The Influence of Knisley Mathematical Learning Model with Geogebra Towards Mathematical Connection and Mathematical Disposition

I G A Jatiariska¹, Sariyasa², I W P Astawa ²

¹SMA Negeri 1 Sukawati, Bali, Indonesia - 80582
²Department of Mathematics, Faculty of Mathematics and Science, Universitas Pendidikan Ganesha, Bali, Indonesia - 81116

E-mail: gungriskaa@gmail.com

Abstract. This research was aimed at comparing mathematical connection and mathematical disposition of student who were taught using Knisley Mathematical learning model with Geogebra and those who learned using conventional learning. This research used quasi experiment method with post-test only control group design. The research population consisted of 213 grade tenth science student at SMA Negeri 6 Denpasar. In addition, cluster random sampling was used to get 2 groups sample. The experimental group was learned using Knisley Mathematical learning model with Geogebra and the control group was treated with conventional learning. The data was collected using test and non-test technique and analysed using Manova. The result showed that mathematical connection and mathematical disposition of students who were taught using Knisley Mathematical learning model with Geogebra were better than students who were taught using conventional learning (F = 4,410; p = 0,016). Knisley Mathematical learning model with Geogebra give students more chance to explore their mind and idea in solving problem, so that can improve their mathematical connection and mathematical disposition.

Keywords: Learning Model, Knisley Mathematical, Mathematical Disposition

1. Introduction

Mathematics is made as one of the compulsory subjects that must be studied by students in every education level [10]. There are five competency standards that must be developed in mathematics in school, namely problem solving competencies, reasoning, connections, communication, and representation [13]. Thus, the ability of mathematical connections need to be controlled well by each student. One of the goals of learning mathematics in schools is the ability to understand and explain the relationships between mathematical concepts [6]. The ability to explain the interrelationships between concepts, both in mathematics itself and in mathematical concepts with other sciences, can be called mathematical connection abilities. Mathematical connections are mathematical relationships internally and externally. Internal relationships are the relations between concepts in mathematics itself, whereas external relationships, namely the relations between mathematics and other sciences and daily life [11].

Unfortunately, the reality shows that students' mathematical connections in Indonesia are not optimal. It shown at the research results which states that the ability of students to make mathematical
connections is relatively low [15]. The average value of the mathematical connection ability of middle school students in Indonesia is about 22.2% on the mathematical connections internally in math, 44.9% for the mathematical connection between mathematics with other sciences, and 67.3% for mathematical connections between mathematics and daily life [15]. There are five main things are done that help students to develop mathematical connection capabilities, namely: Develop the student's ability to use some strategy or representations of mathematical thinking and to show their support that their answers are correct; Encourage students to continue their representation; Explore the rich language of mathematics; Insert investigation into the problem solving process; and Encourage opportunities for self-assessment and peer assessment in the classroom [1].

The affective domain determines a person's learning success [6]. One of the students’ affective in learning mathematics is known as mathematical disposition. Mathematical disposition includes the ability to take risks and explore solutions to diverse problems, persistence to solve challenging problems, taking responsibility for reflecting on work, appreciating the communication power of mathematical language, willingness to ask questions and proposing other mathematical ideas, the willingness to try different ways to explore mathematical concepts, have confidence in their abilities, and view problems as challenges [13]. This can be seen when students are in their learning and when solving mathematical problems given.

The mathematical disposition has a positive effect to mathematical problem solving abilities [14]. The students’ mathematical disposition is influenced by the disposition of class mathematics, and teacher as the greatest influence of class disposition [7]. Therefore, it is very important for teachers to improve students’ mathematical disposition. Innovation in the learning process of mathematics is required. Teachers should use a learning model that can attract students to learn mathematics and develop students’ mathematical connection and mathematical disposition abilities. Knisley learning model is an innovative learning model that can be applied in mathematics learning.

