# Development of geometry module assisted Geogebra to improve the students' ability of visual representation

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**Abstract.** Visual representation of ability is communicating, outlining, or interpreting problems through pictures. This capability is significant in learning mathematics. The use of materials that are monotonous and rarely uses innovative software that causes the visual representation of a student's abilities. This research is the development of research aimed at generating a module using the GeoGebra software so that it can improve the ability of visual representation. The method used is analysis, design, development, implementation, and evaluation (ADDIE). Stage analysis: students require innovative and creative learning materials that can improve the ability of visual representation. The stage design was done by designing a geometry module. Stages of development: 1) the development of the geometry module, 2) this module declares the valid use according to the material with the category very good, and 3) this module declares the valid use according to media expert with the category very good. This module declares the implementation stage of the effective average thoroughness 86.6 average N-gain is high categories, as well as the classical thoroughness, residing at 97.14% percentage. The evaluation stages stated that the practical and decent module used, with a percentage of the feasibility of 81.22% is very good.

**Keywords:** Abstract. Keywords: Geogebra, Geometry Module, Representation

## 1 Introduction

The ability of the mathematical representation of students in Indonesia is still deficient. See this reality, the ability of mathematical representation of students should be trained and upgraded to achieve the learning objectives of mathematics to increase the achievement of students learning math. The ability of mathematical representation of students in Indonesia is still low, especially in visual representation (Kholilatun et al., 2023; Nizaruddin & Murtianto, 2017; Utami et al., 2020). The ability to represent is an essential ability for students and is one of the objectives achieved in learning math in school (Nizaruddin & Murtianto, 2017). Representations of mathematical ability are essential in understanding math, both deals with when the students solve math problems and when they need to share solution for other people. It is also a form of


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attitude in mathematics (Firyal & Tina, 2022; Mulyaningsih et al., 2020; Resa & Iyam, 2022). The representation is instrumental in helping students solve a problem more efficiently. Representation automatically learns to remember the long-term visual concept. The ability of representation can be classified into three: 1) visual representation, 2) symbolic representation, and 3) verbal representation (Mulyaningsih et al., 2020; Resa & Iyam, 2022).

Math problems have completion form numbers, graphs, images, or more. Due to the abstract nature of math concepts, a form of representation is required to get to know the mathematical ideas; there is no way other than forms of representation of those ideas. Mathematical representation is a depiction, translation, disclosure, appointment back, symbolism, or modeling of mathematical concepts idea, displayed in the form of diverse students to gain clarity of meaning (Chen & Zitnick, 2015; Rosengrant et al., 2009). The representation is instrumental in helping students solve a problem more efficiently. Representation is also helpful in communicating mathematical ideas or ideas of other students and students to the teacher. The ability to mathematical representation is essential for the student to understand math concepts well (Nizaruddin & Murtianto, 2017; Rahmi & Subianto, 2020).

As is the case in one of the existing problems in geometry, students need the ability of representation to visualize problem-solving. But in general, the students feel difficulties in the construction wake of space geometry. Then, the psychology of mathematical representation is defined as describing the relationships between objects and symbols (Hwang et al., 2007; Krawec, 2014). Therefore, students should have an excellent visual representation of their ability. Forms of visual representation of the students are the student tools to find a solution to the problem (Habibah et al., 2023; Sa'diyah et al., 2020; Van Garderen & Montague, 2003). Most teachers use lectures regardless of how much students understand the material presented. So, students rarely respond to questions from teachers at a time when the process of teaching and learning, and the lack of attention to students at a time when teachers explain the material and activity (Syahrir & Susilawati, 2015).

Based on the previous, the need for innovation is providing learning resources in the form of systematic learning materials and overcoming all of these limitations that need to be examined further. A module is a tool or a means of learning material, methods, limitations, and how to evaluate systematically designed and attractive to reach the expected competencies, following the level of its complexity. Module can provide feedback so that students know their shortcomings and make improvements immediately (Lasmiyati & Harta, 2014; Syahrir & Susilawati, 2015). In the module, set clear learning objectives so that students' performance is directional in achieving goals in learning. The module can also clarify and simplify the presentation of the message so that it is not too verbal. In addition, the module can also be used appropriately and vary, such as to increase the motivation and passion for learning and develop the ability to interact directly with the environment and other learning resources that let students independently match their abilities and interests (Haleem et al., 2022; Sari et al., 2016). One of the efforts so that more students can use the capabilities of the visual representation also required a more innovative learning media. Media learning has an essential function in teaching and learning to improve the quality of education. One of the interactive media that can be used is geogebra. Various computer programs have been developed and can be used in learning math, namely Geogebra (Nur, 2016; Nuritha & Tsurayya, 2021; Yohannes & Chen, 2021). Geogebra is open software for learning mathematics consisting of feature geometry, algebra, and calculus in the software that is fully connected and easy to use in everyday life; students can understand abstract concepts, can make connections and find the solution of existing problems of mathematics (Antohe, 2009; Hohenwarter et al., 2008).

