Mathematics Learning Outcomes Based on Gender in the Inquiry Learning Model

Ni Ketut Erawati
Mathematics and Natural Science Education
IKIP PGRI
Bali, Indonesia
erawati_niketut@yahoo.com

Abstract— **Gender differences cannot be avoided under any circumstances. The same thing also happens in a classroom. This study aimed at analyzing students' learning outcomes based on their gender in the inquiry learning model. This research used a quantitative descriptive study with a comparative causal method. The sample were fourth-semester mathematics students in IKIP PGRI Bali. The data were collected by using a learning result test with an essay test and direct observation of learning attitudes and oral presentation methods. Data analysis was performed descriptively and inferentially through the t-test. The results showed that female students got higher learning outcomes than male students did. Direct observations showed the average score of oral presentations and learning attitudes of female students was better than that of the male students'. It indicates that gender influences learning outcomes according to the model used. Therefore, learning should be done with an interesting model and provides opportunities for collaboration between different genders in one group.**

Keywords—inquiry learning model; gender; mathematics learning outcomes.

I. INTRODUCTION

Mathematics is an important subject in the curriculum because mathematics is the basis for every individual in order to be able to respond to a problem critically [1]. Therefore, mathematics learning outcomes are in the spotlight and comparison of all countries in the world. Learning outcomes are a reflection of what is obtained by someone after participating in learning activities. Learning outcomes are often measured by looking at the values obtained after taking the test at the end of the learning process. However, behind these values, many factors affect the value of the learning outcomes shown, both internal and external factors. Some internal factors include self-motivation, learning styles, learning attitudes, and interests from within individuals. Besides, gender differences are also one of the internal factors influencing students in learning mathematics [2]. Meanwhile, external factors include learning environment, learning methods, teaching factors, parenting, and family environment.

The influence of internal factors such as gender differences cannot be ignored in determining students' mathematics learning outcomes. Gender difference does not only deal with physical differences, but also with learning attitudes and learning thinking. These are the roots of differences in abilities in mathematics and also the differences in gaining

mathematical knowledge. Reference [2] states that gender, social, and cultural interactions strongly influence Mathematics education. It shows that gender plays a role in influencing learning outcomes in mathematics.

Apart from gender influences, surely external influences in the form of learning models applied cannot be ignored. One learning model that is suitable to be applied in higher education is inquiry learning. The selection of inquiry models is based on the independent attitude held by students at the higher education level. According to reference [3], the inquiry learning model involves investigation activities for students to train their problem-solving ability, so their skills and knowledge will increase independently. At the level of higher education, students must be more independent, especially in learning, in terms of finding learning resources, ways of learning, and conveying something to others [5].

In terms of students' cognitive and affective learning, several studies have been conducted in order to find gender differences in mathematics learning. Some researches indicate that gender becomes a factor influencing students' learning outcome in learning mathematics due to the brain's biological differences possessed between boys and girls. Women generally pay attention to things that are concrete, practical, emotional, and personal, while men focus on things that are oriented intellectually, abstractly, and objectively [6]. There are no essential differences between men and women's ability, but the difference lies in attitudes. The different attitudes also occur in the implementation of learning strategies [2]. The results showed that the effect of gender differences on the achievement of students' mathematical creative thinking abilities, which show the average value of the ability to think mathematically, is significant because creative thinking of the female students is higher than the average value of male students [7]. However, the results of other studies showed that gender differences do not make a difference in students' learning outcomes in mathematics [4].

Because of the different results, it is necessary to do more research to see these factors. Based on the different characteristics of gender, this study aimed at investigating whether gender differences can lead to differences in individual learning outcomes, especially in learning mathematics at the higher education level by using inquiry-learning models.

