



# GEODERIV: EVALUATING THE PRACTICALITY AND EFFECTIVENESS OF AN INTERACTIVE GEOGEBRA-BASED MEDIA FOR DERIVATIVE CONCEPTS IN SENIOR HIGH SCHOOL STUDENTS

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## Abstrak

Konsep turunan sering menjadi materi yang sulit dipahami siswa karena melibatkan hubungan abstrak antara prosedur simbolik dan representasi grafik. Penelitian ini bertujuan untuk mengevaluasi kepraktisan dan keefektifan GeoDeriv, yaitu media pembelajaran terintegrasi berbasis GeoGebra yang dirancang untuk mendukung siswa kelas XII sekolah menengah atas dalam mempelajari konsep turunan. Penelitian ini dilakukan dalam kerangka research and development dengan model ADDIE, dan artikel ini secara khusus melaporkan tahap evaluasi melalui uji lapangan. Partisipan penelitian berjumlah 31 siswa kelas XII di MA YMPI Rappang. GeoDeriv mengintegrasikan materi turunan, simulasi interaktif, visualisasi grafik, latihan soal, dan tampilan solusi dalam satu lingkungan belajar berbasis GeoGebra untuk mendukung pemahaman konseptual dan penalaran visual siswa. Data dikumpulkan melalui angket respons siswa dan guru, tes hasil belajar siswa, serta observasi aktivitas siswa di kelas. Hasil penelitian menunjukkan bahwa GeoDeriv berada pada kategori sangat praktis, dengan skor kepraktisan 94,00% dari siswa dan 93,75% dari guru. Keefektifannya didukung oleh hasil uji One-Sample Wilcoxon Signed-Rank Test ( $p < 0,05$ ), yang menunjukkan bahwa skor tes akhir siswa berbeda secara signifikan dari Kriteria Ketuntasan Minimal. Aktivitas siswa mencapai 90,00% dan berada pada kategori sangat baik. Temuan ini menunjukkan bahwa GeoDeriv memberikan dukungan positif pada tingkat kelas terhadap pembelajaran turunan dengan memfasilitasi keterlibatan siswa pada representasi simbolik, grafik, dan konseptual dalam lingkungan belajar digital yang terintegrasi.

**Kata kunci:** GeoGebra; Media Pembelajaran Matematika Interaktif; Turunan

## Abstract

Derivative concepts are often difficult for students because they involve abstract relationships between symbolic procedures and graphical representations. This study aimed to evaluate the practicality and effectiveness of GeoDeriv, an integrated GeoGebra-based learning media designed to support twelfth-grade senior high school students in learning derivative concepts. The study was conducted within a research and development project using the ADDIE model, with this article specifically reporting the evaluation stage through field testing. The participants were 31 twelfth-grade students at MA YMPI Rappang. GeoDeriv integrates derivative materials, interactive simulations, graphical visualizations, practice tasks, and solution displays within a single GeoGebra-based learning environment to support students'



conceptual understanding and visual reasoning. Data were collected through student and teacher response questionnaires, a student learning outcomes test, and classroom activity observations. The results showed that GeoDeriv was highly practical, with practicality scores of 94.00% from students and 93.75% from the teacher. Its effectiveness was supported by the One-Sample Wilcoxon Signed-Rank Test ( $p < 0.05$ ), indicating that students' post-test scores differed significantly from the Minimum Mastery Criterion. Student activity reached 90.00%, which was categorized as very good. These findings indicate that GeoDeriv provides promising classroom-level support for derivative learning by facilitating students' engagement with symbolic, graphical, and conceptual representations in an integrated digital learning environment.

**Keywords:** Derivatives; Interactive Mathematics Learning Media; GeoGebra

**Citation:** Hafis, Suastika, I.K., Rahaju. 2026. Geoderiv: Evaluating the Practicality and Effectiveness of an Interactive Geogebra-Based Media for Derivative Concepts in Senior High School Students. *Matematika dan Pembelajaran*, 14(1), 203-226. DOI: <http://dx.doi.org/10.33477/mp.v14i2.13974>

## INTRODUCTION

Derivatives are one of the fundamental concepts in mathematics and constitute a core foundation of calculus. They are used to analyze how a function changes with respect to its variables (Rodríguez-Nieto & Font, 2025; Thompson & Harel, 2021). The applications of derivatives are extensive across disciplines. In physics, derivatives are used to calculate velocity and acceleration (Tatira, 2024; Thi et al., 2021). In economics, they are employed to determine points of maximum profit (Prasetio et al., 2024). In engineering, derivatives are used to examine rates of change in various systems (Talib et al., 2023). Within mathematics education, mastery of derivatives is particularly important because it serves as a prerequisite for understanding more advanced mathematical topics, such as integrals, differential equations, and advanced function analysis (Greefrath et al., 2023; Özgeldi & Aydın, 2021).

