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Development of GeoGebra-Assisted Learning Media Using Contextual Learning to Enhance Mathematical Critical Thinking and Independent Learning

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Abstrak

Penelitian ini bertujuan untuk memperoleh media pembelajaran kontekstual berbantuan GeoGebra yang valid, praktis, dan efektif untuk meningkatkan kemampuan berpikir kritis matematis dan kemandirian belajar siswa kelas VIII. Mengkaji kemampuan berpikir kritis matematis siswa kelas VIII setelah menggunakan media pembelajaran kontekstual berbantuan GeoGebra. Menghitung kemandirian belajar siswa kelas VIII setelah menggunakan media pembelajaran kontekstual berbantuan GeoGebra. Penelitian pengembangan ADDIE digunakan. Hasil penelitian: Media pembelajaran kontekstual berbantuan GeoGebra yang valid, praktis, dan berhasil meningkatkan kemampuan berpikir kritis matematis dan kemandirian belajar siswa. Siswa yang belajarnya melalui LKPD kontekstual dan GeoGebra menunjukkan peningkatan nilai yang cukup dalam kemampuan berpikir kritis dan kemandirian matematis.

***Kata kunci**: Kemampuan Berpikir Kritis, Kemandirian Siswa, Pengembangan Media*

Abstract

This study aims to obtain valid, practical, and effective GeoGebra-assisted contextual learning media to improve mathematical critical thinking skills and learning independence of grade VIII students. Assess the mathematical critical thinking skills of grade VIII students after using GeoGebra-assisted contextual learning media. Calculate the learning independence of grade VIII students after using GeoGebra-assisted contextual learning media. ADDIE development research is used. Results of the study: Valid, practical, and successful GeoGebra-assisted contextual learning media improve students' mathematical critical thinking skills and learning independence. Students who learn through contextual LKPD and GeoGebra show a significant increase in their critical thinking skills and mathematical independence.

***Keywords**: Critical Thinking Skills, Student Independence, Media Development*

A. Introduction

Critical thinking solves issues by carefully collecting information and considering viewpoints to reach valid and responsible conclusions (Abdullah, 2018). In the age of industrial revolution 4.0, critical

thinking abilities are essential. (Mardliyah, 2019). Defines critical thinking as mental and intellectual talents that lead to inference, correlation, and analysis. (Florea, N.M., & Hurjui, 2017) define critical thinking as using compelling, logical, and reasonable arguments to verify, evaluate, and choose the proper response. According to (Abrami, P.C., Bernard, R.M., Borokhovski, E., Waddington, D.I., Wade, C.A., & Persson, 2015), critical thinking involves interpretation, analysis, evaluation, inference, and explanation.

Critical thinking requires thorough and logical decision-making (Idris, 2020). (Saadah, N., & Hakim, 2022) suggest that pupils require critical thinking abilities to relate new ideas to past learning. Critical thinking involves unbiased evaluation of one's own and others' views (Asy'ari, M., Prayogi, S., & Samsuri, 2016). Critical thinking helps grasp ideas, apply, synthesize, and evaluate information (Zubaidah, 2020). Critical thinking helps people make smart judgments (Susilowati, Sajidan, 2018) .So far, mathematics learning has focused on topic mastery rather than critical thinking. Observations and interviews with mathematics teachers at MTSS Madinatussalam Percut Sei Tuan show that assessment instruments, questions, and assignments focus on cognitive skills rather than critical thinking. Students struggle to solve issues that are different from the sample questions and get unexpected solutions. Students struggle because they don't grasp the question; therefore, their solutions are incorrect, and they don't know why. This is also shown by MTSS Madinatussalam Percut Sei Tuan observations on August 18, 2024. Five pupils were observed utilizing a mathematics critical thinking exam. Students had to verify and explain two comparable triangles.

The first student wrote the relevant information, defined the technique (solution stages), and provided the necessary reasoning to declare the outcomes accurately. As with the first student, the second student accurately stated the findings, solved the problem, and provided justifications. The third student provided insufficient outcomes, followed improper steps, and identified unexpected causes. The fourth and fifth children said that the responses were insufficient, the processes were improper, and the explanations were unexpected.