Some research results also show that the Knisley learning model is effectively used in learning mathematics. First, the application of the Knisley learning model with the Brainstorming method improves students' mathematical communication skills in learning mathematics [20]. Second, the ability of students' understanding of mathematical concepts that follow Knisley learning model with Geogebra better than students who follow Discovery Learning model [8]. Third, the improvement of students' mathematical conceptual understanding abilities with Knisley mathematics learning model is better than students who get direct learning [16]. Fourth, Knisley mathematical learning model makes a positive contribution to students' mathematics learning achievement, because it help identify the students’ level of understanding when learning takes place. Knisley learning model also includes exploration, elaboration and confirmation activities that embrace the learning paradigm [5].

Activities in Knisley Mathematical Learning Model in mathematics learning [19] namely: 1) Teachers lead students to formulate a new concept based on concepts that have been learned; 2) Distinguish new concepts from concepts already known to students; 3) Divide students into small groups; 4) Make predictions or interpretation the contents of the questions according to concepts that have been formulated; 5) Make a plan of problem solving; 6) Propose a plan to solve the mathematical connection problem; 7) Write down the mathematical connection problem solving; 8) Evaluate. In the first and fourth stages, Geogebra was given so that students could more easily understand the material.

Curriculum 2013, which applied to Indonesia today demand to integrate all subjects with technology. Technology integration in mathematics learning can be done using learning media. The use of instructional media will help the effectiveness of learning in conveying the content of the material at the time. One of the learning media which is currently very helpful in the learning process in class is computer-based learning media [2]. One of the computer-based learning media that can be used to develop the learning process is Geogebra Software. All students of various levels of mathematical knowledge can be encouraged to study mathematics by using dynamic mathematical applications [12]. Referring to its name as dynamic mathematical software, GeoGebra can be used to solve mathematical problems and to create virtual learning media or draw geometric objects and functional graphs [18]. The current trend in the teaching of science called for the use of visualization
techniques, and GeoGebra is very compatible with this trend. In addition, learning with GeoGebra can improve students' problem solving abilities and attitudes towards mathematics [17]. That is because the use of GeoGebra is flexible and can be adjusted to the needs of students so students can do many things related to mathematics [17].

This research was aimed at comparing mathematical connection and mathematical disposition of student who were taught using Knisley Mathematical learning model with GeoGebra and those who learned using conventional learning.

2. Methods
This research used quasi experiment method with post-test only control group design. This study involved two groups that received different treatments. The experimental group was a group of students who took part in learning with the Knisley learning model with GeoGebra, while the control group was a group of students who took conventional learning.

The research population consisted of 213 grade tenth science student at SMA Negeri 6 Denpasar. The Sampling was carried out by cluster random sampling technique because random sampling cannot be done considering we use the natural settings of the school environment. The class sample determined by conduct a draw so that produce class X IPA 2 and X IPA 3 as the research sample. Then they were drawn back to determine the experimental and control group. Then followed by an equivalence test of the two classes. Equivalence test is done by t-test [3].

Based on the results of the equivalence test using two-tailed t-test, the t-test value for the odd semester final exam score was 0.340 and the significance value obtained was 0.735. For a significance level of 5%, the significance value is greater than 0.05. This means that $H_0$ is accepted, so it can be concluded that the sample can be said to have an equivalent variant average. Then the sample was drawn again to determine the experimental group and the control group. Based on the draw results, Class X IPA 3 was selected as the experimental group and Class X IPA 1 as the control group. This study involves one independent variable, one learning model, and two dependent variables, namely mathematical connections and mathematical disposition. The instrument used to obtain quantitative reasoning data is a test instrument in the form of a mathematical connection test consisting of 5 item description items. The indicators of the mathematical connection are in Table 1 below.

| No | Indicator |
|----|-----------|
| 1  | Recognize and utilize relationships between ideas in mathematics. |
| 2  | Understand how ideas in mathematics and underlie interconnected with one another to produce a coherent wholeness. |
| 3  | Recognize and apply mathematics in outside mathematics contexts |

