KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Mathematical Connections Through Brain-Based Learning with Geogebra Assistance

Wati Susilawati, Nia Siti Nursalimah, and Iyon Maryono

Faculty of Tarbiyah and Teacher Training, UIN Sunan Gunung Djati, Jl. Cimencrang, Gedebage, Bandung, Indonesia

ORCID
Wati Susilawati: https://orcid.org/0000-0003-0346-9536

Abstract.
During the COVID-19 pandemic, it became a challenge for the world of education, all exposure to the implementation of learning was carried out online, however, adjusting the learning process required the readiness of students and teachers in the field of technological literacy. The purpose of writing this paper is: to analyse the ability of mathematical connections between students who carry out GeoGebra-assisted brain-based learning and conventional learning, viewed by gender. The research method used was a quasi-experimental design with a non-equivalent control group. The sample consisted of an experimental class and a control class which were not selected randomly but were selected homogeneously. The implementation was carried out at one of the state middle schools in Bandung, Indonesia. Class VIII-C consists of 30 students as an experimental class carrying out GeoGebra-assisted brain-based learning and class VIII-F consists of 28 students as a conventional class. The instrument used is a mathematical connection ability test. Data analysis using two-way ANOVA. Research results: There is a difference in the achievement of increasing the ability of mathematical connections between students in the experimental class and the conventional class. There is no difference in the achievement of increasing the ability to relate mathematics based on gender (male, female). The brain-based learning approach with the help of GeoGebra facilitates the process of construction, interaction, reflection, and easy-to-understand material, so as to improve students' mathematical connection abilities.

Keywords: Mathematical Connections, Brain-Based Learning, Geogebra Assistance

Corresponding Author: Wati Susilawati; email: wati85@uinsgd.ac.id

Published: 26 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

The period of the Covid 19 pandemic is a challenge for the world of education, all learning processes are carried out in networks, the presentation of the implementation of online learning is very interesting to do because learning can be done anytime and anywhere [1]. The effectiveness of implementing online learning requires professional teachers to arouse student interest and motivation to do assignments. Among them, it helps make it easier to solve abstract mathematical tasks quickly, accurately and

efficiently through the GeoGebra application [2]. According to the results of research [3] that students felt that the motivation and skills to connect mathematical concepts with everyday life experiences were enhanced and developed through Bra-based learning assisted by GeoGebra. The findings of [4] GeoGebra software is great for increasing motivation in learning processes and outcomes, as well as modelling in solving mathematical problems. This teachers need to familiarize students with connecting mathematics both internally and externally and pay attention to the emphasis of the material given to students so that students' mathematical connections are more developed, resulting in better academic performance improvements [5].

Empirically online learning has many obstacles in its implementation, such as uneven internet networks [6]. The readiness of teachers and students in adopting technological literacy requires a long time. According to the research results of [7] Reveals that students almost experience difficulties in implementing mathematics learning strategies at home with high stress and anxiety levels The results of research by [8] reveal that students' mathematical connection skills are still low. This can be seen from the indicators that show that students are less capable in modelling contextual questions correctly, students are not able to apply concepts and procedures, students have difficulty developing mathematical ideas. Research results Indra Kusuma [9] revealed that the ability of students' mathematical connections to connect between mathematical concepts and to apply mathematical concepts in solving daily problems was in the low category with 43.47% and 53.26%. Low mathematical connection ability is indicated by the low percentage of students who provide correct answers, students have difficulty understanding problems, determining formulas and theorems used to solve problems. According to the research results of [10] it is revealed that the test of mathematical connection ability is still low, seen from the percentage of each indicator, namely the relationship indicator between mathematical concepts is 38%, the relationship between mathematics and other sciences is 29%, and between math and everyday life is 43%. Students are the lowest in connecting mathematics with other sciences. According to the findings of [8] that students have not been able to apply and adapt various appropriate strategies to solve abstract non-routine mathematical problems that require high thinking.