Despite their importance, derivatives are widely regarded as one of the most difficult topics for students to understand (Bedada & Machaba, 2022; Lumbantoruan, 2022). Students commonly experience difficulties in grasping the concept of limits, which forms the essential basis for learning derivatives (Mkhatshwa, 2024; Mutia et al., 2023), as well as in applying basic derivative rules



such as the chain rule (R. Siregar & Siregar, 2025). In addition, the abstract nature of derivatives often makes it difficult for students to visualize the relationship between a function and its derivative (Lestari et al., 2023; Rodríguez-Nieto & Moll, 2025). These difficulties become even more pronounced when students are required to apply derivative concepts to solve contextual problems, such as determining the maximum or minimum value of a function (Lestari et al., 2023).

These challenges were also identified in the present research context. Preliminary observations indicated that twelfth-grade students experienced considerable difficulty in understanding the fundamental concepts of derivatives. Based on interviews with the mathematics teacher, many students were found to be confused when determining the initial steps in solving derivative problems, particularly those involving the chain rule and implicit differentiation. The teacher also reported that most students struggled to visualize the relationship between a function and its derivative graph, largely due to the limited use of learning media. Classroom instruction relied predominantly on textbooks, which contributed to students' low conceptual understanding and learning outcomes (Hilal, 2024).

Interviews with students further revealed several reasons for their difficulties in learning derivatives. First, the topic requires a solid understanding of functions and limits. Second, the abstract nature of derivatives makes their applications difficult to comprehend. Third, the variety of procedures used to solve derivative problems often confuses students when selecting an appropriate approach. Fourth, the lack of instructional media capable of concretely visualizing the derivative process further intensifies these difficulties. As a consequence, these challenges negatively affect students' confidence in learning mathematics, particularly in derivative topics (Akbar et al., 2024).

Previous studies have shown that difficulties in understanding derivatives are a common phenomenon across educational levels (Litteck et al., 2025; Rochaminah et al., 2025). (Lumbantoruan, 2022) found that students frequently encounter obstacles in understanding both the definition of derivatives and their applications because conventional teaching approaches are often insufficient for explaining



abstract mathematical concepts. To address these challenges, many studies have emphasized the importance of technology-enhanced learning in mathematics (Drijvers & Sinclair, 2024; Yang et al., 2021; Yohannes & Chen, 2026). Several studies on the development of instructional media for derivatives, such as those conducted by (Drijvers & Sinclair, 2024) and (Lestari et al., 2024), produced Android-based applications to assist students in understanding derivative concepts. Other studies, such as (Sofyan & Pradipta, 2021), developed interactive multimedia using software such as Autoplay Media Studio 8. However, the present study employs GeoGebra-based interactive learning media to address these learning difficulties. GeoGebra offers strong pedagogical potential for derivative learning because it enables students to observe more directly how symbolic changes in functions relate to graphical behavior (Oktaviana et al., 2025).

GeoGebra, as a dynamic mathematics software, has been widely examined in mathematics education and has been shown to support students' learning through visualization, interaction, and multiple representations (Yohannes & Chen, 2023; Zhang et al., 2025). It is particularly valued in mathematics education because it enables dynamic connections among algebraic, graphical, and numerical representations. In the context of derivatives, (Nam, 2022) used GeoGebra in a teaching experiment with eleventh-grade students to design tasks on the derivative of a function at a point and found that numerical, graphical, and algebraic representations supported students' conceptual understanding and mathematical competence. Similarly, (Bedada & Machaba, 2022) reported that GeoGebra-based instruction improved students' understanding of derivative material through pretest–posttest activities. (Birgin & Yazici, 2021), also showed that GeoGebra can improve students' understanding of abstract mathematical concepts by providing interactive visualizations that facilitate comprehension. Taken together, these studies demonstrate the pedagogical potential of GeoGebra for derivative learning.