In mathematics research, an innovative learning device can support the implementation of the learning process, particularly in the visual representation ability. Modules and media Geogebra are mutually bound to bolster the ability of the visual representation of the students and are also expected to provide a positive role in gaining understanding improving interaction and participation of the students. This research aims to produce and develop the module flat-side room wake geometry-assisted Geogebra module to enhance the visual representation of the students.

## 2 Methods

The method used is the method of research and development Research and Development (R&D). R&D is a research method that is used to produce a particular product and test the effectiveness of these products (Sugiyono, 2019). Research products not only in the form of materials, such as textbooks, instructional videos, and others but also reference the ways and learning processes that have been there, for example, learning methods or methods of organizing learning. The model used is the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) instructional design model. This model is suitable with its name and consists of five main stages or phases, i.e., Analysis, Design, Development, Implementation, and Evaluation (ADDIE). Stage analysis: students require innovative and creative learning materials that can improve the ability of visual representation. The stage design was done by designing modules. Stages of development: 1) development of pirated, 2) validation of learning devices by expert judgment. Implementation of the module in the experimental and control classes was each carried out on 35 students in one of the schools in Limpung District, Batang Regency. Analysis of validation data using the percentage technique of expert validation results for Geogebra-assisted teaching modules. The t-test was used to test the effectiveness of using Geogebra-assisted modules in improving students' representation abilities. The N-Gain test determines how much students' representational abilities have increased after using the geogebra-assisted module (Iswahyudi et al., 2023).

## 3 Results

Geometry module development gets up flat-sided space-assisted Geogebra to enhance the capabilities of the visual representation of the students developed through 5 stages, namely analysis, design, develop, implementation, and evaluation. The fifth phase is to produce a product in the form of the flat-side room wake geometry-assisted Geogebra module to enhance the students' visual representation capabilities. In the first stage of the development process, an analysis of the needs of the students, the curriculum, and learning materials is performed. The study of the needs of students showed that students require learning materials in the form of a side room of the wake geometry module. The second stage is design, instrument module redesign assessment, and evaluation. Design that is done the lines of products. The design of the module assessment instrument is based on the study of the literature. The results in the assessment and question form the lattice test question. From this stage, the product design developed is module geometry woke up flat-sided space-assisted Geogebra. The third stage is development. The product geometry module is displayed in flat-side room wake-assisted Geogebra (Figure 1).


**Fig. 1.** Product Overview

Product results validated by media experts and material experts. The results of the validation are revised following the advice given by each expert. Based on material validation, module geometry woke up flat-side space-assisted GeoGebra is included in the very good category, 84.67%. Based on the results of media experts, 88% of those included in this category are very good (see Table 1).

**Table 1.** . Percentage Of The Device Validity of Learning Outcomes

| Validator | Percentage of validity products | |
|---|---|---|
| | Material | Media |
| Percentage | 84.67% | 88% |
| Criteria | Very Good | Very Good |

Based on a percentage obtained from the analysis, it can be concluded that the module geometry of flat-sided room wake-assisted GeoGebra is included in the category of very good and worthy of use in learning according to the media and experts' material. This is in line with Syahrir & Susilawati (2015), which resulted in the development of the mathematics learning module for junior high school; the results of validation experts is 82.37%, which indicates that the module is very decent. In addition to the module, students need the media to increase motivation. The required media students are GeoGebra. This is in line with Sari et al. (2016), stating that the module using the Geogebra used to include the category exciting and worthy as the media of instruction. This is apparent in the score test expert material and media experts and linguists, i.e., 4.08, 4.53, and 4.27, with a maximum score of 5.00.

The stage of implementation is a procedure measuring the achievement of representation of the visual ability of students before and after the learning device is applied to learn. The numbers used to measure results from pretest and posttest on a class or class wants to control. The second class compared to see if there is a difference between the classes that use the module geometry of flat-sided room wake-assisted Geogebra and classes that do not.