In line with the results of research by [11] it is revealed that some students can use connections between mathematical concepts and other mathematical concepts, but students cannot identify mathematical problems, and do not provide the correct answer. The results of research by [12] Revealing mathematical connection errors made by students, unable to formulate mathematical problems; unable to find relationships

between topics in mathematics; cannot understand the representation of concepts in mathematical problems, and cannot describe the relationship between procedures in mathematical problems. The results of research by [13] shows that the results of mathematical connection abilities in terms of cognitive style and gender in the impulsive category, students answer mathematical problems without reasons or logical reasoning. According to the findings of [14] shows that the low ability of students' mathematical connections is due to a lack of deep understanding of mathematical concepts, they cannot understand concepts on math topics itself and concepts in other mathematical topics, when they are given problems, they can only understand problems without being able to find a proper solution. Thus the complex problems of the process and the results of learning mathematics require an alternative solution to solve these problems.

Based on the above problems, an alternative improvement is needed in the mathematics learning process, including the application of a GeoGebra-assisted brain-based learning approach that provides opportunities and confidence for students to be actively involved in the learning process in class, so as to reduce these problems. According to the research results [15] that the brain-based learning approach is able to produce actions to convince students, in the process and results of learning mathematics increase significantly. The results of research by [16] revealed that the application of community-based brain-based learning has a significant effect on students' mathematical connection abilities. In line with the findings of [8] that the Instagram-assisted brain-based learning approach is effective in solving math problems. Thus the brain-based learning approach can be an alternative means to significantly improve students' mastery of mathematical concepts. [17].

Applications that support student success in the application of fun brain-based learning can make it easier to understand concepts and be able to solve math problems accurately, including GeoGebra software. [18] Reveals that GeoGebra software can improve conceptual understanding skills and retention of learning mathematics. [19] The results of their research revealed that there was an effective use of GeoGebra in improving students' mathematical communication skills. [20] also revealed that GeoGebra-assisted learning can increase students' self-confidence and independent attitudes based on their initial mathematical abilities at high, medium and low categories. The results of research by [21] Reveal that in rural environments where the availability of limited technological resources, the use of GeoGebra affects student learning and has a positive effect on teacher beliefs during mathematics learning.

Cognitive aspects that are enhanced through GeoGebra-assisted brain-based learning, namely the ability of mathematical connections that have a hierarchical pattern

of relationships that are not partitioned into separate topics, but constitute one unified whole. With indicators of mathematical connection capabilities according to [1] including: (1) Looking for relationships of various representations of concepts and procedures; (2) Understanding the relationship between mathematical topics; (3) Applying mathematics in other fields or in everyday life [22]. The results of his research reveal that students who have mathematical connection abilities can associate mathematical concepts with previous material and concepts related to real life [23]. Revealed the results of his research that realistic mathematics learning can improve students' mathematical connection skills. The findings of [24] reveal that there are differences in the improvement and achievement of mathematical connection skills between students who carry out Prezi-based scientific learning better than students who have lecture-based learning and conventional learning. The results of research by [25] revealed that the discovery method with a scientific approach is effective in improving the mathematical connection skills and characteristics of students' thinking [26]. Revealed that students who have high mathematical connection skills have an effect on their mathematical problem-solving abilities and reading skills of the Koran. Thus the mathematical connection plays an important role in achieving a more meaningful understanding of mathematics, if each student is able to connect all the knowledge they have, both in everyday life and between mathematical concepts or other sciences.

In addition to the empirical factors above, there are other factors that can contribute to improving students' mathematical connection abilities, namely the gender factor (male, female). In the experimental class there were 16 male students and 14 female students, while in the conventional class there were 12 male students and 16 female students. Thus, there is an opportunity from the results of previous research that a brain-based learning approach assisted by GeoGebra can improve mathematical connection abilities in terms of gender (male, female). With the aim of analyzing the differences in the achievement of improving mathematical connection abilities between students who carry out GeoGebra-assisted brain-based learning and conventional learning, seen by gender. So that it can be an innovation in learning mathematics to solve mathematical connection problems in geometric material, which will facilitate the ability to deductively formulate and verify conjectures between mathematical topics, concepts, and procedures that can be applied to solve connection problems in mathematics and other disciplines.