The development of GeoGebra-based learning media in mathematics has been widely carried out for topics such as geometry (Fitriani et al., 2020; Simbolon, 2020), algebra (Ziatdinov & Valles, 2022), and statistics (Ryandi & Dwi, 2022). In



addition, several studies have used GeoGebra-based media to support students' understanding of function graphs (Juandi et al., 2021; Pfeiffer et al., 2025) and integrals (Fahrnunisa & Dewi, 2024; Gökçe & Güner, 2022). Nevertheless, important gaps remain in the literature. First, existing GeoGebra-related studies on derivatives have mainly emphasized teaching experiments or training activities. Second, although many GeoGebra-based media products have been developed for other mathematical topics, there is still limited evidence of a product specifically designed for derivative learning in schools. Third, previous studies have not sufficiently focused on a media design that integrates derivative materials, interactive simulations, graphical visualizations, practice exercises, and solution displays within a single GeoGebra-based environment tailored to senior high school students. Fourth, limited attention has been given to evaluating such a product in terms of practicality and effectiveness, even though these are essential indicators of educational product quality.

This gap is significant because, in educational design research, the quality of a learning product should not be assessed solely in terms of conceptual relevance, but also in terms of its practicality and effectiveness in actual classroom use. (Nieveen, 1999) argues that educational products can be evaluated through three major quality criteria, namely validity, practicality, and effectiveness. In the context of the present study, practicality refers to the ease and feasibility of using the media in classroom instruction, whereas effectiveness refers to the extent to which the media supports student learning outcomes and classroom learning activities. Therefore, an interactive learning medium for derivatives needs to be examined not merely as a technological tool, but also as a pedagogical product whose classroom usability and instructional impact can be empirically demonstrated.

Based on these considerations, this study developed GeoDeriv, a GeoGebra-based interactive learning media for derivative concepts that integrates instructional content, interactive simulations, graphical visualizations, practice exercises, and solution displays within a single learning environment. Therefore, this study was guided by the following research questions:



RQ1: How practical is GeoDeriv as an interactive GeoGebra-based learning media for derivative concepts in senior high school mathematics learning?

RQ2: How effective is GeoDeriv in supporting students' learning outcomes and classroom activity during derivative learning?

## **METHOD**

This study was part of a research and development project employing the ADDIE model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. However, this article specifically reports only the evaluation stage of the developed product, namely the field testing of GeoDeriv, a GeoGebra-based interactive learning media for derivative concepts. The purpose of this stage was to examine the practicality and effectiveness of the media in actual classroom use. The earlier ADDIE stages are referred to only as the developmental background of the product and are not the focus of this article.

The field test was conducted at MA YMPI Rappang, where permission to conduct the study was obtained from the school prior to data collection. The participants were 31 twelfth-grade students who were involved in the classroom implementation of GeoDeriv. They were selected using intact-class total sampling, as all students in the class where the media was implemented participated in the evaluation stage. This sampling technique was considered appropriate because the purpose of the study was not to generalize the findings to a broader population, but to evaluate the practicality and effectiveness of the developed media in its actual instructional setting.

Three instruments were used in the evaluation stage: 1) a practicality questionnaire for students and the mathematics teacher, 2) a student learning outcomes test, and 3) a student activity observation sheet.

The practicality questionnaire was designed to assess five aspects of GeoDeriv, namely content, presentation, appearance, language, and practicality. The questionnaire used a four-point Likert scale consisting of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). In addition to selecting one of



the provided responses, respondents were also given space to provide comments and suggestions regarding the use of the media.

The student learning outcomes test consisted of 10 items covering the derivative concepts taught using GeoDeriv. The student learning outcome test was tested for validity, reliability, difficulty level, and item discrimination. The test results are presented in Table 1. The student activity observation sheet was completed by the mathematics teacher during the learning process and covered five indicators: student enthusiasm in learning, student interaction with the teacher, student cooperation, student activity during learning, and student participation. Each indicator was scored on a four-point scale ranging from 1 (not implemented) to 4 (well implemented).

**Table.1 Summary of Instrument Quality Testing**

Aspect	Result	Interpretation
Pilot-test participants	30 students	Instrument try-out sample
Number of items	10	All items analyzed
Validity coefficient	0.403 – 0.601	All items valid
Reliability	Cronbach’s Alpha = 0.647	Acceptable internal consistency
Item difficulty	9 moderate; 1 difficult	Item 1 is difficult
Discriminative power	2 good; 8 sufficient	All items retained

The data collected in this study were analyzed descriptively. The practicality analysis was measured through the percentage of scores from the teacher and student response questionnaires. The effectiveness analysis was based on the results of student learning tests and student activity observations. The practicality percentage was calculated using the formula in equation (1), while the criteria for the practicality of the e-module can be seen in Table 2. The practicality criteria for the e-module were adapted from (Riduwan, 2018).

$$\bar{x} = \frac{\sum x_n}{\text{Score Kriteria}} \times 100\%$$

Notes:

$\bar{x}$  = Average Percentage

$\sum x_n$  = Total score of All Aspects

Criterion score = Highest Score  $\times \Sigma$  Items  $\times \Sigma$  Students/teachers