II. Literature Review

A. Inquiry Learning Model

Inquiry learning models are designed to bring students closer to a scientific process because they get some exercises. Through questions and answers activity, students' curiosity will be raised, so they can develop their discipline and intelligence [8]. Reference [9] defines the inquiry-based learning as the process of learners in creating meaningful and useful knowledge. The inquiry learning can train students to be independent in searching for any information, solving problems based on the information they obtain, and providing oral and written information on what they understand from the problem. The inquiry-learning model provides equal opportunities for all students, either those who have low, medium, or high ability to succeed. Students can be active during the learning process because they have high curiosity, and are involved in group work. They do not only develop their cognitive abilities, but also psychomotor abilities. Therefore, the inquiry learning model is an innovative learning model that can be used to improve students' learning outcomes. In the learning environments where inquiry-based learning takes place, students perform the experiments and the activities individually or in groups, thus it makes sure that knowledge becomes more meaningful and permanent [9]. There are five steps in applying the inquiry model, namely problem formulation which will be solved by the students, deciding a temporary answer (hypothesis), gaining facts and information for answering the problem, conclusion drawing through the generalization of the answer, and generalizations in new situations [10].

B. Category of Inquiry Learning Model

In the current study, inquiry-based learning is categorized as one of three levels: structured, guided, or open inquiry. In the structured inquiry, students are led by a teacher to discover relationships between variables, which are predetermined by the teacher. Guided inquiry gives more responsibility to the students because the teacher provides only a problem to investigate and materials as a guidance for the investigation. Open inquiry allows students to formulate their problems to investigate mimicking how actual scientists conduct research. In this research, guided inquiry learning was applied. The steps of guided inquiry learning were giving questions or problems, making a hypothesis, designing an experiment, conducting an experiment to obtain information, collecting and analyzing data, and making conclusions. Based on these steps, the model guided inquiry learning encourages students to train their courage, communicate, and try to get their knowledge to solve the problems [11].

C. Gender

Gender is an identity constructed by the social role which represents a person as a male or female attached to their nature being as a man or woman. Gender and sex are not the same things. Gender is the condition of being male, female, or neuter. In a human context, the distinction between gender and sex reflects the usage of these terms; Sex usually refers to the biological aspects of maleness or femaleness, whereas gender implies the psychological, behavioral, social, and cultural aspects of being male or female (i.e., masculinity or femininity). Sex is the trait that distinguishes males and females. Besides, sex refers especially to physical and biological traits, whereas gender refers especially to social or cultural traits, although the distinction between the two terms is not regularly observed [12].

D. Learning Outcome

Bloom suggested cognitive ability, achievement motivation, and the quality of learning as three main factors influencing learning outcomes [3]. Learning outcomes are statements of what are expected that the student will be able to do as a result of learning the activity [4]. Learning outcomes reflect the ability and success of students after following the learning process, which are usually measured by tests or direct observation.

Mathematics is a science that is not only quantitative but also a social science. Mathematics is not an abstract science, but a way of solving problems that occur in real life. Learning mathematics is certainly influenced by many factors. According to [2], the factors that influence learning can be classified into two groups, namely internal factors and external factors. Internal factors exist in individuals who are learning, while external factors exist outside the individual. The internal factors are classified into three factors, namely physical factors (in the form of health and disability factors), psychological factors (in the form of intelligence, interests, talents, motives, maturity, and readiness), and fatigue factors (in the form of physical fatigue and psychological fatigue that are psychological). Then, the external factors are be grouped into three factors as well, namely family factors, school factors (including teaching methods, curriculum, teacher-student relations, student-student relations, learning standards, building conditions, learning methods and homework assignments, as well as community factors). For each student, giving meaning or responding to a subject will be different between male and female students, because it is a process that occurs in students.

III. Research Method

This research was a quantitative research that used a comparative causal method. The independent variable was students' gender, and the dependent variable was students' learning outcomes, especially in mathematics statistics courses. The study was conducted at IKIP PGRI Bali with a sample of 34 fourth-semenster students in the 2018/2019 academic year. Sample determination was done by using a purposive sampling technique, in which fourth-semester students took mathematics statistics courses. The data was collected through a learning result test with an essay test. The essay test contained memorization, understanding, analysis, and problem solving, where the problem was related to real problems of mathematics statistics courses. In addition to

written tests, measurements were also carried out by directing observation of students' learning attitudes in class and how to deliver presentations in front of the class. The data were analyzed statistically by t-test after fulfilling the requirements of the normality and homogeneity of data.