2. RESEARCH METHOD

The research method uses a quasi-experimental, with an experimental design that is Nonequivalent Control Group Design. The population in the study were all students of Class VIII Class 2019-2020 which consisted of 10 parallel classes at SMP Kota Bandung Indonesia. The data source used as the sample consisted of the experimental class and the control class which were not selected randomly, but were selected homogeneously, namely Class VIII-C consisting of 30 students as the experimental class with 16 male students and 14 female students. who carry out GeoGebra-assisted brain-based learning, while class VIII-F as a conventional class consists of 28 students, there are 12 male students and 16 female students. The instrument used is a question of the ability of the mathematical connection which has been tested for validity, reliability, differentiation and difficulty level. Data analysis used independent t test and two-way ANOVA test, which have fulfilled the two assumptions of normality and homogeneity.

3. RESULTS AND DISCUSSION

Analysis of the ability of mathematical connections between students who carry out GeoGebra-assisted brain-based learning and conventional learning is reviewed based on gender (male, female) using n-gain. The average n-gain test of the ability of mathematical connections in the experimental class is at the category level of 0.75, which is better than conventional learning at the level of 0.51. both are in sufficient position. More clearly see the Figure 1.

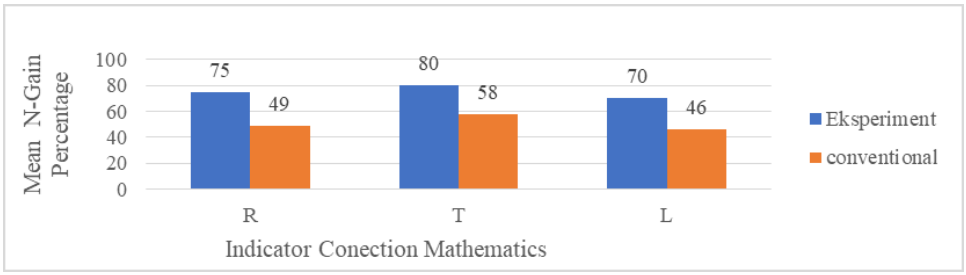

Figure 1: Average percentage <g> of each indicator of conection mathematics.

To find out the difference in the ability of mathematical connections between students who use GeoGebra-assisted brain-based learning and conventional learning, a t-test is carried out on the n-gain data. The assumptions from the results of the normality test and homogeneity test show that the sig value in the experimental class and control class> 0.05. Data are normally distributed and have homogeneous variants. Two assumptions were fulfilled so that the analysis was continued with the t-test, with a sig (2-tailed)

value of 0.01 <0.05. The conclusion of the hypothesis H0 is rejected, meaning that there are differences in the ability of mathematical connections between students who carry out GeoGebra-assisted brain-based learning and conventional learning. Thus, it can be concluded that there are differences in mathematical connection abilities between students who carry out GeoGebra-assisted brain-based learning better than those who use conventional learning. According to research results [27] revealed that the mathematical connection ability which is used as a learning reference becomes more meaningful learning. According to the research results of [22] that students with high mathematical connection skills can associate mathematical concepts with previous material, and are related to real life concepts. The findings [28] revealed that the mathematical connection ability of students who obtained the PJBL learning model with a creative mind map was higher than students who obtained the expository model. According to research results [25] that the ability of mathematical connections and student characteristics is better after learning the discovery method with a scientific approach [23]. The ability of mathematical connections is better after learning realistic mathematics [29]. That the mathematical connection ability is better after interactive media-based learning.

GeoGebra-assisted learning activities require students to relate mathematical ideas to the real world. According to research results [30] that the use of GeoGebra software is easily used by students if they are equipped with mathematical concepts according to everyday life and knowledge of graphics. According to research results [31] that GeoGebra software can be used as an important tool for the development of mathematical connection skills. According to the findings of [32] that learning supported by GeoGebra has sufficient accuracy related to learning outcomes, instruction, and programming. [4] that the GeoGebra software generates motivation in the learning process and modeling in mathematics. Thus that the application of learning with the GeoGebra application facilitates student interaction with more enthusiasm and enthusiasm for doing assignments during the learning process so it is fun because it makes it easy for students to understand concepts and solve geometric problems [2].