**Table 2. Criteria for Practicality of GeoDeriv Media**

Percentage	Criteria
$81\% < \bar{x} \leq 100\%$	Very Practical
$61\% < \bar{x} \leq 80\%$	Practical
$41\% < \bar{x} \leq 60\%$	Moderately Practical
$21\% < \bar{x} \leq 40\%$	Less Practical
$0\% < \bar{x} \leq 20\%$	Not Practical

The effectiveness of GeoDeriv was evaluated using two indicators, namely students' learning outcomes and student learning activity during the implementation of the media. Students' learning outcomes were used as the primary indicator of effectiveness, while student learning activity was used as a supporting indicator to describe students' engagement in the learning process. This distinction was made because an effective learning medium should not only support students' achievement but also encourage active participation during classroom learning.

Students' learning outcomes were measured using a post-test administered after the use of GeoDeriv. Prior to hypothesis testing, the normality of the post-test scores was examined. If the data were normally distributed, a one-sample t-test was used. However, because the post-test scores did not meet the normality assumption, the One-Sample Wilcoxon Signed-Rank Test was applied to compare students' post-test scores with the Minimum Mastery Criterion of 75. The value of 75 was used as the benchmark because it represents the minimum mastery standard for mathematics at the research site. The statistical hypotheses were formulated as follows:

- $H_0$  : The median test score of the students = 75. This indicates that the use of the media has no effect on the test results
- $H_1$  : The median test score of the students  $\neq$  75. This indicates that the use of the media leads to a significant change in the test results.

In addition to learning outcomes, student learning activity was analyzed to provide complementary evidence of the effectiveness of GeoDeriv in classroom implementation. The activity observation focused on students' enthusiasm,



interaction with the teacher, cooperation, active involvement in learning, and participation during the use of the media. The results of student activity observations were analyzed descriptively using percentage scores and interpreted based on the criteria presented in Table 3. The student activity assessment criteria were adapted from (Riduwan, 2018).

**Table 3. Criteria for Assessing Student Activity**

Percentage	Description
$x \geq 85\%$	Very Good
$70\% \leq x < 85\%$	Good
$50\% \leq x < 70\%$	Fair
$x < 50\%$	Very Poor

## RESULT AND DISCUSSION

This study resulted in the development of interactive learning media utilizing GeoGebra software, designed for teaching derivatives to 12th-grade students at MA YMPI Rappang. The developed media is known as GeoDeriv (GeoGebra Derivative). GeoDeriv is an innovative learning tool designed to help students understand the concept of derivatives in mathematics through a visual, interactive, and modern technological approach, using GeoGebra as the primary tool. This media aims to make learning derivatives easier to understand, engaging, and accessible anytime and anywhere. GeoDeriv consists of three main features: the material dashboard (Dasbor), interactive simulations, and graphical visualizations (Graphic). The development of this media followed the ADDIE development model procedure (Branch, 2009; Spatioti et al., 2022). However, this article focuses only on the evaluation phase, specifically field testing. This field test was conducted to assess the practicality and effectiveness of the GeoDeriv media for teaching derivatives.

To enhance the clarity of the developed product, GeoDeriv is visually presented in the following figures. These visual displays are included to provide readers with a clearer understanding of the structure and interface of the media, particularly its main page, dashboard, interactive worksheet feature, and graphical visualization menu. As an interactive GeoGebra-based learning media, GeoDeriv



was designed not only to deliver derivative materials but also to facilitate students' conceptual understanding through dynamic exploration and visual representation



Figure 1. Main Page of GeoDeriv

Caption: The main page of GeoDeriv, displaying the initial interface and the entry point to the media.

