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Salwa Zakiyah Ruhma ✉; Wati Susilawati; Ida Nuraida

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Mathematical Understanding and Student Learning Motivation through Novick Learning Assisted by Pythagorean Calc

Salwa Zakiyah Ruhma[1,a)], Wati Susilawati[1], Ida Nuraida[1]

[1]*Department of Mathematics Education UIN Sunan Gunung Djati, Bandung, Indonesia.*

[a)] Corresponding author: salwazakiyahruhma111@gmail.com

Abstract. Understanding mathematics requires deep thinking in meaningful learning. However, empirically some teachers and students experience complex challenges in understanding these mathematical concepts. The purpose of this research is to improve students' mathematical understanding ability and learning motivation through Novick learning assisted by the Pythagorean Calc. This study uses a quasi-experimental method with purposive sampling obtained a sample of two classes at one of the public junior high schools in Ciamis, West Java, Indonesia. Data collection techniques in the form of pretest and posttest. The instrument used was a test of students' mathematical understanding abilities and a learning motivation questionnaire. Data analysis used was two-way ANOVA test and independent t-test. The findings show that: There are differences in the achievement of increasing mathematical understanding skills between students who carry out Novick learning assisted by the Pythagorean Calc and those who carry out expository learning in terms of gender. There is a difference in the increase in learning motivation between the experimental class students and the control class students. Novick's learning assisted by Pythagorean Calc facilitates students in constructing concepts, communicating ideas, interacting, and reflecting so that the ability to understand mathematics and students' motivation to learn increases.

Keywords: Learning Motivation, Mathematical Understanding, Novick, Pythagorean Calc

INTRODUCTION

The quality of the mathematics learning process in the midst of the Covid-19 pandemic can be improved by a strong synergy between education stakeholders. The variety of challenges in the learning environment is an opportunity for reflection for both educators and students. Two ways that become challenges in the mathematics learning process are developing understanding skills and developing higher-order thinking skills [1-3] Learning that is oriented to memorizing concepts and mastery targets have proven successful in short-term memory competitions but fails to provide an understanding of identifying and applying ideas in developing students' thinking skills to solve problems in long-term life [4-7]. Research results [8-9] state that the development of understanding ability is influenced by learning motivation and the involvement of students' higher-order thinking during the learning process. Therefore, the ability to understand mathematics and students' motivation to learn is very important to achieve optimal learning success.

Empirically, some students have difficulty understanding mathematics in constructing examples or non-examples of a concept and translating mathematical sentences into symbols and pictures [10]. Students mistakenly convert information into other forms and find it difficult to relate the material to different content. Some students make a lot of mistakes in the algorithm process to solve non-routine problems that require high thinking [11]. The application of learning models that are less attractive also makes student learning outcomes less than optimal [12]. Some students have low learning motivation in solving structural math problems because of a crisis of confidence in their abilities [13-14].

One alternative to these complex problems is necessary to immediately carry out constructivist learning that triggers students to find and explore ideas for a mathematical concept so that students are expected to be more

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challenged to develop their mathematical understanding skills and learning motivation [15]. The application of Novick learning assisted by the Pythagorean Calc as an alternative that can improve students' mathematical understanding abilities and learning motivation. The Novick model assisted by the Pythagorean Calc consists of three phases, namely exposing alternative framework, creating conceptual conflict, and encouraging cognitive accommodation. phase exposing alternative framework, students express initial conceptions, so they can focus on something that is in their minds. phase creating conceptual conflict, the teacher is expected to create student cognitive conflicts through various activities such as discussions or experiments. Then in encouraging cognitive accommodation, students are encouraged to create new schemes for new stimuli or modify existing schemes, so that the concepts have been in a scientific direction [16-19]. application Pythagorean Calc can be opened using android to help teachers and students solve Pythagorean theorem problems. The use of mobile applications is more satisfying and motivating and more effective in its implementation [20-21]. In addition to learning model factors, gender factors also affect the ability to understand mathematics. According to research by Almulla and Allamri, male students tend to use the left brain and have the power to find solutions to problems, while girls are more likely to use the right brain, so that in solving problems they can think creatively. In the field of mathematics, men's mathematical understanding ability is more established than women's, because the inferior parietal lobule (IPL) in men is larger than in women. Meanwhile, in the field of communication, women are more able to focus on finding solutions that can be accepted by all parties and are more proficient in using words and gestures [22-24] Therefore, learning is influenced by several personality factors. namely gender or gender. It becomes important to know the learning outcomes, especially in achieving the ability to understand mathematics.

