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Development of GeoGebra-Assisted Interactive Mathematics Learning Media on Linear Equation Material

Farah Dhiba Myrani[1*] , Irvan[2], Ellis Mardiana Panggabean[3]
[1,2,3] Mathematics Education, Postgraduate School, Universitas Muhammadiyah Sumatera Utara (UMSU), Medan, Indonesia

*Corresponding Author. E-mail: faradhibamyrani@gmail.com

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ABSTRACT

At first glance, the goal sounds fairly straightforward, but there's a bit more going on beneath it. The work set out to design an interactive mathematics learning tool using GeoGebra, focusing specifically on linear equations, and then to see whether it actually holds up in practice. Rather than jumping straight into testing, the process followed a Research and Development approach, adapting the familiar 4D model into three main phases: define, design, and development. That slight adjustment felt practical, given the scope of the project. The participants were not a large group, but they were carefully chosen. Three validators took part, including two university lecturers with expertise in the field and one practicing mathematics teacher who understands classroom realities. Alongside them, 15 eighth-grade students from MTsN 1 Aceh Tenggara were involved, offering direct feedback from the learner's side. To gather data, the study relied on validation sheets for the media and questionnaires capturing how students responded after using it. When the numbers came in, they told a fairly clear story. The media achieved a validation score of 92.8 percent, which places it comfortably in the very valid category. Student responses were even slightly higher, reaching 94.5 percent and falling into the very good range. Those figures suggest that the product is not just technically sound but also well received by its intended users. All things considered, the GeoGebra-based learning media seems more than usable in a classroom setting. It doesn't just meet formal feasibility standards; it also appears to spark students' interest and keep them engaged, which, in real teaching situations, is often half the battle.

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INTRODUCTION

Mathematics sits at the core of education, shaping how students think, reason, and make sense of patterns. Ideally, it trains them to be logical, precise, even a bit skeptical in a productive way. Yet, in many classrooms, it doesn't quite feel like that. Instead, it often comes across as rigid and hard to grasp, partly because the ideas are abstract, and partly because teaching still leans heavily on explanation rather than exploration (Muhaimin & Juandi, 2023; Nasution et al., 2020). It's not surprising, then, that students lose interest or struggle to stay motivated when the material feels distant from their experience.

One way to shift this dynamic is by rethinking how the material is presented. Learning media, when designed thoughtfully, can make a noticeable difference. Rather than just supporting

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the lesson, they can reshape how students encounter concepts in the first place. Visuals, interactivity, and a bit of responsiveness can turn something dense into something more approachable (Subagio et al., 2021; Irvan, 2024). And when technology is involved, there's an added layer of engagement, students don't just watch, they participate (Batubara et al., 2019; Bilqis & Astuti, 2025).

In this context, the development of digital tools for mathematics learning feels less like an option and more like a necessity. Software such as GeoGebra, for instance, offers a space where algebra and geometry are not separated but connected through dynamic representation (Zengin et al., 2012; Arbain & Shukor, 2015). Students can manipulate graphs, test ideas, and see immediate results. That kind of direct interaction tends to make abstract relationships feel more concrete, or at least more visible.

Interestingly, what happens in schools does not always reflect these possibilities. Observations at MTsN 1 Aceh Tenggara suggest that teaching is still largely lecture-based, occasionally supported by discussion, but rarely by technology. This is despite the fact that the infrastructure is already there. Computers are available, internet access is not an issue, and most students carry smartphones with them every day. There's a noticeable gap here, not in resources, but in how those resources are actually used. As a result, learning remains less engaging than it could be, and student outcomes reflect that limitation.

Earlier research has consistently pointed in a different direction. The use of GeoGebra, for example, has been linked to improvements in both achievement and conceptual understanding (Ridha et al., 2020; Hidayat et al., 2024). It seems to support not only correct answers but deeper reasoning. Other studies note increased motivation and more active participation during lessons (Nasution et al., 2020; Subagio et al., 2021). More recently, there's even evidence that dynamic visualization can help reduce common misconceptions, which is often one of the hardest challenges in mathematics learning (Irvan, 2024; Zhang et al., 2025).