The difference in the achievement of increasing the ability of mathematical connections between students who use GeoGebra-assisted brain-based learning and conventional learning is viewed on the basis of gender (male, female). The overall average score of students in the experimental class in terms of gender (male, female) is 72.00 respectively. Meanwhile, the conventional class in terms of gender (male, female) is 63.04. To find out the difference in the achievement of increasing the ability of mathematical connections between students who use brain-based learning assisted by GeoGebra

and conventional learning based on gender (male, female, a two-way ANOVA test analysis was carried out, after two assumptions of normality and homogeneity were met. Two-way ANOVA results. with SPSS version 26 can be seen in the Table 1.

Table 1: Tests of between-subjects effects.

Dependent Variable: KONEKSI					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	1257.502[a]	3	419.167	9.042	.000
Intercept	261153.508	1	261153.508	5633.539	.000
Learning	1079.838	1	1079.838	23.294	.000
Gender	93.668	1	93.668	2.021	.161
Learning * Gender	.317	1	.317	.007	.934
Error	2503.274	54	46.357		
Total	269375.000	58			
Corrected Total	3760.776	57			
a. R Squared = .334 (Adjusted R Squared = .297)					

Based on the results of data processing using the two-way ANOVA test to test the research hypothesis based on the type of learning with a Sig value of 0.00 <0.05, then H0 is rejected. That is, there are differences in the achievement of increasing students' mathematical connection abilities based on GeoGebra-assisted brain-based learning which is better than conventional learning. According to the research results [33] revealed that the application of brain-based learning can improve students' higher order thinking skills. The findings of [34] that brain-based learning provides contributions and influences in increasing scientific literacy [35]. Brain-based learning can improve mathematical problem-solving abilities based on students' cognitive styles. [36] that the brain-based learning approach can improve higher-order thinking skills and student motivation more effectively than traditional approaches [37]. Brain-based learning improves problem solving skills better than the control class which uses problem-based learning [38]. The application of smart card assisted brain-based learning is effective for mathematical critical thinking skills [5]. Brain-based learning provides safe facilities, the presentation of meaningful content prepares students' brains to store, process, and retrieve information in a soothing way. According to the research results of [39] that the implementation of PPA with the STEAM brain-based learning approach has increased student learning achievement better than those using PJBL with the STEAM approach without brain-based learning [40]. Brain-based learning is effective in improving students' mathematical connection skills. So that the application of brain-based learning

can be an alternative means to significantly improve mastery of mathematical concepts [17].

Brain-based learning with GeoGebra interactive applications can improve mathematical connection skills. Apart from this learning, the application of GeoGebra affects the ability of mathematical connections. According to the research results [19] that there is an effective use of GeoGebra in improving students' mathematical communication skills. The findings [41] that learning using GeoGebra can improve the ability to understand geometric concepts higher than students taught conventionally. According to the results of the study [42] revealed that learning assisted by GeoGebra was effective in improving geometric spatial abilities and positive student responses.

The results of two-way ANOVA data processing hypothesis testing based on gender (male, female), that the sig value 0.16 > 0.05 then H_0 is accepted or H_1 is rejected. So it can be concluded that there is no difference in the achievement of increasing the ability of mathematical connections based on gender (male, female). Furthermore, the interaction test between the type of learning and gender on the students 'mathematical connection ability, with a sig value of 0.93 > 0.05, then H_O is accepted or H_1 is rejected, so it can be concluded that there is no interaction between the type of learning and gender on the students' mathematical connection ability. The mathematical connection ability of students who carry out brain-based learning based on gender, the average score is better than female students, as well as students who learn conventionally, that male students are superior to female students at the junior high school level.

According to research results [43] that the gender gap in the achievement and mathematics attitudes of male students is better than female students. The findings of [44] that the differences in final junior high school mathematics scores for high school entrance tests are substantial, consistent with the bias in assessing boys over girls. According to the research results of [45] reveal that mind mapping-assisted brain-based learning can improve mathematical critical thinking skills based on learning styles and gender.