The results of Faridah's research stated that there was an effect of the application of flipped classrooms on students' motivation [25]. Arafa's research reveals that Novick's learning has an effect on critical thinking skills during online learning, so this shows that Novick's learning is considered effective in implementing online-based learning [26]. Another study by Rahayu, et al stated that Guided Note Taking (GNT) learning had a positive effect on students' understanding of mathematical concepts [27]. This suggests that the innovation of the learning model can foster students' mathematical understanding abilities. Furthermore, [28] in his research that the use of mobile GeoGebra and sketchpad make it easy for students to understand geometric concepts.

Based on some of the results of these studies, there is an opportunity to analyze students' mathematical understanding abilities and learning motivation through the Novick learning model assisted by the Pythagorean Calc. This has the potential to be followed up, so it will complement new insights in knowledge. Therefore, the purpose of this paper is to analyze the achievement of students' mathematical understanding abilities and learning motivation through Novick learning assisted by the Pythagorean Calc based on gender (male and female).

METHOD

The research method uses a quasi-experimental method. The research population includes all class VIII SMP Negeri in Ciamis, West Java, Indonesia. The sample selection was based on purposive sampling, involving class VIII A as the experimental class using the Novick learning model assisted by the Pythagorean Calc and class VIII D as the control class using the expository learning model. Research design is a nonequivalent pretest-posttest design. The test instrument for the ability to understand mathematics and non-test was in the form of a student learning motivation questionnaire. The research procedure consists of 1) Planning stage, a series of activities carried out such as preliminary studies to analyze students' mathematical understanding abilities. Followed by making test and non-test instruments, test trials, and analysis results, 2) The implementation phase begins with the pretest, and the last four times the learning process is carried out post-test. 3) The data analysis phase used two-way ANOVA and an independent t-test.

RESULT AND DISCUSSION

To analyze the difference in the improvement of mathematical understanding skills between students who received Novick learning assisted by the Pythagorean Calc and students who received expository learning based on gender. The data on the results of the mathematical understanding ability test were obtained through a written test in the form of a description of four questions. In this study, the normality test and the homogeneity of variance test were carried out as prerequisite assumption tests. The normality test obtained information that the $|F_T - F_s|$ of the overall posttest in the class using Novick learning assisted Pythagorean Calc by gender category (male and female) $0.191 < 0.327$ Kolmogorov Smirnov table value. Thus, it can be concluded that the posttest is normally distributed.

Based on the results of the homogeneity test of the posttest, it was concluded that $x^2_{count}(1,286) < x^2_{table}(7,814)$, which means that the posttest on Novick learning assisted by the Pythagorean Calc and expository learning based on gender (male and female) has a large variance. homogeneous. Both classes are normally distributed and have homogeneous variances. data analysis post-test was followed by a two-way ANOVA test. The following are the results of the calculations presented in table 1.

TABLE 1. Two-way ANOVA Test Based on Category Gender

Source of Variance (SV)	Number of Squares (NS)	Degrees of Freedom (DF)	Mean Squared (MS)	F
Gender group of students (A)	4455.563	1	4455.563	8,771
Learning group (B)	2139,063	1	2139,063	18,270
A interaction B (AB)	156.25	1	156.25	0.640
Inner group (d)	14632.125	60	243,869	
Total (T)	21383			

Based on table 1, the results of the two-way ANOVA test concluded that there were differences in the achievement of understanding ability mathematics between students using the Novick learning model assisted by the Pythagorean Calc and the expository learning model. The achievement of students' mathematical understanding skills using Novick learning assisted by the Pythagorean Calc is better than students using expository learning. This achievement is due to the implementation of Novick's learning going well, involving students more actively, critically, and creatively in forming new knowledge during the learning process so that students can understand the material and concepts for the long term. According to the results of research [29] that learning using the Novick learning model is more effective in students' mathematical reasoning. so that students can understand the material and concepts for the long term through the use of the Student Worksheet (LKPD) which helps students to improve their mathematical understanding skills. The findings [30] explain that active learning with the help of LKPD can improve students' mathematical understanding abilities.