IV. RESULTS AND DISCUSSION

Inquiry learning that was applied in this research was guided inquiry in terms of the arrangement of material that must be presented. Before students found their learning resources, the lecturer provided the main reading material and basic material that must be found. It aimed at directing material that is appropriate to the subject being studied. Furthermore, students could develop these materials according to the additional material needed. After finding the material, they found examples of related problems and solutions. The final stage assessed was when the students did presentations in front of the class. The presentation would show the students' understanding, analysis, and problem-solving abilities, as well as speaking skills to convey information to others. Based on the presentation activities whose results are shown in Table 1, it can be seen that the presentation ability of female students is on average better than male students.

TABLE I. AVERAGE PRESENTATION SCORE

No	Indicator	average score	
		Male	Female
1	Deliver the purpose of the presentation	4	4
2	Explain supporting material in general	3.5	3.7
3	Present the problem in accordance with the material	3.7	3.8
4	Analyze and solve problems correctly	3.7	3.8
5	Presenting material in polite language	4	4
6	Presenting material in fluent and clear language	3.5	3.8
7	Provide opportunities for presentation participants to ask questions or express opinions	3.6	3.7
8	Answering questions from other participants or lecturers correctly and clearly	3.5	3.6
9	Close the presentation politely	3.5	3.7
	General average score	3.66667	3.78889

The second assessment was the attitude assessment seen from the attitude of students when learning. An active attitude could be seen from the students' willingness to ask questions when other students present, their willingness to try to answer the problems given by the lecturers, and their willingness to listen carefully when the discussion began. Meanwhile, less active students tend to just listen passively without asking questions, and in discussions they were not trying to find answers of the presented problems. Based on observations in general, female students tended to be more active in asking questions or in discussions with friends. This showed female students' willingness to speak, which is in line with the characteristics of the female brain in general [4].

The third assessment was based on the results of the written test given by answering the question description that contains understanding, analysis, and problem-solving. Based on the results of data analysis, the average data of female students' learning outcomes was 81.05 and that of the male

students' were 73.94. The difference in the average results was also further tested statistically by the t-test at a significance level of 5%. For the normality and homogeneity of data, homogeneity test results showed the value of Sig. is 0.294> 0.05 which means homogeneous data variance, and data normality test showed the value 0.055 > 0.05 which means the data comes from the normal distribution. T-test prerequisites had been met. Furthermore, the t-test results showed a value of Sig 0.039 < 0.05, which means the difference in learning outcomes between male and female students was significant at a 95% confidence level.

Aside from being based on numerical data, the observations also showed that in doing individual assignments, the work of female students were more complete. In the presentation, female students were more enthusiastic about speaking in front of the class. Meanwhile, most male students found difficulty in expressing what they think in oral or written form. This certainly affects the value obtained because what was assessed was the process of completion and completeness of the material. The habit that affects the learning outcomes of male students was the habit of being lazy to write and take notes. In inquiry learning, all information obtained either by reading or listening should be recorded, so it can be used if it is needed. Female students looked more diligent and neat in making notes. Through notes, students could learn in their way and language, so that later they could convey what they understand to others.
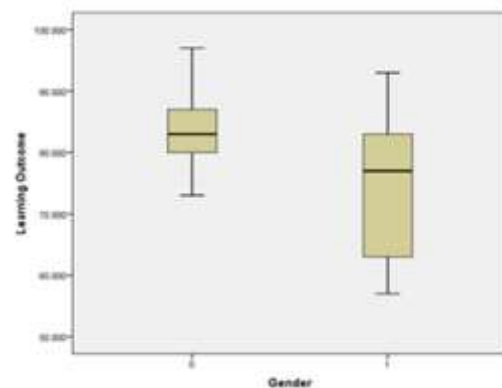

Fig 1. Box plot of learning outcome

Figure 1 shows the box plot of the average learning outcomes of female students (code 0) and male students (code 1). Box plots show that learning outcomes for mathematical statistics of female students were higher than male students. Besides, the range of female student data was shorter than that of male students', which means that the average abilities of all female students were not much different. Whereas in male students, the cognitive ability gap was quite high. In this study, the number of male and female students was balanced, namely 17 females and 17 males, so the difference in number was not a factor affecting the data.

The results of this study are supported by the other research which states that the proportion of women in the group had a direct positive relationship with a group

performance in cooperative learning [13]. It means that women are more active in the tasks given so that they can influence the results obtained. Research conducted in 2018 showed that female students tend to be superior in creative thinking abilities than male students because male students tend to have lack of confidence and they further did not try to answer questions [7].

