Effect of knisley's mathematical model on gender's mathematical critical thinking ability

V T A Sari1* and P Nurfauziah2
1,2 Pendidikan Matematika, Institut Keguruan dan Ilmu Pendidikan Siliwangi, Jl. Terusan Jenderal Sudirman, Cimahi 40526, Indonesia
Email: venytriyana050113@gmail.com

Abstract. The aim of the study was to determine the effect of Knisley's mathematical model on students' mathematical critical thinking skills based on gender. The research sample consisted of two classes in class 2018 in one of the PTS Cimahi. The research instrument was a test of mathematical critical thinking skills. The analysis technique uses ANAVA with IBM SPSS Statistics 24 application. Overall the results of this study are that there is no interaction seen between the learning model carried out with gender differences because there is still a mismatch between the interactions obtained by the significance value and the general average, especially those which indicate the average mathematical thinking ability of male students men who use the Knisley mathematical model are lower than male students who use the normal learning model and the average mathematical thinking ability of male students who use Knisley's mathematical model is lower than female students.

1. Introduction

The importance of mathematics influences technological developments that are increasingly visible today. The science that underlies the development of science and technology is supported by one field of science, namely mathematics, because mathematics is the queen and other ministers and has an important role in various other sciences [1–3]. Besides that, it was clarified again by [4] revealing that mathematics education has an important role in efforts to create quality human resources as capital for the development process. Therefore, mathematics is one of the important sciences mastered at every level of education even to tertiary level [5]. This shows that it is expected that by studying mathematics, the availability of reliable Indonesian human resources, namely being able to think critically, systematically, logically, creatively, and meticulously can be fulfilled [6–8].

Critical thinking can be interpreted as one of the abilities that affects the quality of Indonesian human resources [9]. Therefore the ability to think critically is an important capability that needs to be possessed, especially students in Indonesia. This is supported by [10] arguing that critical thinking skills are very important to be mastered by students so that students are more skilled in compiling an argument, checking the credibility of the source, or making a decision. In addition, Lunenburg [6] states that the concept of critical thinking is one of the most significant trends in education and has a dynamic relationship in how teachers teach and learners learn. In addition, critical thinking is a very important ability in the social world today, Inch [11] argues "critical thinking is a vital skill in today's society, which can be used as a situation, problem, question, or special event to arrive at viable hypothesis or conclusion ". That is, if students already have the ability to think critically well, then various situations that occur in everyday life faced by students later. According to Ikhsan, et al. [11] the character of critical thinking is identical to the awareness of his ability to develop various ways taken to solve a problem.
Awareness in solving problems in various ways is usually influenced by gender, because based on experience during teaching activities and assignment of assignments in any subject it can be seen that female students are more diligent in trying to solve problems both in front of the class and collection of tasks compared to male students. This is supported by the statement [12] theoretically it can be said that women are more accomplished than men because in doing school assignments women are more motivated and more diligent in completing tasks.

But the results of Gallagher's study [12] suggested that female students had lower math test scores than men. The results of these studies need to be proven because they are behind the reality in the learning process which always shows female students are superior in completing tasks compared to male students, which means the ability to think critically (in solving problems) female students is higher than the critical thinking abilities of male students man. If it is known the truth is expected to provide better treatment in order to improve students' critical thinking skills to be more optimal, because in general both female students and male students need to be improved on how to solve their problems in order to further improve their critical thinking skills. In addition, critical thinking skills still need to be improved, especially for prospective teachers or mathematics education students themselves. This is evident from the results of the study [6] concluded that students studied both from high and low critical thinking skills already have the ability to generalize, but do not have the ability to identify and justify concepts and do not have the ability to analyze or evaluate an algorithm. This conclusion means that students' critical thinking skills are still not mastered, because students have not been able to identify, analyze or evaluate an algorithm. Whereas according to Abdullah [11] critical thinking skills include understanding and formulating problems, collecting and analyzing information that is needed and reliable, formulating prejudices and hypotheses, testing hypotheses logically, drawing conclusions carefully, evaluating and deciding what to believe or something that will be done, and predict the consequences that might occur.