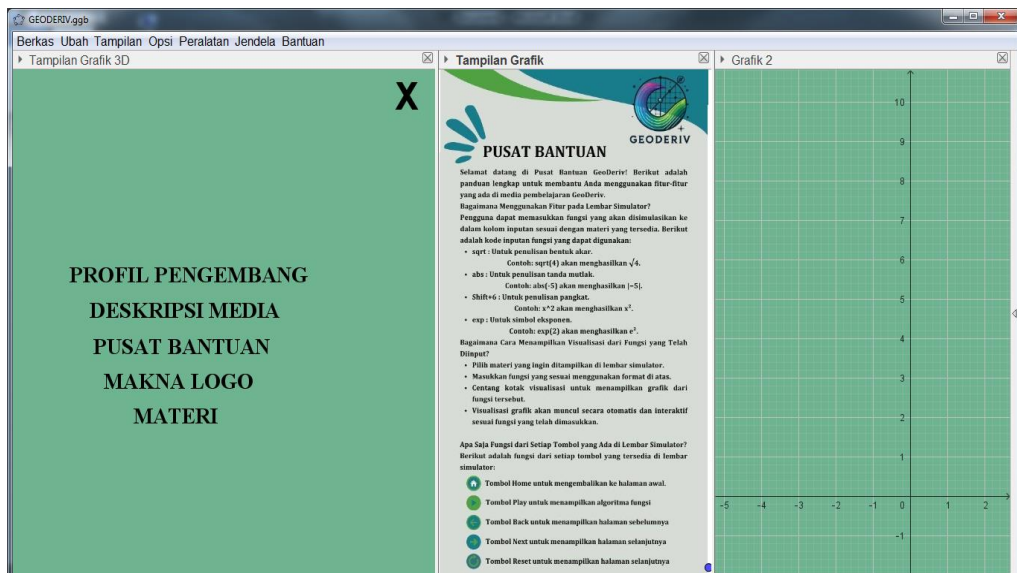
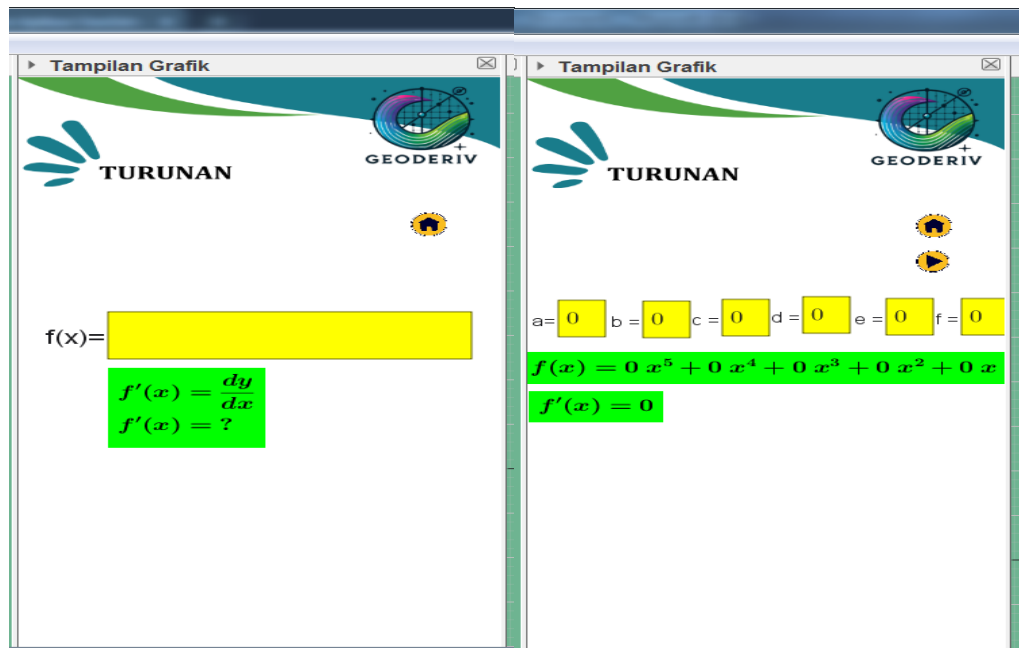


Figure 2. Desktop Dashboard Display

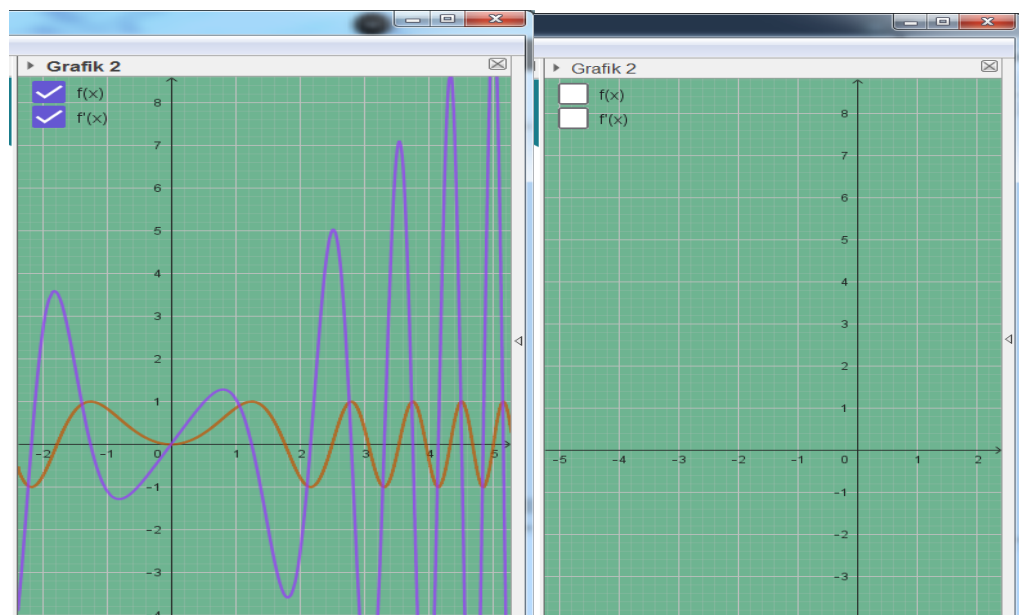
Caption: The dashboard of GeoDeriv, presenting the main navigation structure for accessing learning materials and media features.





