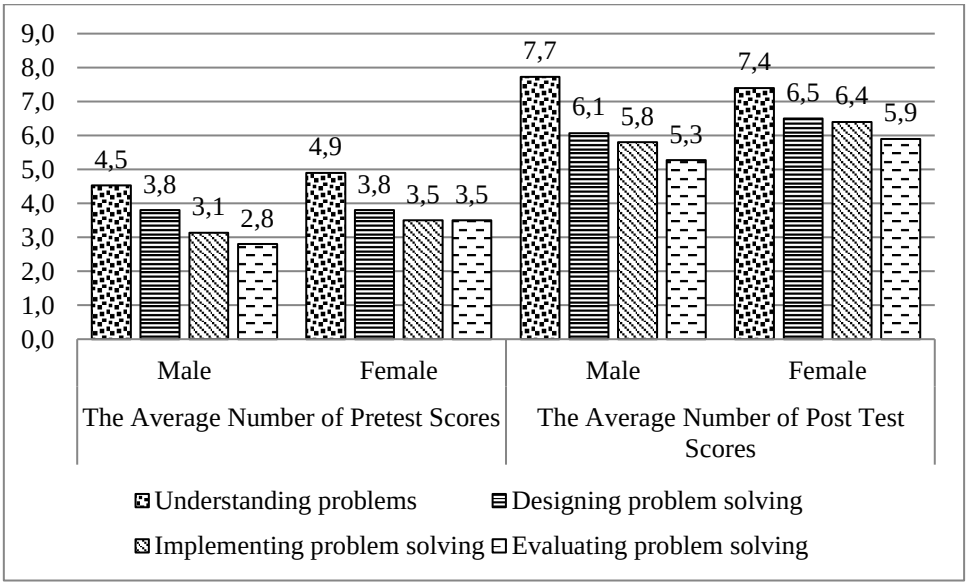

Figure 2. The Average Number of Pretest an Post Test Scores Based on Gender

Based on **Figure 2**, the average number of pretest scores in female students is higher compared to male students. In the indicator of understanding problems, male students have an average number of scores of 4.5 and female students have an average number of scores 4.9 out of a maximum scores 8. In the problem-solving design indicator, male students have same average number of scores as female students, which is 3.8 out of a maximum scores 8. In the problem-solving indicator, male students have an average number of scores 3.1 and female students have an average number of scores 3.5 out of a maximum score 8. In the problem-solving evaluation indicator, male students have an average total score of 2.8 and female students have an average total score 3.5 out of a maximum score 8.

In general, the average of post test scores in female students is higher than male students. In the indicator of understanding problems, male students have an average number of scores higher than female students, namely 7.7, and female students have an average number of scores 7.4 out of a maximum score 8. In the problem-solving design indicator, male students have an average number of scores 6.1 and female students 6.5 out of a maximum score 8. In the problem-solving indicator, male students have an average number of scores 5.8 and female students have an average number of scores 6.4 out of a maximum score 8. In the problem-solving evaluation indicator, male students have an average number of scores 5.3 and female students have an average number of scores 5.9 out of a maximum score 8. The value of N-Gain can be seen in **Table 2**.

Table 2. The Values of N-Gain

	N-Gain Values	**Interpretation**
Male Student	0,59	Medium
Female Student	0,67	Medium

Based on **Table 2**, the male student's N-Gain value is 0.59 and the female student's N-Gain value is 0.67 with medium interpretation. From the value of N-Gain we know that Education for Sustainable Development (ESD)-based Environmental Change Topics module is enough effective in improving male and female students' problem-solving abilities.

Discussion

Based on **Figure 1**, the pretest and post test values of female students are higher than male students. This shows that the problem-solving ability of female students is higher than male students. This is in accordance with the results of research from Ngongo & Efendi (2021) which states that the problem-solving ability of female students are greater than male students. The results of research from Wahyudiati (2021) also show that in female students' ability to solve problems is higher than male students.

The female students' problem-solving ability is due to several things. Female students have a freer and more varied learning style compared to male students (Wulandari et al., 2016). The difference of learning styles allows female students to handle holistic problem solving (Nur & Palobo, 2018). High problem-solving ability in female students are also due to differences in the level of seriousness, prudence and accuracy with male students (Ngongo & Efendi, 2021). Problem-solving ability are also

influenced by experience. The more experience person has various problem solving, so the problem-solving ability will be fine (Wardani & Kurniawan, 2014).