In order to increase the ability of students to think critically, one alternative is to apply Knisley's mathematical model. The reason stated in Knisley's journal [13] states that the most useful learning model for learning mathematics is the Kolb model that Knisley has adopted where the learning process is based on experience [14]. Indirectly, if students learn from things they already know or understand, then students will be able to understand and describe the concepts of a material more easily. This is supported by [15] stating that in Knisley's learning, students are given the opportunity to actively sharpen previously owned knowledge so that they can be more active in expressing ideas to solve mathematical problems [11]. In line with Romdhoni's opinion, it is clarified by Knisley [14]; Haety & Mulyana [11] who states that Knisley's mathematical model has four stages, namely at the stage of concrete-active students as an allegorizer where students learn new concepts based on previously owned concepts; concrete-active students as integrators where students try to add new concepts through exploring the characteristics of the new concept; abstract-Reflective students as an analyzer where students analyze the concepts introduced by the teacher by paying attention to their representation in concrete-reflective and concrete-active tasks; abstract-active students as synthesizers where students can make procedures for solving problems. The stages described are related to indicators of critical thinking skills so that it is expected to be a solution to improve mathematical abilities that are still low. This has been answered from the results of the study [11] which is to produce an increase in mathematical critical thinking skills of students who use trigonometry teaching materials with technical mathematical models better than those who do not use trigonometric teaching materials with Knisley’s mathematical model.

From the results of this study, the researchers were interested in finding out the truth of Gallegher's conclusions which showed that female students had lower math test scores than men. Therefore, researchers are interested in examining the effect of knisley's mathematical model on gender's mathematical critical thinking ability.

2. Method

The type of research used is quantitative research, with a population of all regular students of class 2018 registered in the odd semester of 2018/2019, while a sample of 104 students consisted of 53 students who were the experimental groups who obtained the Knisley mathematical model and 51 students who
were control groups who obtained an ordinary learning model. The place of research was held at IKIP Siliwangi, Cimahi.

Research procedures, among others: compiling trigonometry teaching materials based on Knisley's mathematical model, tested the validity and effectiveness of teaching materials to experts, namely two senior lecturers, carrying out instrument trials in the form of critical thinking skills, pre-test before trigonometric learning both using Knisley's mathematical models and those using ordinary learning models, prosetst after learning, and data processing.

The data analysis technique is done to determine normality and homogeneity based on the article [11] stating that the data is normally distributed but not homogeneous. Furthermore, this article only continues by analyzing the interaction of learning models conducted by gender using student two-way variance analysis (ANAVA) with IBM SPSS Statistics 24 application. The calculation is to test several hypotheses with the criteria N-sig. < .05, H₀ rejected and N-sig. ≥ .05, H₀ accepted. Following is the explanation of the hypothesis:

1) Hypothesis 1
   \( H₀: \mu_1 = \mu_2 \) (there is no difference in the average mathematical critical thinking ability among students who use Knisley's mathematical model and students who use ordinary learning models)
   \( H₁: \mu_1 \neq \mu_2 \) (there is a difference in the average mathematical critical thinking ability among students who use Knisley's mathematical model and students who use ordinary learning models)

2) Hypothesis 2
   \( H₀: \mu_1 = \mu_2 \) (there was no difference between the average mathematical thinking ability of female students with male students' mathematical critical thinking abilities)
   \( H₁: \mu_1 \neq \mu_2 \) (there is a difference between the average mathematical thinking ability of female students with male students' mathematical critical thinking abilities)

3) Hypothesis 3
   \( H₀: \mu_1 = \mu_2 \) (there is no interaction between learning models with gender on mathematical critical thinking skills)
   \( H₁: \mu_1 \neq \mu_2 \) (there is an interaction between learning models with gender on mathematical critical thinking skills)

4) Hypothesis 4
   \( H₀: \mu_1 \leq \mu_2 \) (the average critical thinking ability of students who use Knisley's mathematical model in women (A1B1) is lower or equal to students who use the normal learning model for women (A2B1))
   \( H₁: \mu_1 > \mu_2 \) (the average critical thinking ability of students using Knisley's mathematical model in women (A1B1) was higher than students who used the normal learning model for women (A2B1))