**Figure 3. Worksheet Menu Display (Interactive Simulation)**

Caption: The worksheet menu of GeoDeriv, providing interactive simulation features to support students' active exploration of derivative concepts.



**Figure 4. Graphic Menu Display**

Caption: The graphic menu of GeoDeriv, showing the visualization feature used to illustrate the relationship between a function and its derivative.



The practicality of GeoDeriv media was assessed based on the results of the teacher and student response questionnaires. A total of 31 12<sup>th</sup> grade students participated in filling out this questionnaire, along with 1 mathematics teacher. The results of the student response questionnaire are presented in Table 4, while the results of the teacher response questionnaire are presented in Table 5.

**Table 4 Student Practicality Assessment**

Aspect	Score	Criteria
Content	696	Very Practical
Presentation	459	
Appearance	458	
Language	357	
Practicality	361	
Total Score	2331	
Maximum Score	2480	
Average (%)	94.00%	

The results in Table 4 show that the score obtained from 31 students in the 2331, with a practicality percentage of 94.00%, which falls under the "Very Practical" criterion.

**Table 5 Teacher Practicality Assessment**

Aspect	Score	Criteria
Content	22	Very Practical
Presentation	15	
Appearance	16	
Language	11	
Practicality	11	
Total Score	75	
Maximum Score	80	
Average (%)	93.75%	

The results in Table 5 show that the score obtained from one teacher was 75, with a practicality percentage of 93.75%, which falls under the "Very Practical" criterion.

The effectiveness of GeoDeriv was assessed based on student learning outcome tests and student activity observations. Data analysis of the student learning tests was conducted using IBM SPSS Statistics 25. The results of the normality test showed that the student test scores were not normally distributed, so



the non-parametric One-Sample Wilcoxon Signed-Rank Test was used to test for significant differences between the students' test scores and the Minimum Passing Criteria (KKM), which is 75.

The testing criteria were set as follows:

- If  $p < 0.05$ , then  $H_0$  is rejected, and  $H_1$  is accepted, indicating that the media significantly affects the test results.
- If  $p \geq 0.05$ , then  $H_1$  is rejected, and  $H_0$  is accepted, indicating that the media does not significantly affect the test results.

**Table 6. One-Sample Wilcoxon Signed-Rank Test**

Null Hypothesis	Test	Sig.	Decision
The median test score is equal to 75.	One-Sample Wilcoxon Signed-Rank Test	0.000	Reject the null hypothesis

*Asymptotic significances are displayed. The significance level is 0,05*

The results of the One-Sample Wilcoxon test (Table 6) showed that the p-value = 0.000 ( $< 0.05$ ), thus  $H_0$  is rejected, and  $H_1$  is accepted. This indicates that there is a significant difference between the students' test scores after using GeoDeriv and the established Minimum Passing Criteria (KKM), suggesting that GeoDeriv media is effective in enhancing students' mathematics learning.

To provide a more comprehensive account of student achievement, descriptive statistics of the post-test scores are presented in Table 7. The analysis indicates that the students obtained a mean score of 83.23, with a median of 80.00 and a mode of 90. A standard deviation of 8.713 suggests a moderate distribution of scores, indicating that the variation in student performance remained within a reasonable range. The scores ranged from 60 to 100, yielding a score range of 40 and a total score of 2580. Overall, these findings suggest that students' achievement after using GeoDeriv tended to exceed the school's Minimum Mastery Criterion (KKM), thereby indicating a positive tendency in learning outcomes following the implementation of the media.