From a theoretical standpoint, this shift makes sense. Technology-based media like GeoGebra align quite naturally with constructivist ideas about learning. Instead of receiving information passively, students build understanding through interaction, trial, and sometimes error (Rokaya, 2021; Pratama, 2025). Learning becomes less about following steps and more about making sense of relationships.

Linear equations provide a good example of where this approach could matter. Many students find the topic challenging, not necessarily because the procedures are complex, but because it requires linking symbolic expressions to graphical meaning. Without clear visualization, that connection can feel abstract, almost arbitrary. So, tools that allow students to see how equations translate into lines, slopes, and intercepts in real time could make a real difference (Hidayat et al., 2024; Zhang et al., 2025).

Of course, creating effective learning media is not just about using the right software. It requires a structured development process to ensure the result is both usable and meaningful. A Research and Development approach offers that structure, guiding the process from initial design to refinement (Sugiyono, 2019; Branch, 2009). At the same time, the final product needs to stay aligned with curriculum demands and the broader direction of educational technology (Kemendikbud, 2019; Bilqis & Astuti, 2025).

That said, there is still a gap in the existing body of research. Many studies highlight the effectiveness of GeoGebra in practice, often through experiments or classroom implementation.

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

Fewer focus on developing a complete learning medium that is carefully tailored to students' needs and learning contexts. Even fewer attempt to integrate interactivity, independent exploration, and dynamic visualization into a single, coherent design, especially for topics like linear equations at the junior secondary level.

This study, then, tries to move in that direction. It focuses on developing an interactive mathematics learning medium supported by GeoGebra, built through a systematic model. The aim is not just to create a visual aid, but something closer to a learning environment, where students can explore, test ideas, and gradually construct their understanding.

In the end, the goal is fairly simple, though not trivial to achieve. The study seeks to produce a GeoGebra-assisted learning medium on linear equations and to examine whether it is actually feasible for classroom use. If it works as intended, it could help make mathematics feel less distant and, perhaps, a bit more meaningful for students.

RESEARCH METHOD

This research followed a Research and Development (R&D) approach, with a fairly clear intention from the start: to create an interactive mathematics learning medium using GeoGebra, specifically for linear equations, and then see whether it is actually suitable for classroom use. The development process was guided by the 4D model introduced by Thiagarajan, Semmel, and Semmel, although it wasn't applied in its entirety. Given the limitations of time and resources, the process was narrowed down to three stages, define, design, and development, leaving out the dissemination phase.

The study itself took place at MTsN 1 Aceh Tenggara during the second semester of the 2024/2025 academic year. The participants were selected purposively, which makes sense considering the specific roles they needed to play. In total, there were 18 individuals involved: three validators, two university lecturers and one mathematics teacher, alongside 15 eighth-grade students. The validators focused on assessing the feasibility of the developed media, while the students were involved in a limited trial, mainly to share their impressions and responses after using it.

To gather the data, two main instruments were used. The first was a media validation sheet, designed to evaluate aspects such as content quality, visual appearance, and the level of interactivity. This used a Likert scale ranging from 1 to 5. The second instrument was a student response questionnaire, slightly simpler, using a 1 to 4 scale. Before being used in the field, both instruments were reviewed and validated by experts, which helps ensure that they actually measure what they are supposed to measure.

As for the analysis, the study relied on descriptive quantitative methods, mainly by converting scores into percentages. Feasibility was calculated using the formula:

$$K = (T / Ti) \times 100\%$$

Here, K represents the feasibility percentage, T refers to the total score obtained, and Ti is the maximum possible score. A result of 61 percent or higher was taken as an indication that the media is feasible.

Student responses were processed in a similar way, though with a slightly more detailed formula:

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

$$K = (F / (N \times I \times R)) \times 100\%$$

In this case, K stands for the response percentage, F is the total score collected, N is the maximum score, I is the number of questionnaire items, and R is the number of respondents. When the percentage exceeded 80 percent, the responses were categorized as very good, suggesting that the media was not only acceptable but also well received by the students.