5) Hypothesis 5
   \( H₀: \mu_1 \leq \mu_2 \) (the average critical thinking ability of students who use Knisley's mathematical model in men (A1B2) is lower or equal to students who use the normal learning model in men (A2B2))
   \( H₁: \mu_1 > \mu_2 \) (the average critical thinking ability of students who use Knisley's mathematical model in men (A1B2) is higher than students who use the normal learning model in men (A2B2))

6) Hypothesis 6
   \( H₀: \mu_1 \leq \mu_2 \) (the average critical thinking ability of students who use Knisley's mathematical model in men (A1B2) is lower or equal to students who use Knisley's mathematical model in women (A1B1))
   \( H₁: \mu_1 > \mu_2 \) (the average critical thinking ability of students using Knisley's mathematical model in men (A1B2) was higher than students who used Knisley's mathematical model in women (A1B1))

7) Hypothesis 7
\( H_0: \mu_1 \leq \mu_2 \) (the average critical thinking ability of students using the normal learning model for men (A2B2) is lower or equal to students who use the normal learning model for women (A2B1))

\( H_1: \mu_1 > \mu_2 \) (the average critical thinking ability of students who use the normal learning model for men (A2B2) is higher than students who use the normal learning model for women (A2B1))

3. Result and Discussion

Based on the results of the posttest of critical thinking skills produced already declared normal and not homogeneous in the study [11], the analysis of variance (ANAVA) was carried out so that the following results were obtained.

| Source               | Type III Sum of Squares | Df | Mean Square | F     | Sig.  |
|----------------------|-------------------------|----|-------------|-------|-------|
| Corrected Model      | 155.532^a               | 3  | 51.844      | 6.069 | .001  |
| Intercept            | 8609.880                | 1  | 8609.880    | 1007.824 | .000  |
| Model                | 114.990                 | 1  | 114.990     | 13.460 | .000  |
| Gender               | .175                    | 1  | .175        | .020  | .887  |
| Model * Gender       | 11.199                  | 1  | 11.199      | 1.311 | .255  |
| Error                | 854.304                 | 100 | 8.543      |       |       |
| Total                | 17637.000               | 104 |            |       |       |
| Corrected Total      | 1009.837                | 103 |            |       |       |

| a. R Squared = .154 (Adjusted R Squared = .129) |

Based on Table 1, it can be seen that the learning model has a significant value (sig.) = .001 < .05, which means that \( H_0 \) is rejected. Thus, it can be concluded that there are differences in critical thinking skills in students who use the Knisley (A1) mathematical model with students using the normal learning model (A2). These results are clear because it is different in learning where A1 students learn with teaching materials designed using Knisley's mathematical model while A2 students learn with the usual learning model that lecturers explain the material in front of the class. In addition, the table also shows that gender has a significance value (sig.) = .887 > .05, which means that \( H_0 \) is accepted. Thus, it can be concluded that there is no difference in critical thinking skills mastered by female students (B1) with the ability to think critically, which is controlled by male students (B2). The results are obtained because in reality the critical thinking skills of the two classes have been seen and there is only a slight difference in scores (scores). Whereas the interaction between learning model (A) and gender (B) obtained a significance value (sig.) = .255 > .05, which means that \( H_0 \) is accepted. Thus, it can be concluded that there is no interaction between learning model (A) and gender (B) on critical thinking skills. However, it differs from the graph shown in Figure 1, as follows:
Figure 1. Graph of Interactions between Learning Models and Gender Based on Mathematical Critical Thinking Ability Scores

Based on Figure 1. The graph shows that there is an interaction between the learning models used with gender, which is seen from two intersecting lines which means that there is an interaction. So that it can be concluded that the A1 learning model (Knisley's mathematical model) increases the score of mathematical critical thinking abilities of male students (B2) compared to female students (B1), while the A2 learning model (female learning models) improves mathematical thinking skills of female students (B1) compared to male students (B2). However, the scores of students' mathematical critical thinking abilities using Knisley's mathematical model were higher than the students' mathematical critical thinking ability scores using ordinary learning models. Therefore, it needs to be tested further in order to clarify the interactions that occur using the Post Hoc test, the Tamhane's T2 test because of the Equal Variances Not Assumed group, as table 2.