**Table 7. Descriptive Statistics of Student Test Scores**

N	Mean	Median	Mode	Std. Deviation	Variance	Range	Minimum	Maximum	Sum
31	83.23	80.00	90	8.713	75.914	40	60	100	2580

These descriptive statistics further substantiate the Wilcoxon test result by showing that, although a small proportion of students still scored below the benchmark, the overall score distribution remained above the Minimum Mastery Criterion (KKM)

Student activity assessments were conducted by the subject teacher during the students' use of the media. The results of the student activity assessment are presented in the following Table 8.

**Table 8. Student Activity Evaluation**

Aspect	Score	Criteria
Student Enthusiasm in Learning	8	Very Good
Student Interaction with Teacher	7	
Student Cooperation	7	
Student Activity in Learning	7	
Student Participation	7	
Total Score	36	
Maximum Score	40	
Average (%)	90,00%	

The results in Table 8 show that the score obtained was 36, with a student activity percentage of 90.00%, which falls under the "Very Good" criterion. This indicates that the student activity in the class using the GeoDeriv media was very successful.

The findings of this study indicate that GeoDeriv was perceived as highly practical and showed positive evidence of effectiveness in supporting students' learning of derivative concepts. The student practicality score of 94.00% and the teacher practicality score of 93.75% suggest that the media was acceptable, usable, and feasible to implement in an authentic classroom setting. In educational design research, practicality refers to the extent to which a learning product can be used easily and meaningfully by its intended



users. From this perspective, the high practicality score obtained in this study indicates that GeoDeriv was not merely attractive as a digital tool but also manageable as a classroom learning medium.

The practicality of GeoDeriv can be explained by its integrated media design. GeoDeriv combines derivative materials, interactive simulations, graphical visualizations, practice exercises, and solution displays within a single GeoGebra-based learning environment. This design differs from learning situations in which students have to use separate resources for explanation, visualization, and practice. By integrating these components, GeoDeriv may reduce operational complexity and help students focus on understanding derivative concepts. This finding is relevant to the argument of (Nieveen, 1999) who emphasized that educational products should be evaluated not only based on their design quality but also on their practicality and effectiveness in real learning contexts.

The high practicality score in this study is also consistent with previous GeoGebra-based media studies, although several contextual differences should be considered. (T. Siregar, 2025) reported a very high practicality score in GeoGebra-supported learning trajectories for algebraic function derivatives, while (Omarisa et al., 2025) found that a GeoGebra-integrated teaching module was practical for supporting students' mathematical learning. The similarity between these studies and the present study suggests that GeoGebra-based learning media tend to be positively received when they are organized clearly and aligned with students' learning needs. However, the practicality score in this study may differ from previous findings because GeoDeriv was implemented in a specific classroom context where students were previously more familiar with textbook-based learning than with dynamic mathematical software. Thus, the high practicality of GeoDeriv may be related not only to the GeoGebra platform itself but also to the novelty and relevance of the media in addressing students' difficulties in learning derivatives.

The effectiveness findings also require interpretation beyond statistical significance. The One-Sample Wilcoxon Signed-Rank Test showed that students' post-test scores differed significantly from the Minimum Mastery Criterion of 75. The



descriptive statistics further showed that the mean score was 83.23, the median was 80.00, and the mode was 90. These results indicate that students' achievement after using GeoDeriv generally exceeded the required mastery standard. However, the minimum score of 60 shows that not all students achieved the same level of understanding. Therefore, GeoDeriv should be interpreted as providing positive classroom-level support for derivative learning, rather than as completely eliminating all students' difficulties in understanding derivatives.

The positive effectiveness of GeoDeriv is in line with previous studies showing that GeoGebra can support students' mathematical understanding. (Nam, 2022) found that GeoGebra helped students understand derivatives by connecting numerical, graphical, and algebraic representations. Similarly, (Bedada & Machaba, 2022) reported that GeoGebra-based instruction improved students' understanding of derivative material. (Lumbantobing, 2020) also found that students who learned derivatives using GeoGebra interactive media achieved better learning outcomes than those who learned without GeoGebra support. The similarity between these studies and the present findings may be explained by the representational strength of GeoGebra. Derivative concepts are abstract because students must coordinate symbolic procedures, graphical behavior, and conceptual meaning. GeoDeriv supports this coordination by allowing students to observe the relationship between a function and its derivative through dynamic visualization.

The role of multiple representations is central to understanding why GeoDeriv supported students' learning outcomes. In derivative learning, students often do not struggle only with calculation procedures, but also with interpreting what the derivative means graphically and conceptually. (García & Flores, 2021) emphasized that students need to build mathematical connections when interpreting graphs of derivative and antiderivative functions. Similarly, (Kunwar & Laxmi, 2023) argued that derivative learning requires strategies that help students conceptualize derivatives and their applications. GeoDeriv responds to this need by providing students with symbolic expressions, graphical representations, interactive simulations, and solution displays in



one environment. Through this structure, students can move from procedural calculation to conceptual interpretation.