Gender can be a differentiator in problem-solving ability (Lestari *et al.*, 2021). When faced with problems, male and female students tend to have different problem solving (Nur & Palobo, 2018). Male students and female students have different ways of thinking caused by differences in brain structure and hormonal influences (Davita & Pujiastuti, 2020). Women are more dominant in their left brain, while men are more dominant in their right brain (Isnaini et al., 2021). It causes differences way to solve a problem in male students and female students.

The brain structure of men and women has differences. Corpus collasum is the part of the brain located between cerebrum and limbic system. Women have a thicker corpus collasum when compared to men (Amin, 2018). It allows women to do many things at the same time and think holistically (Suyadi, 2018). In problem solving, female students are more able to think of comprehensive problem-solving solutions when compared to male students. It causes the problem-solving ability of female students to be better when compared to male students. We can see the corpus collasum of men and women in **Figure 3**.

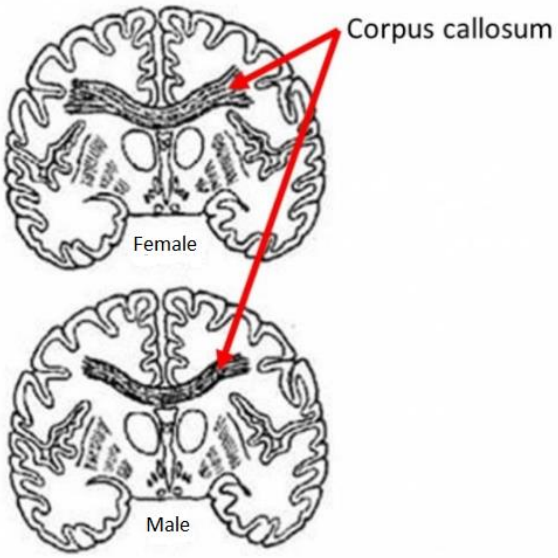

Figure 3. The Corpus Collasum of Men and Women in Figure 3

Women and men have biological differences caused by hormonal differences. Hormonal difference causes differences in ways of thinking and abilities between men and women (Saputra, 2021). Testosterone hormone affects the performance of the male

left brain, so men prefer learning that is challenging especially that require them to be hands-on (Amin, 2018). Women tend to enjoy the learning process and can solve problems in ways that promote "persuasive" and communal communication by learning together, reading, casual discussions, formulating mutual understanding, presentations and lectures.

Based on **figure 2**, there is a difference in the average number of scores per problem-solving ability indicator between male and female students. In general, the average number of students' pretest and post-test scores has increased per indicator in male and female students. On indicators of understanding the problem, the increase was highest in male students. In addition, the post test results also showed that the average number of post test scores of male students was higher than female students on the indicator of understanding the problem. This is in accordance with the results of research by Isnaini et al. (2021) which states that male students are better at understanding problems in problem solving compared to female students. The results of research from Lestari et al. (2021) also show that male students are able to reach the level of understanding problems well compared to female students. Male students tend to be better at understanding problems compared to women (Davita & Pujiastuti, 2020). It happens because of differences in structure of the male and female brains in the hypothalamus. Hypothalamus is a part of the brain located below the thalamus and just above the brainstem. In general, the male hypothalamus, especially in the *preoptic region*, is 2.5 – 3 times larger than the female (Amin, 2018). It causes men more sensitive to stimuli when compared to women. In dealing with problems, male students are more sensitive to the problems at they hand, so the ability to understand the problems of male students is better than female students.

In the indicator of designing problem solving, students are required to choose what way to do with clear and logical reasons so they can make decisions to get the right solution (Rahma et al., 2020). In this indicator, male and female students have the same average number of pretest scores. The average number of post test scores in female students is higher than male students. This is in accordance with the results of Indrawati & Tasni (2017) research which states that female students are more detailed and very careful in designing problem solving. This is also in line with Dorisno (2019)

which states that boys are able to conclude the solution of a problem but have not been able to design the right problem solving.