The results of other studies using the Moore method modification show that gender has been proven to be an important variable in determining learning outcomes, where the learning outcomes and participation of female students are significantly better than that of men's [14]. The other concluded the results of his research based on quantitative measurements showing that girls' scores were much higher in science skills than boys' [1]. Another research also shows that gender differences significantly affected the critical-thinking abilities of students. It was found that women were better than men in terms of critical thinking skills and there were differences in the process [15].

This study used guided inquiry method. The guided inquiry conducted in this study was that lecturers provided topics that must be carried out individually and limited the material being studied, so that was in line with the material expected. Another way was that lecturers gave problems that must be solved independently or in groups which were then presented in front of the class. During the presentation, the lecturer became a controller of the concept of the presented material, provided questions to find out the extent of understanding that was owned by students, and provided opportunities for other students to ask and answer questions by giving points as rewards. Questions and awards were expected to make students truly learn what they are conveying.

Differences in learning outcomes between males and females are also caused by innate habits in general [16]. Females prefer to spend time indoors. In a structured room, females are more exposed to language through radio and television, and they are more aware of the time because there are clocks, media, and other family members outside the home [16]. On the other hand, males are more likely to spend time outside the unstructured, so they are more dependent on space than time [16]. They play a game themselves, so they use more visual skills than verbal skills, and use limited language just to get the job done [16]. This difference also affects the presence of female students and male students in the class. The school structures environment that run on a timetable, selected facts, rules in a certain pattern and conveys teaching mostly using verbal instructions [16]. It means that girls feel more comfortable in this environment. Conversely, boys don't feel comfortable in this environment [16].

Men and women handle numbers and calculations differently [16]. There are some differences between men and women. After being given a trial, it turned out women were better at testing the speed of understanding, fluency in speaking, determining the placement of the subject (sorting), identifying the specific characteristics of the subject, the accuracy of manual tasks. This shows that what women did

was more detailed, and they could do presentations in front of the class and express opinions better.

The results of this study are also supported by the research that explains how women can solve problems by using metacognition abilities, namely planning, tracking, and evaluating better on male students [17]. This means that women are willing to solve a bigger problem so that they can obtain better learning outcomes. Another research results about the cognitive abilities of students towards the ability to predict, observe and explain, viewed by sex, show that women are superior in all cognitive criteria in solving physical problems [18].

The results of this study are also supported by the results of previous studies, namely the results of the analysis of the level of problem-solving skills after learning with the CTL model, which shows a different level of ability. The female group is superior to the male group [19]. In the learning activities based on the problem, the female students were more active in gathering information in the process of solving the problem being investigated. Besides, the developmental factors of the individual also have implications for the learning outcomes of mathematics.

Based on the theory of brain function, it is said that women are more dominant in the right hemisphere while men are more dominant in left-brain function. The right hemisphere of the brain has a function in developing imagination and creativity, while the cerebral hemisphere of the left serves to think rationally and count. Based on this theory, men's mathematical abilities are better. However, the results of this study showed a different fact, where women had a better cognitive level. In theory, women have sensitivity in processing something to be more valuable and beautiful, while men tend to have visual excellence. The results of the study proved that the ability of female students to process information more maximal than male students. However, not all research states the same thing.

One of the factors that influence learning outcomes is the material being studied. In this study, the material studied was mathematical statistics. Mathematical Statistics is one of the courses in the Mathematics Education Study Program which has the following characteristics: (1) abstract material, (2) requiring the ability to generalize and synthesize, (3) supporting the aspects of deductive/proof expertise, (4) analytic and geometric, and (5) buying creative ideas [20]. Based on these characteristics, it can be seen from Mathematics Statistics courses that require a variety of mathematical abilities, one of which is the ability to think mathematically creative. The characteristics of this statistical material are following the way of thinking of women who rely on the right brain, which further develops imagination and creativity so that it is more beneficial for female students to obtain better learning outcomes than male students.

The results of other studies concerning the analysis of gender differences in their effects on thought processes in solving problems at the higher education level, explains that in the stage of understanding, more female subjects use their senses in receiving information, namely the sense of sight,

hearing, and sense of touch from male subjects. In storing the second information by repeating reading questions, male subjects read the questions one time aloud and moved on rereading slowly three times, while the female subjects slowly read the question three times. In the information processing of the two subjects, link information was received from the problem provided with the scheme that was owned. In calling back, the female subject, in recounting the problem, was more detail than the male subject.