GeoDeriv also strengthens students' visual reasoning. Visual reasoning is important in calculus learning because the concept of derivative involves changes, slopes, and graphical behavior that are difficult to understand through static explanation alone. When students interact with GeoDeriv, they can observe how changes in a function are related to changes in its derivative graph. This dynamic interaction may help students construct mental images of derivative concepts and reduce the abstractness of calculus learning. Therefore, the effectiveness of GeoDeriv can be understood not only from the post-test results but also from the way the media supports students in connecting visual, symbolic, and conceptual representations.

The student activity score of 90.00% further supports this interpretation. High student activity indicates that GeoDeriv encouraged students to participate actively during the learning process. This result is relevant to previous findings that technology-enhanced mathematics learning can increase student engagement when the media provides opportunities for exploration and interaction. (Matsha, 2025) showed that GeoGebra-assisted media could support students' conceptual understanding, while (Rangkuti et al., 2023) reported that GeoGebra-based media helped improve students' understanding of mathematical concepts. In the present study, students' high activity may be explained by the design of GeoDeriv, which allows students to interact directly with visual representations, complete practice exercises, and examine solution displays. Thus, student activity was not only a behavioral outcome but also an indication that the media encouraged active conceptual engagement.

The findings of this study also show that the effectiveness of GeoDeriv may be influenced by contextual factors. The students involved in this study had previously experienced difficulties in understanding derivative concepts, particularly in connecting formulas with graphical meaning. In such a context, GeoDeriv became relevant because it provided visual and interactive support that was not sufficiently available in textbook-based instruction. This may explain why the findings are similar to previous GeoGebra studies, although the media design and classroom context were different. The similarity



lies in GeoGebra's ability to support visualization, while the specific contribution of GeoDeriv lies in its integrated derivative-specific design.

From a theoretical perspective, this study contributes to mathematics education by positioning GeoDeriv as an integrated representational environment for derivative learning. Previous studies have often emphasized GeoGebra as a visualization tool or supplementary instructional medium. In contrast, GeoDeriv demonstrates that GeoGebra can be developed into a structured learning environment that integrates content, simulation, visualization, practice, and solution support. This contributes to the theory of multiple representations in mathematics learning, especially in calculus, by showing how symbolic, graphical, and conceptual representations can be coordinated through interactive media. Therefore, the contribution of this study is not limited to producing a practical learning product but also to showing how technology-based media can support conceptual understanding and visual reasoning in derivative learning.

Nevertheless, the findings should be interpreted within several methodological limitations. First, this study was conducted in one school with a limited number of participants, so the findings cannot be generalized broadly without further studies. Second, the effectiveness analysis was based on comparison with the Minimum Mastery Criterion rather than comparison with a control group. Therefore, the findings provide classroom-level evidence of effectiveness but do not yet prove that GeoDeriv is superior to other instructional approaches. Third, the student activity data were obtained from one observer, so future studies should involve multiple observers to strengthen the reliability of classroom activity assessment. Future research should compare GeoDeriv with conventional instruction or other digital media, investigate its effect on students' long-term retention and conceptual understanding, and extend its use to other calculus topics such as limits, integrals, and optimization.

## CONCLUSION

This study evaluated the practicality and effectiveness of GeoDeriv, an integrated GeoGebra-based learning media for derivative concepts in senior high school mathematics learning. The findings showed that GeoDeriv was highly practical, with practicality scores of 94.00% from students and 93.75% from the



teacher. Its effectiveness was supported by the One-Sample Wilcoxon Signed-Rank Test, which indicated that students' post-test scores differed significantly from the Minimum Mastery Criterion, and by student learning activity, which reached 90.00% and was categorized as very good. These findings suggest that GeoDeriv can support derivative learning by helping students engage with symbolic, graphical, and conceptual representations through materials, simulations, visualizations, exercises, and solution displays within a single learning environment.

The findings provide practical implications for mathematics teachers and curriculum implementation. Teachers can use GeoDeriv in Grade XII derivative lessons to introduce concepts, guide students in exploring the relationship between functions and their derivatives, and support reflection or formative assessment through exercises and solution displays. GeoDeriv is also suitable for blended learning because students can access it outside the classroom for independent exploration, review, and practice. However, this study was limited to one school, involved a small number of participants, did not include a control group, and used classroom activity observation by one teacher. Future research should compare GeoDeriv with other instructional approaches, examine its long-term effect on retention and conceptual understanding, and extend its use to other calculus topics.

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