The instrument that used to obtain the data on mathematical disposition is a non-test instrument, a mathematical disposition questionnaire consisting of 50 items. The questionnaire was used to measure students' mathematical dispositions using a modified Likert scale. Each statement contains five answer choices namely Always (A), Frequently (F), Rarely (R), and Never (N). The results obtained will be analysed so that the mathematical disposition scale of students can be determined classically. The indicators of the mathematical disposition are in Table 2 below.
### Table 2. Mathematical Disposition Indicators

| No | Indicator                                                                 |
|----|---------------------------------------------------------------------------|
| 1  | Confident in using mathematics to solve problems, communicate mathematical ideas and provide arguments |
| 2  | Think flexibly in exploring mathematical ideas and try alternate methods of solving problems |
| 3  | Persistent in doing math tasks                                            |
| 4  | Interested, have curiosity and inventiveness in mathematical activities    |
| 5  | Monitor and reflect on thought and performance                             |
| 6  | Appreciate the application of mathematics in other disciplines or in everyday life |
| 7  | Appreciate the role of mathematics as a tool and as a language            |

These instruments must be tested before use. Based on trials of 5 items about mathematical connection, the five questions are valid. Furthermore, the questionnaire items that were tested were 50 valid questions. Based on the results of the validity test above, valid items were analysed to find out the reliability coefficient. Based on the calculation results, the instrument reliability coefficient for the mathematical connection test was 0.740 and the instrument reliability coefficient for mathematical disposition was 0.755. From the predetermined criteria, these items have a high degree of reliability.

Data analysis was performed using the one tail Manova test at a significance level of 5% because this study involved one independent variable and two dependent variables. Before performing the Manova test, prerequisite test are conducted, namely bivariate normality, variant homogeneity, the homogeneity of the matrix of variance / covariance and correlation between the dependent variable [4].

### 3. Result and Discussion

Research data were analysed using SPSS software. Students' mathematical connection data and mathematical disposition in the two sample classes can be seen in Table 3 below.

| No | Variable | Mathematical Connection | Mathematical Disposition |
|----|----------|-------------------------|--------------------------|
|    |          | Experimental | Control | Experimental | Control |
| 1  | N        | 36           | 35      | 36           | 35      |
| 2  | X        | 71.67        | 66.89   | 140.72       | 133.11  |
| 3  | SD       | 6.57         | 7.08    | 12.88        | 13.86   |

Based on Table 3, it can be seen that the average mathematical connections and mathematical disposition of students who take learning with the Geogebra-assisted Knisley learning model in the experimental group are better than the average mathematical connection score of students who take conventional learning in the control group.

Furthermore, the prerequisite test is done before the test Manova. The tests include bivariate normality tests, variance homogeneity tests, variance / covariance matrix homogeneity tests, and correlation between dependent variables tests. Multivariate data normality testing was performed with a correlation between Mahalanobis distances at a significance level of 5%.

Based on the SPSS test results, the value of Pearson Correlation Mahalanobis Distance in the experimental class was 0.994 with a significance level of 0.000 and the value of Pearson Correlation Mahalanobis Distance in the control class was 0.983 and with a significance level of 0.000 less than the significance value set at 0.05. Thus, the null hypothesis (H₀) is accepted, so it can be concluded that the data come from populations that are normally bivariate in distribution.

Furthermore, the results of the calculation of the homogeneity of the variance tested by the Levene test showed a significant value that greater than the significance value of 5%. The summary of the homogeneity testing of the data distribution can be seen in Table 4.
Table 4. Summary of Data Distribution Homogeneity Tests

| Levene's Test of Equality of Error Variances
|----------------|-----|-----|-----|-----|
| Dependent variable | F   | df₁ | df₂ | Sig. |
|---------------------|-----|-----|-----|-----|
| Mathematical Connection | .335 | 1   | 69  | .564 |
| Mathematical Disposition | .583 | 1   | 69  | .448 |

Based on the results, Levene test results for the mathematical connection score of the experimental class and the control class $F_{count} = 0.335$ with a significance value of 0.564, while for the mathematical disposition score of the experimental class and the control class the $F_{count}$ value = 0.583 with a significance value of 0.448. This means that the mathematical connections and mathematical dispositions of the experimental class and the control class have homogeneous variances. Then, the experimental and control class variance / covariance matrix is obtained as follows:

Experimental Class = \[
\begin{bmatrix}
43.20 & 55.33 \\
55.33 & 165.86
\end{bmatrix}
\]

Control Class = \[
\begin{bmatrix}
50.20 & 71.01 \\
71.01 & 191.99
\end{bmatrix}
\]

The results of the covariant variant matrix test are summarized in Table 5 below.