There are differences in the achievement of mathematical understanding abilities between students who use the Novick learning model assisted by the Pythagorean Calc and those who use the expository learning model in terms of gender categories (male and female). The analysis was continued through the Post Hoc Tukey test. For more details, see table 2 below.

TABLE 2. Post Hoc Tukey Test Post-test Data Based on Gender

(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Male	Female	-16,688*	3.904	.000	-24.497	-8.878
Female	Male	16,688*	3.904	.000	8.878	24,497

The value of Sig. for the gender pair of male students and female students, namely $0.000 < 0.05$, then H_0 is rejected, which means that there are differences in the achievement of students' mathematical understanding abilities between male and female students. The achievement of the mathematical understanding ability of female students in the Novick learning class assisted by the Pythagorean Calc application was better than that of the male students in the experimental class or in the control class. This is because female students tend to be able to take part in learning with an active attitude and can focus more on the learning process so that the material presented by the teacher is easier to digest and understand. Girls tend to be more accurate and more detailed and will make more complete and thorough lesson notes than boys, so they get higher learning outcomes than male students. This is due to the desire of female students to learn and a higher curiosity than male students [31]. In addition, the ability to understand mathematics is also influenced by the characteristics of the material being studied and the use of Novick's learning model assisted by the Pythagorean Calc is effective to encourage students to build their own knowledge. Female students have a higher level of self-confidence and confidence than boys, so they are able to solve mathematical problems through their thinking skills [32].

Research results [33] show that both male and female students who are highly capable in mathematics are generally able to express situations in the form of pictures or mathematical models, and analyze and evaluate

mathematical ideas in other forms, but male and female students In general, those who have medium and low abilities still have difficulty in expressing situations in the form of pictures or mathematical models, analyzing and evaluating mathematical ideas in other forms.

There is no interaction between the Novick learning model assisted by the Pythagorean Calc application and the expository learning model based on male and female gender categories on students' mathematical understanding abilities. In other words, Novick's learning model and gender together do not have a significant effect on students' mathematical understanding abilities. There are other factors that affect students' mathematical understanding abilities, both internal and external factors of students. Internal factors that affect the ability to understand mathematics include intelligence, attention, health, motivation, self-confidence, interest in learning, and discipline. While external factors include learning environment factors, both family, school, and community [34-35].

There is a difference in the increase in students' learning motivation using the Novick learning model assisted by the Pythagorean Calc application with students using the expository learning model. The increase in students' learning motivation can be obtained by distributing motivation questionnaires through pretest and post-test scores which are processed using the normalized N-Gain formula. N-Gain statistical data obtained in this study will be presented in table 3 below.

TABLE 3. Descriptive Statistics of N-Gain Data Learning Motivation

Learning Class	Min	Max	Mean	Standard Deviation	N-Gain Criteria
Assisted *Pythagorean Calc*	0.14	0.63	0.32	0.13	Medium
Expository	0.04	0.6	0.22	0,11	Low

Table 3 shows the average N-Gain value of students' learning motivation using Novick learning assisted by the Pythagorean Calc application better than students using expository learning.

The analysis was carried out using an independent t-test after testing for normality and homogeneity, the data were normally distributed and the variance was homogeneous. The results of the independent t-test calculations are presented in table 4.