Thus, the application of geogebra-assisted brain-based learning requires students to be skilled in solving mathematical connection problems in the concept of geometry. Mathematical connection skills can help students to connect mathematical concepts so that students do not learn them separately. One of the mathematical connection ability problems with indicators using mathematics in everyday life: Use GeoGebra to construct a building at the position below. Explain the concept of what happens, if the building consists of 24 rooms that are congruent in size?

Beam broad concept: (lh+ wh+ lw).

2	1	1	1
1	1		
1			

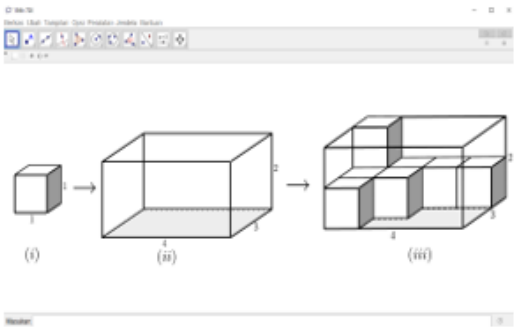

Figure 2: The concept that occurs is the beam volume: length x width x height.

Most of the students in the geography-assisted brain-based learning class were able to solve these connection questions, but conventional class students still found it difficult to construct the model.

4. CONCLUSION

The ability to connect mathematics through GeoGebra-assisted brain-based learning is better than conventional learning. There are differences in the achievement of an increase in the ability of mathematical connections between students who implement a GeoGebra-assisted brain-based learning approach with conventional learning. There is no difference in the achievement of increasing the ability of mathematical connections based on gender (male, female). In the application of GeoGebra-assisted and conventional types of brain-based learning, the male students' average score of mathematical connection ability is superior to that of female students. Male students' math connection ability scores in the experimental class were higher than male students in the conventional class. There is no interaction between the type of learning and gender on the mathematical connection ability.

ACKNOWLEDGEMENT

The authors acknowledge special to the Research and Publishing Center UIN Sunan Gunung Djati Bandung the financial support.

References

[1] Susilawati W, Nuraida I. "Mathematic connections through scientific prezi and lectora inspire.," In: *Journal of Physics: Conference Series*. pp. 012129. *IOP Publishing* (2021).

https://doi.org/10.1088/1742-6596/1869/1/012129.

[2] Tamam B, Dasari D. "The use of Geogebra software in teaching mathematics.," In: *Journal of Physics: Conference Series*. pp. 012042. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1882/1/012042.

[3] Baiduri B, Khusna AH. The process of students' mathematical connection in solving mathematical problems in terms of learning styles [TURCOMAT]. Turkish Journal of Computer and Mathematics Education. 2021;12(6):1451–66.

[4] Funes JO, Kari ER. "Exploring the exact differential equations with GeoGebra software.," In: *Journal of Physics: Conference Series*. pp. 012063. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1730/1/012063.

[5] D.S.M.R. Reshma HS. Influence of brain-based learning strategies on academic motivation, stress and self-esteem of high school students in North Banagalore. Journal Psychology and Education; 2021. p. 53.

[6] Adnan M, Anwar K. Online Learning amid the COVID-19 Pandemic: Students' Perspectives. Online Submission. 2020;2(1):45–51.

[7] Sayoga R, Nuurjannah PE. "The analysis of the three dimensional material observed from the mathematical critical thinking ability of high school students by applying Brain Based Learning (BBL).," *(JIML)*. Journal of Innovative Mathematics Learning. 2019;2(4):169–77.

[8] Kusumastuti AN, Indriati D. "Students' Mathematical external connection ability based on personality types of sensing intuition." In: *Journal of Physics: Conference Series*. pp. 012051. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1808/1/012051.

[9] Kusuma Wijayanti I, Maman Abadi A. "Analysis of the difficulty of VIIIth grade junior high school students in circle material reviewed from the mathematics connection ability.," In: *Journal of Physics: Conference Series*. pp. 012086. *IOP Publishing* (2019). https://doi.org/10.1088/1742-6596/1397/1/012086.