RESULTS AND DISCUSSION

What emerged from this work is an interactive learning medium built with GeoGebra, centered on linear equations. At its core, it tries to respond to a familiar issue in mathematics classrooms, students often treat equations as symbols to manipulate, rather than as representations of something visual and meaningful. Because of that, the design leans quite heavily on dynamic graphs. For instance, when the slope changes from 2 to 3, the line tilts instantly, or when the intercept shifts, the entire graph moves accordingly. These small, immediate changes help make abstract relationships feel more concrete, which is essential for deeper conceptual understanding (Hidayat et al., 2024; Zhang et al., 2025).

The interface itself encourages exploration, though not in an overwhelming way. Students can input their own values, adjust parameters, and observe how the graph responds in real time. When their expectations do not match what appears on the screen, that moment becomes an opportunity to rethink. In a sense, the media invites students to reflect on their own thinking process, not just follow procedures. This kind of interaction aligns closely with the idea that learning happens through active construction, rather than passive reception (Rokaya, 2021; Pratama, 2025).

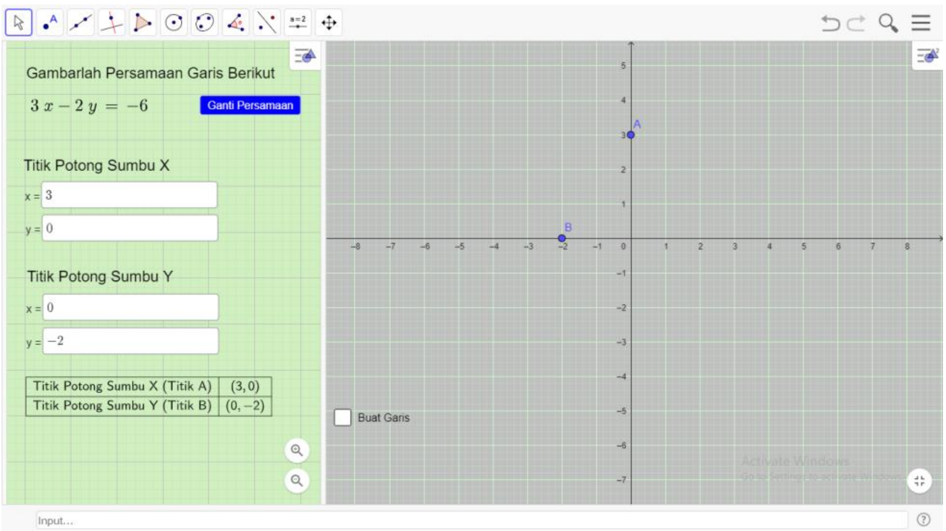

Figure 1. GeoGebra Display After Development

Figure 1 presents the GeoGebra display after development, although a static image only tells part of the story. What really matters is how the visual elements respond dynamically when students engage with them.

When evaluated by three validators, two university lecturers and one mathematics teacher, the media obtained a feasibility percentage of 92.8%, which falls into the "very valid" category. The

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

assessment covered content quality, visual appearance, and interactivity. This high score suggests that the media has been designed in a way that balances these elements effectively, meeting the general standards of instructional media development (Sugiyono, 2019; Branch, 2009).

Student responses provide another perspective, and interestingly, they reinforce the same pattern. The overall response reached 94.5%, categorized as “very good.” More specifically, content quality was rated at 92.5%, enjoyment at 91.6%, character at 93.6%, evaluation at 92.5%, appearance at 92%, and motivation at 96%. The particularly high score in motivation suggests that the media does more than support understanding, it seems to make students more willing to engage with the material.

This positive response, especially in terms of motivation and appearance, does not happen by accident. It is likely influenced by the dynamic and interactive nature of the media itself. When students manipulate input values and immediately see the graph change, the experience becomes exploratory. They are not just receiving information; they are testing ideas and seeing the consequences directly. This kind of immediate feedback also allows them to identify and correct errors more quickly, which can improve overall learning effectiveness (Irvan, 2024; Zhang et al., 2025).