TABLE 4 . T-test Data on Learning Motivation Questionnaire

T count	T table
3,311	2,0002

From table 4, the $t_{count}(3{,}311) > t_{table}(2{,}0002)$, so that H_o rejected. This means that it can be concluded that there are differences in the increase in learning motivation between students who use Novick learning assisted by the Pythagorean Calc application and students who use expository learning. Therefore, it was concluded that the increase in student motivation using the Novick learning model was better than the students using the expository learning model. This shows that students who use Novick learning assisted by the Pythagorean Calc application have more enthusiasm and motivation to learn which encourages them to be actively involved in learning and have a desire to get the best value from the learning process that their mathematical understanding skills develop better. In the process of achieving results and good mathematical understanding skills, students must of course have high motivation in learning. Learning motivation can increase student activities related to the teaching and learning process [36]. Pramita obtained the results of research on differences in student learning outcomes by considering learning factors including motivation and learning media that there were significant differences in student learning outcomes between students who had high learning motivation and students who had low learning motivation [37]. Therefore, Novick learning assisted by the Pythagorean Calc application has an important role in achieving learning success and student motivation.

The improvement of students' learning motivation using Novick learning assisted by the Pythagorean Calc application is better due to the factors of higher student aspirations, active learning, and the use of learning applications. Learning motivation will be more optimal if it is associated with the use of learning media [38-39] In addition, other factors that cause increased motivation are the desire to learn and encouragement from oneself as well as other factors such as learning activities and classroom conditions. Novick learning assisted by the Pythagorean Calc application provides students with opportunities to participate in mathematical activities so that students are more enthusiastic about learning. One implication is that teachers are required to make efforts to prepare and develop professionalism so that learning can be carried out effectively and efficiently in developing technological, pedagogical abilities, content understanding, and students' learning motivation [40-41].

CONCLUSION

There are differences in the achievement of mathematical understanding skills between students who apply Novick learning assisted by Pythagorean Calc applications better than students who carry out expository learning in terms of gender (male, female). In addition, related to learning motivation, it was found that there was a difference in the increase in learning motivation between students who applied Novick learning with the help of the Pythagorean Calc application and students who used the expository learning model. There is no interaction between Novick learning assisted by the Pythagorean Calc application and expository learning in terms of gender (male, female) on students' mathematical understanding ability, there are still several other factors that influence it.

Novick learning assisted by the Pythagorean Calc application can be an alternative learning that can be used by teachers in an effort to improve mathematical understanding skills and student learning motivation because Novick learning allows students to be active, confident in expressing ideas through a question and answer process or discussion, spurring students to think scientific, have a sense of responsibility and enthusiasm for learning. It is hoped that in the learning process the teacher can direct and guide students, especially in discussion activities and working on the Student Worksheet, so that each student can be active in the learning process.