Table 2. Interaction of Student Critical Thinking Ability between Learning and Gender Models

|           | (I) Interaksi | (J) Interaksi | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | Lower Bound | Upper Bound |
|-----------|---------------|---------------|-----------------------|------------|-----|------------------------|-------------|-------------|
| Tamhane   | A1B1          | A1B2          | -0.80                 | 1.369      | .995| -6.08                  | -4.48       | 6.08        |
|           | A2B1          |               | 2.01*                 | .651       | .017| .25                    | 3.77        |             |
|           | A2B2          |               | 3.04*                 | .822       | .010| .61                    | 5.46        |             |
|           | A1B1          | A1B2          | .80                   | 1.369      | .995| -4.48                  | -6.08       | 4.48        |
|           | A2B1          |               | 2.81                  | 1.409      | .427| -2.39                  | 8.00        |             |
|           | A2B2          |               | 3.83                  | 1.496      | .182| -1.32                  | 8.99        |             |
|           | A1B1          | A1B2          | -2.01*                | .651       | .017| -3.77                  | -.25        |             |
|           | A1B2          |               | -2.81                 | 1.409      | .427| -8.00                  | 2.39        |             |
|           | A2B2          |               | 1.03                  | .887       | .835| -1.52                  | 3.57        |             |
|           | A1B1          | A1B2          | -3.04*                | .822       | .010| -5.46                  | -.61        |             |
|           | A1B2          |               | -3.83                 | 1.496      | .182| -8.99                  | 1.32        |             |
|           | A2B1          |               | -1.03                 | .887       | .835| -3.57                  | 1.52        |             |

Based on observed means.
The error term is Mean Square(Error) = 8.543.

*. The mean difference is significant at the 0.05 level.
Based on Table 2, it can be seen the average $A1B1 > A2B1$ because the average difference between the two is 2.01, so the fourth hypothesis which states that the average critical thinking ability of students using Knisley's mathematical model in women ($A1B1$) is higher than students those who use the normal learning model for women ($A2B1$) can be accepted, according to the difference in interaction between $A1B1$ and $A1B2$, the significance value ($N_{-sig.}$) is .017 < .05, which means that $H_0$ is rejected. Then the mean $A1B2 > A2B2$ because the average difference between the two is 3.83, so the fifth hypothesis which states that the average critical thinking ability of students who use Knisley's mathematical model in men ($A1B2$) is lower than students who use the model ordinary learning in men ($A2B2$) is not acceptable, but with the difference in interaction between $A1B2$ and $A2B2$ a significance value ($N_{-sig.}$) is expressed as .182 > .05, which means that $H_0$ is accepted. Furthermore, the average $A1B2 > A1B1$ because the average difference between the two is .80, so the sixth hypothesis which states that the average critical thinking ability of students using Knisley's mathematical model in men ($A1B2$) is higher than students who use the model Knisley's mathematics in women ($A1B1$) is acceptable, but with the difference in interaction between $A1B2$ and $A1B1$ the significance value ($N_{-sig.}$) is .995 > .05, which means that $H_0$ is accepted. Finally, the average $A2B2 < A2B1$ is because the average difference between the two is -1.03, so the seventh hypothesis states that the average critical thinking ability of students who use the normal learning model in men ($A2B2$) is lower or equal to students those who use the normal learning model for women ($A2B1$) can be accepted, according to the difference in interaction between $A2B2$ and $A2B1$, the significance value ($N_{-sig.}$) is .835 > .05, which means that $H_0$ is accepted.

Overall the results of this study are that there is no interaction seen between the learning model carried out with gender differences because there is still a mismatch between the interactions obtained by the significance value and the general average, especially those which indicate the average mathematical thinking ability of male students men who use the Knisley mathematical model are lower than male students who use the normal learning model and the average mathematical thinking ability of male students who use Knisley's mathematical model is lower than female students. This is contrary to the results of the Gallagher's study [12], it was suggested that female students had lower math test scores than men. This was clarified by Susento's statement [16] stating that gender differences not only resulted in differences in abilities in mathematics, but how to obtain mathematical knowledge.