The initial analysis was used to test the prerequisite samples for class experiments and classroom control. From the normality results, the second class proved to be derived from a normal class with the values of L0 control class being 0.1486 and L0 experiment class being 0.1271, showing the value of less than L0, i.e., Ltable = 0.1498. And its homogeneity of the test has been done, it is evident that both the same class (homogeneity) i.e., with the value Fcount = 1.1347 and Ftable = 1.77207 so Fcount < Ftable. In addition, the two sides t-test was conducted to determine if the average grade class experiment equals class control or if there is no difference between the two classes. The class experiment is equal to class control. and the result obtained tcount = 0.591 and ttable = 1.9955. Look tcount < ttable -0.591 < 1.9955 can be concluded that the average results of a second study in the same class. The result of the data is presented in Table 2.

**Table 2.** Preliminary Analysis of the Data

| Data | Normality | | Homogeneity | Two pair t-test |
|---|---|---|---|---|
| | Experiment | Control | | |
| Preliminary data | 0,1486 | 0,1271 | 0,7152 | -0,591 |

During the final stages of meeting students' learning in the class of experiment and class of control given to question posttest. This is done to find out if there is a visual representation of a good upgrade from a class of experiments or classroom control. From the normality results, the second class proved to be derived from a normal class with the values of Lo 0.1396 and 0.1342 and seen that the value of less than Lo, Ltable i.e., 0.1498. And its homogeneity of the test has been done it is evident that both the same class (homogeneity) with a value of Fcount < Ftable and 1.77207 < 0.7152 so Fcount < Ftabel. In addition, the two sides t-test was conducted to determine if the average grade class experiment equal to class control or if there was no difference between the two classes. And the class experiment equal to class control. The result obtained tcount 4.682 and ttable = 1.9955. Look tcount > ttable i.e., 4.682 < 1.9955 can be concluded that the average of the results of the second study classes is not the same. The result of the data is presented in Table 3.

**Table 3.** Analysis of the Data Research

| Data | Normality | | Homogeneity | Two pair t-test |
|---|---|---|---|---|
| | Experiment | Control | | |
| Data result | 0,1396 | 0,1342 | 0,7152 | 4,682 |

To find out the value of learning, students then calculated the mastery of classical learning. Data in the control class indicates the percentage of mastery learning, whereas, in the experiment class, the percentage was 97.14%. In addition, the test also N-Gain. An indicator of the ability of the visual representation of the two indicators: 1) makes the image geometry and patterns, and 2) makes a picture to clarify issues and facilitate settlement. If the items reserved class experiment's views are better than the control class's. The difference is seen in Figure 2.

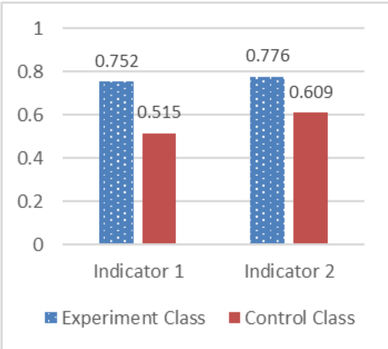


**Fig. 2.** Visual Representation of Each Indicator

Based on the results of the test N-gain overall, students have an increased ability for visual representation. On indicator (1), namely making geometric images, the value of N-gain class 0.752 experiments belong in the categories high, and 0.515 at the control classes are included in the category of being. As indicator (2) makes a picture to clarify issues, the value of N-gain is included in 0.776 high in-class experiments, and 0.609 is included in the categories on the class of the control.

Figure 3 clearly shows that upgrades visual representation per indicator, an experimental class higher than the control class. For the average grade improved the ability of visual representations obtained experimental classes scored 0.764 included in the categories high. In contrast, the control class scored 0.562 and is included in the category of being. The use of the module geometry of flat-sided room wake-assisted GeoGebra conventional learning is better than it looks from the upgrade; a visual representation of the class experiments is high, in contrast to improvement on the control class only in the category of being. That difference in capacity between the visual representation of the class of experiments and classroom control is 0.202 with a percentage of 20.2%. Therefore, the product is said to be effective under the hypothesis of 3 modules, flat-sided room wake geometry-assisted GeoGebra, both descriptive and inferential. Because the overall aspects have fulfilled, i.e., average score exceeds the posttest KKM, i.e., 86.6 average N-gain is at a high category and thoroughly students in classical 84.9% have exceeded i.e., be at 97.14% percentage.