In the indicators of implementating problem solving, the average number of *pretest* and *post test* scores in female students is higher than male students. This shows that in implementating problem solving, female students are better than male students. This is accordance with the results of Nur & Palobo (2018) research which states that female students show the ability to implementating problem solving based on they design higher than male students. The study of Davita & Pujiastuti (2020) also show that in implementing problem-solving plans, female students are better than male students. Girls and boys have different approaches to solving problems. Girls tend to solve problems with a slow but accurate approach, while boys solve problems with a faster but error-prone approach (Dorisno, 2019).

In the indicator evaluating problem solving, the average number of pretest and post test scores of female students is higher than male students. This is according to the results of research from Lestari et al. (2021) which shows that female students are more able to reach the level of evaluating the problem-solving process that has been carried out when compared to male students. The results of research from Indrawati & Tasni (2017) also show that evaluating the problem solving of female students is more detailed than male students. Female students can propose other alternatives in evaluating problem solving because they tend to think holistically and divergently (Nur & Palobo, 2018).

Environmental change topic modules based ESD contribute to improving problem-solving ability. The environmental change topic module based ESD has characteristics of problem solving that occurs in the environment around students so it can improve the quality of learning and student problem-solving ability. The students' involvement in problems solving of a variety of complex environmental change problems also improve students' cognitive development to a higher level (Kusumaningrum et al., 2022). In environmental change material, students are required to solve problems in their environmental, so they have a potential to develop problem-solving ability (Hidayanti et al., 2023). The environmental change topic module based ESD contains worksheets to solve environmental problems from an ESD point of view, so this module can train students' problem-solving ability.

Based on **Table 2**, the N-Gain value of female students is higher than male students. The *N-Gain* value of female students is 0.69 and the *N-Gain* value of male students is 0.57. Female students have increased when compared to male students. This is because male and female students have different academic efforts and learning styles. Female students tend to focus more on academic efforts compared to male students (Fitriani et al., 2015). In learning styles, male students tend to be more inclined to visual learning styles, while female students tend to have auditory learning styles (Syafitri, 2017). According to Syafitri (2017), female students are more dominant in discussion learning activities and absorb verbal instructions well compared to male students who tend to be better at understanding a material with image media or other visual media.

The N-Gain interpretation of male and female students is in medium category. It means that learning of environmental change topics based on ESD is enough effective to improving problem-solving ability of male and female students. This is in accordance with the results of Pradipta & Hariyono (2021) research that the effectiveness of *ESD*-based learning tools can improve students' problem-solving ability in the medium category. The results of the study are also in line with research conducted by Saragih et al. (2021) which states that the application of ESD in biology learning has a moderate influence on improving student problem solving.

To train students' problem-solving ability, continuous practice or continuous stimulus about problem solving is needed (Palennari et al., 2021). By incorporating *ESD* concepts in learning environmental change topics, students' problem-solving ability can be trained. It is because in ESD itself there are eight competencies that can be improved and one of them is the ability to solve problems (Fatiyah et al., 2020; Saragih et al., 2021). ESD displays competencies for students that relate to collaboration, critical thinking, deciding goals based on problem solving, improving communication skills, managing conflict and planning (Perello-Marín et al., 2018).

CONCLUSION

In general, female students have higher problem-solving ability compared to male students. On the indicators of understanding problems, male students have higher average number of scores than female students. While in the indicators of designing

problem solving, implementating problem solving and evaluating problem solving, female students have an average number of higher scores compared to male students. The problem-solving ability of female students is higher because women have a thicker *corpus collasum* compared to men. In addition, men have testosterone hormone which affects the performance of the male left brain, so men prefer challenging learning especially *hands-on.* The N-Gain score of female students is higher compared to male students. The interpretation of N-Gain scores of male and female students is in medium category, so that ESD-based learning of environmental change topics is enough effective to improving problem-solving ability in male and female students.

The implication of this research is teachers can develop students' abilities, especially problem-solving ability. Teachers can integrate ESD in learning process to improve students' abilities. Teachers also can develop teaching materials and ESD-based learning models that are integrated with problem solving to improve students' problem-solving ability. This research only limited to develop students' problem-solving ability, so other researchers can add other abilities of students that can be improved through ESD.

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