Table 5. Box's M Test Summary

| Box's M Test of Equality of Covariance Matrices a
|----------------|-----|-----|-----|-----|-----|
| Box's M         | .363 |     |     |     |
| $F$             | .117 |     |     |     |
| $df_1$          | 3    |     |     |     |
| $df_2$          | 880158.282 |     |     |     |
| Sig.            | .950 |     |     |     |

Based on the table above, it appears that the value of Box’s M = 0.363 with a significance of 0.950. The significance value obtained by 0.950 is greater than 0.05. Thus, the null hypothesis (H0) is accepted, so it can be said that the variance / covariance matrix between homogeneous dependent variables. Next, product moment correlation is used to test the correlation between dependent variables. The test results are listed in Table 6 and Table 7.

Table 6. Summary of Dependent Variables Correlation Test on Experimental Class

| Mathematical Connection | Mathematical Disposition
|-------------------------|-------------------------|
| Pearson Correlation     | .654**                  |
| Sig. (2-tailed)         | .000                    |
| N                       | 36                      |

The table above shows that for Pearson Correlation of 0.645 with a significance level of 0.000 is less than the specified significance value of 0.05. Thus between mathematical connections and mathematical disposition in the experimental group correlated with a correlation coefficient of 0.654.
Table 7. Summary of Dependent Variables Correlation Test on Control Class

| Correlations | Mathematical Connection | Mathematical Disposition |
|--------------|--------------------------|--------------------------|
| Pearson Correlation | 1 | .724** |
| Sig. (2-tailed) | .000 | 1 |
| N | 35 | 35 |

Based on the mathematical connection correlation and mathematical disposition test in the control group shows that for Pearson Correlation of 0.724 with a significance level of 0.000 is smaller than the significance value set at 0.05. Thus between mathematical connections and mathematical disposition in the control group are correlated with a correlation coefficient of 0.724. After all prerequisite tests are carried out, then it continued with the Manova test at the 5% significance level. The following table shows a summary of the Manova test results.

Table 8. Analysis Result by Manova

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|--------|-------------------------|----|-------------|---|------|
| Corrected Model | Mathematical Connection | 405,640a | 1 | 405,640 | 8,704 | .004 |
| | Mathematical Disposition | 1027,179b | 1 | 1027,179 | 5,747 | .019 |
| Intercept | Mathematical Connection | 340674,936 | 1 | 340674,936 | 7310,296 | .000 |
| | Mathematical Disposition | 1330745,150 | 1 | 1330745,150 | 7445,323 | .000 |
| Class | Mathematical Connection | 405,640 | 1 | 405,640 | 8,704 | .004 |
| | Mathematical Disposition | 1027,179 | 1 | 1027,179 | 5,747 | .019 |

Based on the table, the Wilks' Lambda statistical values are obtained, respectively as F = 4300.294a and F = 4.410a, and have a significance of 0.000 and 0.016 which less than 0.025 (p <0.025). This result is used as the basis for accepting H1. This means that the mathematical connections and mathematical dispositions of students who are taught by Knisley learning model with Geogebra are better than the mathematical connections and mathematical dispositions of students who are taught by conventional learning. Subsequently, the second hypothesis test shown in Tests of Between-Subjects Effects table.