On stage Compile a plan of completion, in storing information, both subjects repeated seeing questions and reading the question returned, but the male subject read the question quietly, while the female subject read slowly. In the information processing, both subjects forgot to explain the scheme they have. In explaining, more male subjects understood symbols. At the stage of implementing the completion plan, the female subject started by writing down what was known and what was requested even if it was incomplete, while the male subject did not write down what was known and what was requested. In processing information, the female subject linked the elements that had been sought to the next step, while the male subject did not link the previous element to the next step.

Male subjects were better at presenting answers in symbolic form than female subjects. In the checking stage again settlement, the male subject checked the settlement in the doubtful part, while the female subject double-checked the settlement from the beginning of the settlement until the end in sequence. Based on the conclusions obtained, it shows that gender differences affect the students' thinking process in solving problems, so lecturers need to pay attention to this condition in lecture activities in the classroom to be able to provide positive learning outcomes [21]. Lindberg et al. conclude that their data provide strong evidence of gender similarities in mathematics performance, the existence, and magnitude of gender differences in performance vary as a function of many factors [12]. Gender can be conceptualized as one of many predictors of mathematics performance. Socioeconomic status, parents' occupation, and the quality of schooling were among other variables likely to influence performance outcomes.

The research shows that there are significant differences in learning outcomes between male and female students. However, there are also many studies, which show that this difference is not significant. For example, in a study which finds that there is no difference in mathematical connection ability between male and female students [22]. This study uses Contextual Teaching Learning (CTL). CTL also requires students' activity that begins with a question that is answered orally, but the results show the ability of men and women is the same.

At a high level of education, usually, students work with families. Of course, there is a greater responsibility, so learning might be a top priority. Different research discusses a different gender. In addition to these factors, the learning environment is also different, wherein higher education, lecturers are freer to arrange study time with students, whereas

in schools it cannot be done. Therefore, the possibility of research results on the effect of gender on learning outcomes at different levels does not support one another because, as what is stated before, many factors affect one's learning outcomes.

V. CONCLUSION AND SUGGESTION

The learning outcomes of female students are higher than male students and the difference is significant. Based on observations on learning with inquiry models, the willingness of female students to learn is better and the curiosity of female students is higher. The learning outcomes obtained are also influenced by the characteristics of the material being studied. Besides, individual learning uses an effective inquiry model to encourage students to build their knowledge independently. Based on these conclusions, the authors' suggestion, namely learning in class must be designed in combination with heterogeneous groups in terms of initial ability and gender. Lecturers and teachers should pay attention to gender diversity in the classroom to determine the right learning model. Furthermore, further research on the effect of gender on students' learning outcomes needs to be carried out again in different learning characteristics.

REFERENCES

[1] K. L Zaleta, "The Effects Of Gender And Type Of Inquiry Curriculum On Sixth Grade Students' Science Process Skills And Epistemological Beliefs In Science," Education Dissertation, 2014.

[2] A. M. Z Zubaidah, "Perspektif Gender Dalam Pembelajaran Matematika," Marwah: Jurnal Perempuan, Agama Dan Gender, vol. 12, pp. 15-31, 2013.

[3] V. S. Andriani, "The Effectiveness of Inquiry Learning Method to Enhance Students' Learning Outcome: A Theoretical and Empirical Review," Journal of Education and Practice, vol. 7, pp. 38-42, 2016.

[4] O. Afianty, R. MAnogu, and M. Marthaulina, "A Comparison Of Gender Differences Toward Mathematics' Cognitive Learning Outcomes In A Middle School," JOHME, vol. 1, pp. 60-68, 2018.

[5] K. Hidayati and E. Listyani, "Pengembangan Instrumen Kemandirian Belajar Mahasiswa," Jurnal Penelitian dan Evaluasi Pendidikan, vol. 14, pp. 84-100, 2010.

[6] R. Kusumawati and A. Nayazik, "Kecemasan Matematika Siswa SMA Berdasarkan Gender," Journal of Medives, vol. 1, pp. 92-99, 2017.