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REFERENCES

1. A. Siddquie and R. Tyagi, **3**, 164 (2022).
2. A. Jihad, W. Susilawati, and N. Sobarningsih, IOP Conf. Ser. Mater. Sci. Eng. **434**, 1 (2018).
3. Qiaoping Zhang, *Values and Valuing in Mathematics Education* (ICME-13 Monographs, Switzerland, 2019).
4. NCTM, *Principles and Standars for School Mathematics* (The National Council of Teachers of Mathematics, United States of Amerika: 2000).
5. W. Susilawati, R. Karyadinata, and H. Sugilar, J. Phys. Conf. Ser. **1175**, (2019).
6. I.Q. Utami and W.Y. Hwang, J. Comput. Educ. **9**, 427 (2021).
7. L.S. Lomibao, C.J.G. Silk, and C.A. Luna, Int. J. Sci. Res. **6**, 2188 (2017).
8. J. Ferrer, A. Ringer, K. Saville, M. A Parris, and K. Kashi, High. Educ. **83**, 317 (2022).
9. S. Hadi, H. Retnawati, S. Munadi, E. Apino, and N.F. Wulandari, Probl. Educ. 21st Century **76**, 97 (2018).
10. A. Rashidov (2020). European J. Research and Reflection in Educational Sciences, **8**, 10 (2020)
11. M. Cason, J. Young, and E. Kuehnert, Investig. Math. Learn. **11**, 134 (2019).
12. Nunes, T., Hamdan, D., Leboeuf, C., El Bouchtaoui, M., Gapihan, G., Nguyen, T. T., .& Janin, A. Int. J. molecular sciences, **19**, 4036 (2018)
13. R.E. Simamora, S. Saragih, and H. Hasratuddin, Int. Electron. J. Math. Educ. **14**, 61 (2018).
14. B. Amandha and R. Ahmad, J. Neo Konseling **2**, 1 (2020).
15. H.P. Andres, J. Furth. High. Educ. **43**, 220 (2019).
16. M. Cevikbas and G. Kaiser, ZDM - Math. Educ. **52**, 1291 (2020).
17. J. Nussbaum and S. Novick, Instr. Sci. **11**, 183 (1982).
18. W. Susilawati, J. Phys. Conf. Ser. **1467**, (2020).
19. R. Kariadinata, R.P. Yaniawati, J. Juariah, W. Susilawati, and A. Cahyana, J. Phys. Conf. Ser. **1402**, (2019).
20. A. Akmam, R. Anshari, H. Amir, N. Jalinus, and A. Amran, IOP Conf. Ser. Mater. Sci. Eng. **335**, (2018).
21. F.H.P.M. Saragih, J. Appl. Linguist. **2**, 55 (2022).
22. M.A. Almulla and M.M. Alamri, Sustain. J. Phys. Conf. Ser **13**, (2021).
23. L.M. Jeno, P.J.C. Adachi, J.A. Grytnes, V. Vandvik, and E.L. Deci, Br. J. Educ. Technol. **50**, 669 (2019).
24. M.A.M.; Nurjannah, *Neuro Sains Menjiwai Sistem Saraf dan Otak [Neuro Science Imbuing the Nervous System and the Brain]* (Kencana, Jakarta: 2021).
25. N. Faridah, S. Ridlo, and S. Saptono, J. Innov. Sci. Educ. **10**, 339 (2021).
26. M. Arafa, S. Dwiastuti, U. Fatmawati, Biosf. J. Tadris. **12**, 40 (2021).
27. A.T. Rahayu, A. Muchyidin, and B. Manfaat, **1**, 12, J. of General Education and Humanities, **1,** 12. (2022)
28. M.A. Alkhateeb and A.M. Al-Duwairi, Int. Electron. J. Math. Educ. **14**, 523 (2019).

29. M. Yasin, N. Nasiroh, A. Fadila, S. Hartinah, and N. Novalia, Desimal J. Mat. **3**, 83 (2020).
30. F. Kudri, R. Rahmi, and Y. Haryono, IOP Conf. Ser. Mater. Sci. Eng. **335**, (2018).
31. N.K. Erawati, International Conference on Innovative Research Across Disciplines. **394**, 264 (2020)
32. A.H. Kaluge, J. Phys. Conf. Ser. **1375**, (2019).
33. N.H. Firdiani, T. Herman, and A. Hasanah, J. Phys. Conf. Ser. **1521**, (2020).
34. B. Rittle-Johnson, E.L. Zippert, and K.L. Boice, Early Child. Res. Q, J. Phys. Conf. Ser. **46**, 166 (2019).
35. J.C. Hong, J.H. Ye, and Y.Y. Shih, Bull. Educ. Psychol. **51**, 321 (2019).
36. Ş.S. Anagün, Int. J. Instr. **11**, 825 (2018).
37. R. Capuno, H. Revalde, J.O. Etcuban, M. Aventuna, G. Medio, and R.A. Demeterio, Int. Electron. J. Math. Educ. **15**, 677 (2019).
38. U. Rahmi, Y. Helsa, and Azrul, J. Phys. Conf. Ser. **1088**, (2018).
39. M. Pramita, R.A. Sukmawati, and N. Wiranda, J. Pengabdian Masyarakat [J. Community Service], **13**, 153 (2022)
40. S. Sahronih, A. Purwanto, and M.S. Sumantri, Int. J. Educ. Vocat. Stud. **2**, 1 (2020).
41. W. Susilawati and H. Sugilar, J. Perspektif [J. Perspective], **5**, 112, (2021).