[10] Sari DN, Mardiyana M, Pramudya I. "Analysis of the ability of mathematical connections of middle school students in the field of algebra.," In: *Journal of Physics: Conference Series*. pp. 012159. *IOP Publishing* (2020). https://doi.org/10.1088/1742-6596/1469/1/012159.

[11] Qondiyana D. "An analysis of the ability of mathematical connection with the material of rectangles and triangles.," In: *Journal of Physics: Conference Series*. pp. 012040. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1796/1/012040.

[12] Hidayati VR, Subanji S, Sisworo S. Students' mathematical connection error in solving PISA circle problem [Jurnal Ilmiah Pendidikan Matematika]. JIPM. 2020;8(2):76–84.

[13] [13] A.R. Maulida, H. Suyitno, and T.S.N. Asih, “Mathematical connection ability viewed from cognitive style and gender in the CONINCON Learning (Constructivism, Integrative & Contextual).,” *Unnes Journal of Mathematics Education Research*. vol. 10, no. A, p. 2021.

[14] Itasari K, Pramudya I, Slamet I. “Mathematical connection profile of high school students with converger learning style.,” In: *Journal of Physics: Conference Series*. pp. 012024. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1796/1/012024.

[15] Koşar G, Bedir H. An intervention in brain-based learning: leading to shifts in language learning beliefs. International Journal of Curriculum and Instruction. 2020;12(2):176–90.

[16] Tohir M, Atikurrahman M, Maswar M, et al. “Building a caring community in problem based learning to improve students’ mathematical connection capabilities,” In: *Journal of Physics: Conference Series*. pp. 012008. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1839/1/012008.

[17] Sani A, Rochintaniawati D, Winarno N. Using brain-based learning to promote students’ concept mastery in learning electric circuit. Journal of Science Learning. 2019;2(2):42–9.

[18] Birgin O, Uzun Yazc K. The effect of GeoGebra software–supported mathematics instruction on eighth□grade students’ conceptual understanding and retention. J Comput Assist Learn. 2021;37(4):925–39.

[19] Istikomah E. “The effectiveness of Geogebra-assisted direct instruction learning in improving students’ mathematical communication skill viewed from academic level,” In: *Journal of Physics: Conference Series*. pp. 012049. *IOP Publishing* (2019).

[20] Istikomah E. The increasing self-efficacy and self-regulated through geogebra based teaching reviewed from Initial Mathematical Ability (IMA) level. Int J Instr. 2021;14(1):587–98.

[21] [21] M. Mthethwa, A. Bayaga, M.J. Bossé, and D. Williams, “GeoGebra for learning and teaching: A parallel investigation.,” *South African Journal of Education*. vol. 40, no. 2, p. 2020. https://doi.org/10.15700/saje.v40n2a1669.

[22] Suryono WA, Suyitno H, Junaedi I. Mathematical connection ability and studentsâ€^{tm} independence in Missouri mathematics project e-learning. Unnes Journal of Mathematics Education Research. 2020;9(2):185–9.

[23] Hasbi M, Lukito A, Sulaiman R, Muzaini M. Improving the mathematical connection ability of middle-school students through realistic mathematics approach [JoMP]. Journal of Mathematical Pedagogy. 2019;1(1):37–46.

[24] Susilawati W. “Mathematical communications through project based learning based on android.,” In: *Journal of Physics: Conference Series*. pp. 012128. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1869/1/012128.

[25] Hidayati F, Kartono K, Masrukan M. Analysis of mathematical connection ability based on student characteristics thinking on discovery learning scientific approach. Unnes Journal of Mathematics Education Research. 2018;7(1):109–16.

[26] Syafri FS, Isran D. “The relationship between mathematical problem-solving ability, mathematical connection ability, and ability to read the qur’an,” In: *International Conference on Educational Sciences and Teacher Profession (ICETeP 2020)*. pp. 186–191. *Atlantis Press* (2021).

[27] Suyitno H, Karomah N. “Connection ability in learning mathematics in Indonesia.,” In: *International Conference on Science and Education and Technology (ISET 2019)*. pp. 275–278. *Atlantis Press* (2020).