Looking at the findings more broadly, the media demonstrates a very high level of feasibility, as reflected in the validation score of 92.8%. This does not only indicate technical quality, but also suggests that the product aligns well with students’ needs and learning characteristics. Such alignment is often a key factor in determining whether a learning tool is actually useful in practice (Sugiyono, 2019; Branch, 2009).

The strong student responses, particularly in motivation and engagement, are also consistent with previous studies. Research has shown that interactive and technology-based media can increase students’ participation and interest in learning activities (Bilqis & Astuti, 2025; Subagio et al., 2021). In this case, the findings seem to support that idea, though in a more specific context.

From a conceptual standpoint, the use of GeoGebra appears to help students connect algebraic expressions with their graphical representations. This connection is often one of the more challenging aspects of learning linear equations. By allowing students to observe how changes in equations affect the graph directly, the media supports the development of a more integrated understanding. Over time, this can help reduce common misconceptions in mathematics learning (Irvan, 2024; Zhang et al., 2025).

The results also fit quite naturally within a constructivist perspective. Learning here is not about receiving ready-made information, but about building understanding through interaction and experience. The GeoGebra-based media facilitates this by allowing students to explore independently, manipulate objects, and observe outcomes directly (Rokaya, 2021; Pratama, 2025).

These findings are in line with earlier research indicating that GeoGebra can enhance mathematical thinking skills and conceptual understanding (Ridha et al., 2020; Hidayat et al., 2024). At the same time, it has also been associated with increased learning activity and motivation among students (Nasution et al., 2020; Subagio et al., 2021). What makes this study slightly different, however, is its focus on systematically developing the learning media itself, rather than simply applying GeoGebra in classroom instruction.

When compared to more conventional approaches, the difference becomes quite noticeable. Traditional learning tends to be teacher-centered, with limited space for exploration. In contrast, the developed media allows students to experiment, observe real-time changes, and

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

receive immediate feedback. This level of interactivity appears to play an important role in enhancing both cognitive and affective engagement (Etyarisky & Marsigit, 2022; Bilqis & Astuti, 2025).

That said, one limitation needs to be acknowledged. The study does not yet provide evidence of effectiveness in terms of measurable learning outcomes. There was no experimental design, such as pretest-posttest or control group comparison, which would be necessary to quantify learning gains. As a result, the findings are limited to feasibility and user responses, rather than instructional effectiveness.

Even so, the overall picture is quite promising. The GeoGebra-assisted media seems capable of bridging the gap between abstract mathematical concepts and their visual representations, supporting a deeper level of understanding.

Of course, there are still limitations, including the relatively small sample size and the absence of a more rigorous experimental design. Future research could address these by involving a larger and more diverse group of students, as well as applying quasi-experimental or true experimental methods. It may also be worth exploring how this type of media can be integrated with specific instructional models to further enhance learning outcomes (Hidayat et al., 2024; Zhang et al., 2025).

CONCLUSION

Looking back at the results and the discussion, the conclusion feels fairly clear, even if a bit cautious. The GeoGebra-assisted learning media for linear equations can be considered feasible for classroom use. The validation results alone already point in that direction, reaching 92.8% and falling into the “very valid” category. Student responses seem to reinforce that impression, with a slightly higher percentage of 94.5%. Taken together, these numbers suggest that the media is not only acceptable in a technical sense but also well received by the students who actually use it.

What is perhaps more interesting is how the media seems to influence the learning experience itself. Students do not just interact with static material; they engage with moving graphs, test their own inputs, and see immediate results. That kind of interaction appears to spark interest and, to some extent, motivation. It also helps them make sense of linear equations in a more concrete way, especially when they can directly observe how changes in an equation affect the graph.

In that sense, the GeoGebra-based media does more than meet feasibility standards. It contributes, at least in a practical way, to a learning environment that feels more active and engaging. There is a shift from simply receiving explanations to actually exploring ideas, which, even if subtle, can make learning more meaningful. The study, then, adds something to the ongoing effort to develop technology-based learning tools that are not only functional but genuinely useful in improving the quality of mathematics education.