Table 9. Tests of Between-Subjects Effects

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. |
|--------|-------------------|--------------------------|----|-------------|---|------|
| Corrected Model | Mathematical Connection | 405,640a | 1 | 405,640 | 8,704 | .004 |
| | Mathematical Disposition | 1027,179b | 1 | 1027,179 | 5,747 | .019 |
| Intercept | Mathematical Connection | 340674,936 | 1 | 340674,936 | 7310,296 | .000 |
| | Mathematical Disposition | 1330745,150 | 1 | 1330745,150 | 7445,323 | .000 |
| Class | Mathematical Connection | 405,640 | 1 | 405,640 | 8,704 | .004 |
| | Mathematical Disposition | 1027,179 | 1 | 1027,179 | 5,747 | .019 |

The table above shows the result that the F value for the mathematical connection dependent variable is 8.704 and has a significance value of 0.004 less than the specified significance value (p <0.025), so the F value is significant. Therefore we can conclude that H0 rejected and H1 accepted. It can be concluded that mathematical connection of students who were taught using Knisley Mathematical learning model with Geogebra were better than students who were taught using conventional learning.

Data analysis for the third hypothesis is also shown in the Tests of Between-Subjects Effects table above. Table 9 shows the results, namely the F value for the dependent variable in
mathematical disposition of 5.747 and has a significance value of 0.019 that less than the predetermined significance value (p <0.025), so the F value is significant. Therefore we can conclude that H0 rejected and H1 accepted.

It can be concluded that mathematical disposition of students who were taught using Knisley Mathematical learning model with Geogebra were better than students who were taught using conventional learning.

Knisley learning model with Geogebra facilitates students to be able to improve mathematical connections through problems given by the teacher. Knisley learning model facilitates students to construct their knowledge by providing opportunities to arrange what they will learn, how to learn it, and discover directly what is learned. Geogebra can help students to identify the information provided and can better to understand the material. By using Geogebra, students can investigate and try to find their understanding of the material being taught. In addition, students become more enthusiastic in learning because they use media that utilizes technology.

In addition, the learning process using the Knisley learning model can help students understand a concept by linking a new concept with a concept that they have learned. This is consistent with the theory Ausubel meaningful learning. According to Ausubel's theory, meaningful learning is where students are able to associate the concepts being studied with concepts they already know beforehand.

In addition to learning using the Knisley learning model, the Ausubel theory concept is used in the Analyser activity. In these activities students are required to make or choose statements related to new concepts.

Knisley learning model includes the stages: Allegoriser, Integrator, Analyser, and Synthesizer [9]. It help students in mathematical connections which include: (1) Recognize and utilize relationships between ideas in mathematics; (2) Understand how ideas in mathematics and underlie interconnected with one another to produce a coherent wholeness, and (3) Recognize and apply mathematics in outside mathematics contexts.

In addition, students also assisted in the disposition of mathematics which include: (1) Confident in using mathematics to solve problems, communicate mathematical ideas and provide arguments; (2) Think flexibly in exploring mathematical ideas and try alternative methods of solving problems; (3) Persistent in doing math tasks; (4) Interested, have curiosity and inventiveness in mathematical activities; (5) Monitor and reflect on thought and performance; (6) Appreciate the application of mathematics in other disciplines or in everyday life; and (7) Appreciate the role of mathematics as a tool and as a language.

Geogebra is used in the Integrator, Analyser stages. Students are given the opportunity to export the learning media in Geogebra. Geogebra media is expected to help students understand and describe the material concretely.

Learning that conducted using Knisley learning model with Geogebra creates learning that able to attract students' interest and to encourage students to be active. Through this learning model students are led to actively find and understand knowledge. Thus, learning using the Knisley learning model can be used to overcome students' mathematical connection and mathematical dispositions problems.

4. Conclusion

Based on the analysis and hypothesis tests that has been done, shows that mathematical connection and mathematical disposition of students who were taught using Knisley Mathematical learning model with Geogebra were better than students who were taught using conventional learning. Knisley learning model with contributes positively to the mathematical connections and mathematical disposition of students in due; (1) students become more enthusiastic in participating in learning activities; (2) students can construct their knowledge through a process of inquiry; (3) students can
understand the material more easily because it is assisted by Geogebra; and (4) students have the opportunity to explore their abilities through the learning process.

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