[7] S. C. Dilla, W. Hidayat, and E. E. Rohaeti, "Faktor Gender Dan Resiliensi Dalam Pencapaian Kemampuan Berpikir Kreatif Matematis Siswa SMA," Journal of Medives, vol. 2, pp. 129-136, 2018.

[8] H. W. Sihaloho, Sahyar, and P. S. Maria, "The Effect of Inquiry Training Learning Model on Science Process Skills and Student Learning Outcomes," IOSR Journal of Research & Method in Education (IOSR-JRME), vol. 7, pp. 46-51, 2017.

[9] Z. Bayram, O. Oskay, E. Erdem, S. D. Ozgur, and S. Sen, "Effect of Inquiry-Based Learning Method on Students' Motivation," Elsevier. Procedia - Social and Behavioral Sciences, vol. 106, pp. 988-996, 2013.

[10] Sagala, Strategi Pembelajaran, Jakarta: Kencana Prenada Media Group, 2006.

[11] N. L. Dewi, N. Dantes, and I. W. Sadia, "Pengaruh Model Pembelajaran Inkuiri Terbimbing Terhadap Sikap Ilmiah Dan Hasil Belajar IPA," e-Journal Program Pascasarjana Universitas Pendidikan Ganesha Jurusan Pendidikan Dasar, vol. 3, 2013.

[12] G. C. Leder, G. Kaiser, and N. Presmeg, "Gender and Mathematics Education: An Overview," ICME-13 Monographs, 2019.

[13] P. L. Curseu, M. M. H. Chappin, and R. J. G. Jansen, "Gender Diversity And Motivation In Collaborativelearning Groups: The Mediating Role Of Group Discussion Quality," Soc Psychol Educ, vol. 21, pp. 289–302, 2018.

[14] T. E. Cooper, B. Bailey, and K. S. Briggs, "Gender Differences in Achievement in an Inquiry-Based Learning Precalculus Course," ISER, Mathematics Education, vol. 10, pp. 97-110, 2015.

[15] B. Cahyono, "Analisis Ketrampilan Berfikir Kritis Dalam Memecahkan Masalah Ditinjau Perbedaan Gender," Aksioma, vol. 1, pp. 50-64, 2017.

[16] N. Hasanah, Zulhemi, and Azizahwati, "Perbedaan Motivasi Belajar Siswa Berdasarkan Gender Dalam Pembelajaran Fisika Dengan Model Collaborative Learning Dikelas X Madrasah Aliyah Al-Ihsan Boarding School Kampar", 2016.

[17] R. Khairunnisa and N. Setyaningsih, "Analisis Metakognisi Siswa Dalam Pemecahan Masalah Aritmatika Sosial Ditinjau Dari Perbedaan Gender," Prosiding Konferensi Nasional Penelitian Matematika dan Pembelajarannya II, pp. 465-467, 2017.

[18] F. O. Rosa, Eksplorasi Kemampuan Kognitif Siswa Terhadap Kemampuan Memprediksi, Mengobservasi Dan Menjelaskan Ditinjau Dari Gender, JPF, vol. V, pp. 111-118, 2017.

[19] H. Laili, "Pengaruh Model Pembelajaran Contextual Teaching and Learning (CTL) Dalam Meningkatkan Kemampuan Pemecahan Masalah Matematika Siswa MTs Nurul Hakim Kediri Ditinjau dari Segi Gender," Palapa: Jurnal Studi Keislaman dan Ilmu Pendidikan, vol. 5, 2016.

[20] A. Suryana, "Analisis Kesulitan Mahasiswa Dalam Menyelesaikan Soal Berpikir Kreatif Matematis Pada Mata

[21] S. Rahayuningsih and Feriyanto, "Analisis Proses Berpikir Mahasiswa dalam Memecahkan Masalah Grup Ditinjau dari Gender," Jurnal Pendidikan, vol. 3, pp. 1672-1681, 2018.

[22] C. Musriliani, B. I. Marwan, and Anshari, "Pengaruh Pembelajaran Contextual Teaching Learning (CTL) terhadap Kemampuan Koneksi Matematis Siswa SMP Ditinjau dari Gender," Jurnal Didaktik Matematika, vol. 2, 2015.