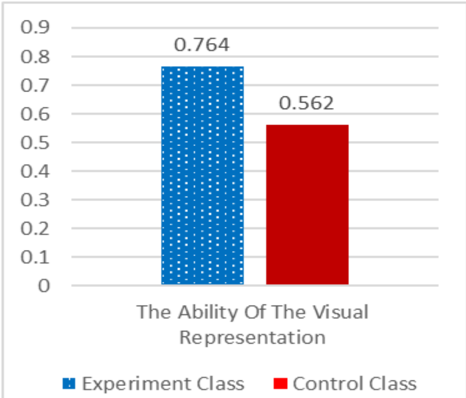


**Fig. 3.** The Ability of the Visual Representation

The last stage is the analysis of the aspects of partisan students. On practicability analysis done on the question form, module geometry students woke up flat-sided space-assisted Geogebra as the percentage shown in Table 4. The percentage of the total was 81.22%. This indicates that the module geometry of flat-sided room wake-assisted Geogebra is in a very good category. This is in line with Syahrir & Susilawati (2015), which shows the result of practitioners of 92.85% and indicates that the module is in the category of very good.

**Table 4.** Practicability Analysis

| No | Aspects of Assessment | Percentage worthy | Criteria |
|---|---|---|---|
| 1 | The Eligibility of the Contents | 82,06 % | Very Good |
| 2 | Feasibility Presentation | 81,43 % | Very Good |
| 3 | The Appropriateness of the Language | 81,57 % | Very Good |
| 4 | Contextual Assessment | 78,00 % | Good |
| | Total | 81,22 % | Very Good |

The percentage of the total was 81.22%. This indicates that the module geometry of flat-sided room wake-assisted Geogebra is in a very good category. The result of developing a mathematics learning module shows the effect of practitioners and indicates that the module is in the category of very good.

## 4 Conclusion

The results showed that the development of a module is declared valid and is used per the assessment of the material experts, acquiring a percentage of 84.67%, and media experts getting a rate of 88% by category. The development module was declared practically used under the results of the appraisal question from students who indicated that the percentage of the feasibility of 81.22% is very good practical value. The development of the module is said to be effective because it meets these three indicators of effectiveness. After all, the average value of the use class posttest module geometry woke up flat-side space exceeds the criteria, i.e., 86.6 average N-gain is high in the thorough category, as well as classical 0.758 pupils in classes that use the module geometry woke up flat-side spaces exceeds 84.9% i.e., be at 97.14% percentage.

## References

1. Antohe, V. (2009). *Limits of Educational Soft "GeoGebra" in a Critical Constructive Review* (arXiv:0905.4430). arXiv. http://arxiv.org/abs/0905.4430
2. Chen, X., & Lawrence Zitnick, C. (2015). Mind's eye: A recurrent visual representation for image caption generation. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 2422–2431. https://www.cv-foundation.org/openaccess/content_cvpr_2015/html/Chen_Minds_Eye_A_2015_CVPR_paper.html
3. Firyal, A. S., & Tina, S. S. (2022). Kemampuan Representasi Matematis Siswa antara yang Mendapatkan Pembelajaran Contextual Teaching and Learning dan Discovery Learning. *Plusminus: Jurnal Pendidikan Matematika*, *2*(2), 265–274.
4. Habibah, N., Nizaruddin, N., & Pramasdyahsari, A. S. (2023). Analisis kemampuan multi representasi dalam pemecahan masalah soal TIMSS ditinjau dari kemampuan berpikir kritis siswa. *Jurnal Penelitian Dan Pembelajaran Matematika*, *16*(2), 259–276.
5. Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285.
6. Hohenwarter, M., Hohenwarter, J., Kreis, Y., & Lavicza, Z. (2008). *Teaching and learning calculus with free dynamic mathematics software GeoGebra*. https://orbilu.uni.lu/handle/10993/47219
7. Hwang, W.-Y., Chen, N.-S., Dung, J.-J., & Yang, Y.-L. (2007). Multiple representation skills and creativity effects on mathematical problem solving using a multimedia whiteboard system. *Journal of Educational Technology & Society*, *10*(2), 191–212.
8. Iswahyudi, M. S., Wulandari, R., Samsuddin, H., Sukowati, I., Nurhayati, S., Makrus, M., Amalia, M. M., Faizah, H., & Febianingsih, N. P. E. (2023). *Buku ajar metodologi penelitian*. PT. Sonpedia Publishing Indonesia. https://books.google.com/books?hl=id&lr=&id=_SPbEAAAQBAJ&oi=fnd&pg=PA1&dq=metodologi+R%26D+buku&ots=YT3L-vatbj&sig=u-XzrsLP-3aVKqP4eG7ybWdCK8I
9. Kholilatun, F., Nizaruddin, N., & Purwosetiyono, F. D. (2023). Kemampuan Representasi Siswa SMP Kelas VIII dalam Menyelesaikan Soal Cerita Materi Peluang Ditinjau dari Gaya Belajar Visual. *Jurnal Kualita Pendidikan*, *4*(1), 54–59.