Still, a few limitations are hard to ignore. The number of participants is relatively small, and the study stops at a limited trial stage without broader implementation. Because of that, it is difficult to make strong claims about how effective the media would be in different contexts or on a larger scale. There is also the absence of an experimental design, so improvements in learning outcomes cannot be measured in a strict, quantitative sense.

For that reason, future research could take this a step further. It would be worth testing the media with a larger and more diverse group of students, perhaps across different schools or

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

learning environments. Using designs such as pretest-posttest or even controlled experiments could provide clearer evidence of its impact on learning outcomes. Beyond that, there is also room to expand the idea, applying similar media to other mathematical topics or combining it with specific instructional models. With a bit more exploration, the potential here could develop into something even more substantial.

REFERENCES

Arbain, N., & Shukor, N. A. (2015). The effects of GeoGebra on students achievement. *Procedia-Social and Behavioral Sciences*, *172*, 208-214.

Bilqis, A. A. S., & Astuti, W. (2025). The Role of Interactive Technology in Enhancing Student Engagement in Mathematics. *Jurnal Pendidikan Matematika*, *16*(2), 209-215.

Branch, R. M., & Varank, İ. (2009). *Instructional design: The ADDIE approach* (Vol. 722, p. 84). New York: Springer.

Etyarisky, V., & Marsigit, M. (2022). The effectiveness of interactive learning multimedia with a contextual approach to student's understanding mathematical concepts. *Al-Ishlah: Jurnal Pendidikan*, *14*(3), 3101-3110.

Hidayat, R., Noor, W. N. W. M., Nasir, N., & Ayub, A. F. M. (2024). The role of GeoGebra software in conceptual understanding and engagement among secondary school student. *Infinity Journal*, *13*(2), 317-332.

Irvan, I. (2024). Application of Integrals in Calculating Ball Volume using GeoGebra. *Indonesian Journal of Education and Mathematical Science*, *5*(1), 58-63.

Kemendikbud. (2019). *Panduan implementasi kurikulum 2013*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

Muhaimin, L. H., & Juandi, D. (2023). The role of learning media in learning mathematics: A systematic literature review. *Journal of Mathematics and Mathematics Education*, *13*(1), 85-107.

Nasution, A. E., Irvan, I., & Batubara, I. H. (2020). Penerapan model Problem Based Learning dan etnomatematik berbantuan Geogebra untuk meningkatkan kemampuan komunikasi matematis. *Journal Mathematics Education Sigma [JMES]*, *1*(2), 55-64.

Pratama, R. A. (2025). Effectiveness of research and development (R&D) of android-based educational games to improve students' mathematical reasoning: a meta-analysis approach. *Discover Education*, *4*(1), 315.

Ridha, M. R., Pramiarsih, E. E., & Widjajani. (2020, March). The use of GeoGebra software in learning Geometry transformation to improve students' mathematical understanding ability. In *Journal of Physics: Conference Series* (Vol. 1477, No. 4, p. 042048). IOP Publishing.

Rokaya, B. B. (2021). Constructive learning approach in mathematics education: Challenges and possibilities. *Academic Journal of Mathematics Education*, *4*(1), 1-6.

Subagio, L., Karnasih, I., & Irvan, I. (2021). Meningkatkan motivasi belajar siswa dengan menerapkan model discovery-learning dan problem-based-learning berbantuan Geogebra. *Jurnal Pendidikan Matematika Raflesia*, *6*(2), 15-26.

Sugiyono. (2019). *Metode penelitian pendidikan*. Bandung: Alfabeta.

Vol. 05, No 01, February 2026 , pp. 36-43 DOI: https://doi.org/10.30596/jmea.v5i1.31043

Zengin, Y., Furkan, H., & Kutluca, T. (2012). The effect of dynamic mathematics software geogebra on student achievement in teaching of trigonometry. *Procedia-social and behavioral sciences*, *31*, 183-187.

Zhang, Y., Wang, P., Jia, W., Zhang, A., & Chen, G. (2025). Dynamic visualization by GeoGebra for mathematics learning: a meta-analysis of 20 years of research. *Journal of Research on Technology in Education*, *57*(2), 437-458.