[28] Kartika YK, Pujiastuti E, Soedjoko E. The effectiveness of project based learning with creative mind-map tasks for improving mathematical connection ability and student curiosity. Unnes Journal of Mathematics Education. 2019;8(2):145–51.

[29] Purwanti M, Indriati D. “The development of interactive multimedia based on mathematics to increase the mathematical connection ability in probability learning.,” In: *Journal of Physics: Conference Series*. pp. 012047. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1808/1/012047.

[30] Halim A, Hamid A, Zainuddin Z, Nurulwati N, Herman H, Irwandi I. “Application of GeoGebra media in teaching the concept of particle kinematics in 1D and 2D.,” In: *AIP Conference Proceedings. AIP Publishing* (2021). https://doi.org/10.1063/5.0041624.

[31] Zengin Y. Development of mathematical connection skills in a dynamic learning environment. Educ Inf Technol. 2019;24(3):2175–94.

[32] Açıkgül K. Mathematics teachers’ opinions about a GeoGebra-supported learning kit for teaching polygons. Int J Math Educ Sci Technol. 2022;53(9):2482–503.

[33] Lusiana R, Andari T. “Brain based learning to improve students’ higher order thinking skills,” In: *Journal of Physics: Conference Series*. pp. 012004. *IOP Publishing* (2020). https://doi.org/10.1088/1742-6596/1613/1/012004.

[34] Sugiarti L, Purwanto A, Sumantri MS. Literature study of the application of Brain Based Learning (BBL) learning models to environmental science literacy. International Journal of Multicultural and Multireligious Understanding. 2021;8(2):374–84.

[35] L.T. Uji, M. Asikin, and M. Mulyono, “Problem solving ability viewed from studentsâ€^{tm} cognitive style on brain-based learning model based on self-assessment.,” *Unnes Journal of Mathematics Education Research*. vol. 10, no. A, pp. 21–26, 2021.

[36] Permana AA, Kartika I. Brain-Based Learning: the impact on student's higher order thinking skills and motivation. Jurnal Ilmiah Pendidikan Fisika Al-Biruni. 2021;10(1):47–58.

[37] Rahman AA, Kharisudin I. An analysis of problem solving ability using mathematical modeling strategies in brain-based learning. Unnes Journal of Mathematics Education. 2019;8(3):173–80.

[38] Rohmah NZ, Mashuri M. Mathematical critical thinking ability in terms of mathematical anxiety in Smart Card assisted Brain-Based Learning model. Unnes Journal of Mathematics Education. 2021;10(1):63–70.

[39] Badriyah NL, Anekawati A, Azizah LF. Application of PjBL with brain-based STEAM approach to improve learning achievement of students. Jurnal Inovasi Pendidikan IPA. 2020;6(1):88–100.

[40] Nugraheni MD, Junaedi I. The mathematics connection ability of 8th grade students in terms of cultural capital in brain-based learning. Unnes Journal of Mathematics Education. 2019;8(2):128–34.

[41] Widada W, Herawaty D, Nugroho KU, Anggoro AF. An augmented reality application with hand gestures for learning 3D geometry. In. J. Phys. Conf. Ser; 2021.

[42] Daulay LA, Nasution AK, Tohir M, Simamora Y, Saragih RM. "Geogebra assisted blended learning on students' spatial geometry ability," In: *Journal of Physics: Conference Series*. pp. 012009. *IOP Publishing* (2021). https://doi.org/10.1088/1742-6596/1839/1/012009.

[43] Wang Z, Rimfeld K, Shakeshaft N, Schofield K, Malanchini M. The longitudinal role of mathematics anxiety in mathematics development: issues of gender differences and domain-specificity. J Adolesc. 2020 Apr;80(1):220–32.

[44] Berg P, Palmgren O, Tyrefors B. Gender grading bias in junior high school mathematics. Appl Econ Lett. 2020;27(11):915–9.

[45] U. Arifah, H. Suyitno, and N.R. Dewi, "Mathematics critical thinking skills based on learning styles and genders on brain-based learning assisted by mind-mapping.," *Unnes Journal of Mathematics Education Research*. vol. 10, no. A, pp. 27–34, 2021.