4. Conclusion

It is expected that the findings in this study generally state that the female students' critical thinking ability is higher than the mathematical critical thinking abilities of male students who use Knisley's mathematical models and ordinary learning models, can be used as a reference for further research and are advised to examine male student ways men and women in mastering or understanding mathematics.

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References

[1] Septiyana W, Pujiastuti H and Ihsanudin 2016 Model Pembelajaran Matematika Knisley untuk Meningkatkan Kemampuan Pemahaman Konseptual Matematis Siswa SMP Jppm 9 128–37
[2] Jalaludin M A and Sari V T A 2018 Analisis Kesalahan Siswa dalam Menyelesaikan Soal Bilangan Berpangkat pada Siswa kelas x SMK Swasta di Kota Cimahi J. Pendidik. Tambusai 2 1796–801
[3] Hanipa A and Sari V T A 2018 Analisis Kesalahan Siswa dalam Menyelesaikan Soal Sistem Persamaan Linear Dua Variabel pada Siswa kelas VIII MTs di Kabupaten Bandung Barat J. Educ. 01 15–22
[4] Setiawan W and Sari V T A 2019 The effectiveness of cognitive conflict on the concept of differential J. Phys. Conf. Ser. 1157 1–6
[5] Wen Chun T and Su Wei L 2015 Relationship between problem-solving style and mathematical literacy *Educ. Res. Rev.* **10** 1480–6

[6] Zetrisulita Z, Ariawan R and Nufus H 2016 Analisis Kemampuan Berpikir Kritis Matematis Mahasiswa Dalam Menyelesaikan Soal Uraian Kalkulus Integral Berdasarkan Level Kemampuan Mahasiswa *Infin. J.* **5** 56–65

[7] Fuad N M, Zubaidah S, Mahanal S and Suarsini E 2017 Improving Junior High Schools’ Critical Thinking Skills Based on Test Three Different Models of Learning *Int. J. Instr.* **10** 101–16

[8] Rahman S A and Manaf N F A 2017 A Critical Analysis of Bloom’s Taxonomy in Teaching Creative and Critical Thinking Skills in Malaysia through English Literature *English Lang. Teach.* **10** 245

[9] Sujatmika S, Irfan M, Ernawati T, Wijayanti A and Widodo S A 2019 Designing E-Worksheet Based On Problem-Based Learning To Improve Critical Thinking *ICSTI 2018, October 19-20, Yogyakarta, Indonesia* pp 1–8

[10] Sulistiani E and Masrukan 2016 Pentingnya Berpikir Kritis dalam Pembelajaran Matematika untuk Menghadapi Tantangan *Seminar Nasional Matematika X Universitas Negeri Semarang* 2016 pp 605–12

[11] Nurfauziah, Puji; Sari V T A 2018 Penerapan Bahan Ajar Trigonometri dengan Model Matematika Knisley untuk Meningkatkan Kemampuan Berpikir Kritis Matematik *AKSIOMA* **7** 356–62

[12] Nurfauziah P, Faudziah L, Nuryatin S and Mustaqimah I A 2018 Analisis Self Efficacy Matematik Siswa Kelas Viii Smp 7 Cimahi Dilihat Dari Gender (Mathematical Self Efficacy Analysis of Grade VIII Students of Smp 7 Cimahi Viewed From Gender) *J. Mat. dan Pendidik. Mat.* **3** 61–70

[13] Romadhoni E M C 2016 Implementasi Model Pembelajaran Matematika Knisley (MPMK) Dalam Upaya Meningkatkan *Knpmp / 2502–6526* 570–9

[14] Sari V T A and Nurfauziah P 2019 Development of Trigonometry Teaching Materials with Knisley Mathematical Models *ICSTI 2018, October 19-20, Yogyakarta, Indonesia* (EAI) pp 1–8

[15] Indrasari R D 2016 Penerapan Model Pembelajaran Knisley untuk Melatih Kemampuan Pemahaman Konsep Matematika Siswa pada Materi Perbandingan Kelas VIII SMP *MATHEdunesa J. Ilm. Pendidik. Mat.* **3** 463–72

[16] Zubaidah A 2013 Perspektif gender dalam pembelajaran matematika *Marwah* **12** 14–31