10. Krawec, J. L. (2014). Problem Representation and Mathematical Problem Solving of Students of Varying Math Ability. *Journal of Learning Disabilities*, *47*(2), 103–115. https://doi.org/10.1177/0022219412436976
11. Lasmiyati, L., & Harta, I. (2014). Pengembangan modul pembelajaran untuk meningkatkan pemahaman konsep dan minat SMP. *Pythagoras: Jurnal Matematika Dan Pendidikan Matematika*, *9*(2), 161–174.
12. Mulyaningsih, S., Marlina, R., & Effendi, K. N. S. (2020). Analisis kemampuan representasi matematis siswa SMP dalam menyelesaikan soal matematika. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *6*(1), 99–110.
13. Nizaruddin, M., & Murtianto, Y. H. (2017). Exploring of multi mathematical representation capability in problem solving on senior high school students. *Problems of Education in the 21st Century*, *75*(6), 591.
14. Nur, I. M. (2016). Pemanfaatan program geogebra dalam pembelajaran matematika. *Delta-Pi: Jurnal Matematika dan Pendidikan Matematika*, *5*(1). http://ejournal.unkhair.ac.id/index.php/deltapi/article/viewFile/236/188
15. Nuritha, C., & Tsurayya, A. (2021). Pengembangan video pembelajaran berbantuan geogebra untuk meningkatkan kemandirian belajar siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(1), 48–64.
16. Rahmi, M., & Subianto, M. (2020). First-grade junior high school students' mathematical connection ability. *Journal of Physics: Conference Series*, *1460*(1), 012003. https://iopscience.iop.org/article/10.1088/1742-6596/1460/1/012003/meta
17. Resa, K., & Iyam, M. (2022). Kemampuan representasi matematis siswa smp terhadap materi segiempat. *Plusminus: Jurnal Pendidikan Matematika*, *2*(1), 165–176.
18. Rosengrant, D., Van Heuvelen, A., & Etkina, E. (2009). Do students use and understand free-body diagrams? *Physical Review Special Topics - Physics Education Research*, *5*(1), 010108. https://doi.org/10.1103/PhysRevSTPER.5.010108
19. Sa'diyah, U., Nizaruddin, N., & Muhtarom, M. (2020). Translasi Antar Representasi Matematis Visual Ke Verbal Dalam Memahami Konsep Pada Materi Spldv Ditinjau Dari Kemampuan Matematika Tinggi. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *2*(4), 266–275.
20. Sari, F. K., Farida, F., & Syazali, M. (2016). Pengembangan media pembelajaran (modul) berbantuan GeoGebra pokok bahasan Turunan. *Al-Jabar: Jurnal Pendidikan Matematika*, *7*(2), 135–152.
21. Sugiyono, S. (2019). Metodologi Penelitian Kualitatif Kuantitatif Dan R&D. *Bandung: Cv. Alfabeta*.
22. Syahrir, S., & Susilawati, S. (2015). Pengembangan modul pembelajaran matematika siswa SMP. *Jurnal Ilmiah Mandala Education*, *1*(2), 162–171.
23. Utami, N. A., Murtianto, Y. H., & Nizaruddin, N. (2020). Profil kemampuan representasi matematis ditinjau dari kemampuan berpikir kritis dan kecerdasan emosional. *AKSIOMA: Jurnal Matematika Dan Pendidikan Matematika*, *11*(2), 274–285.
24. Van Garderen, D., & Montague, M. (2003). Visual-Spatial Representation, Mathematical Problem Solving, and Students of Varying Abilities. *Learning Disabilities Research and Practice*, *18*(4), 246–254. https://doi.org/10.1111/1540-5826.00079
25. Yohannes, A., & Chen, H.-L. (2021). GeoGebra in mathematics education: A systematic review of journal articles published from 2010 to 2020. *Interactive Learning Environments*, 1–16. https://doi.org/10.1080/10494820.2021.2016861