Only two of the five students correctly stated the findings, explained the technique, and presented problem-based reasoning. The researcher said the other three students had trouble describing findings, explaining procedures, and presenting arguments. Because these pupils just presented reasons and were less detailed about findings and solutions. This aligns with Facione's (2020) framework for interpreting, analyzing, assessing, and inferring. An interview with one of the class VIII MTSS Madinatussalam Percut Sei Tuan students about his problems solving the problem confirmed the observation that students don't know why they choose their strategy.

The lack of instructors who integrate mathematics into real-life situations contributes to pupils' poor mathematical critical thinking and independence, notably at MTSS Madinatussalam Percut Sei Tuan. Additionally, kids have never heard or experienced the queries. This can lead to a decrease in student enthusiasm and response to these inquiries. According to (Ruseffendi, 2012) learning independence is another affective factor in student math performance. According to (Umar, 2008), learners gain independence via will, choice, and responsibility. Additionally (Agustina, 2018) defines learning

independence as learning without outside assistance. Learning independence is being self-reliant, able to solve difficulties, and accountable for choices.

Independent learners are self-reliant, confident, and able to learn. (Fauzi, K.A., & Mukasyaf, 2018) agrees that autonomous learning is important since the curriculum requires students to solve more difficult issues in and out of the classroom and minimize their dependency on others. (Yamin, M. dan Ansari, 2008) says, "Independent students will be able to deal with or overcome problems and obstacles." From the concerns above, contextual learning may increase students' mathematical thinking and independence. Contextual learning promotes student engagement in finding and applying content to real-life circumstances (Muhartini, M., Mansur, A., & Bakar, 2023).

Students would quickly learn the topic by connecting their prior knowledge to its application in daily life (Haryanto, Putri Chandra, Arty, 2019). Students may handle life challenges with contextual learning (Syamsuddin, S., & Utami, 2021) .Contextual learning allows pupils to build knowledge from real-life circumstances. Contextual learning emphasizes deep connections, meaningful work, autonomous learning methodologies, cooperation, creative and critical thinking, student personal growth, high expectations, and genuine evaluation (Maryati, 2018) . (Gustia, D., Hanifah, Jenab dan Afrilianto, 2019) found that contextual learners exhibit self-efficacy attitudes like confidence in their success, problem-solving skills, risk-taking, understanding their strengths and weaknesses, not giving up, and social skills. Therefore, contextual learning helps improve pupils' critical mathematical thinking and learning independence. The reason for developing the learning module was because the previous learning module was conventional and referred to the teacher.

On August 18, 2024, the researcher interviewed a mathematics instructor at the school and found that the teaching modules, notably technology, were not optimum. The teacher's Figure 1 instructional modules corroborate this claim.

D. Sarana dan Prasarana
Media : • Buku tulis, alat tulis • LKPD • *Power point* Sumber Belajar : • Buku Paket Matematika Kelas VII dari Kemendibudristek
E. Target Peserta Didik
Peserta didik yang menjadi target adalah peserta didik regular.
F. Model Pembelajaran yang Digunakan
Model pembelajaran *Contextual Teaching Learning* (CTL)
G. Metode Pembelajaran
Ceramah, Diskusi, tanya jawab, penugasan

Figure 1. Teacher Teaching Module

The instructional modules do not include educational technology that enhances learning. The usage of less creative learning material makes learning dull and boring for pupils. A teacher's inability to build

and deploy technology-based instructional material creates a dull, uninteresting learning environment. During the industrial revolution 4.0, media assistance is crucial for learning. (Wibawanto, 2017) states that learning media makes learning activities more effective and efficient in a conducive environment, speeding up student comprehension. To develop 21st-century learning abilities, we need technology (Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, 2017). Technology makes learning more engaging, participatory, and meaningful for kids. GeoGebra supports dynamic and interactive math instruction. (Pakpahan, R., & Fitriani, 2020) recommend GeoGebra for junior high school mathematics because it helps pupils grasp abstract arithmetic ideas. Students' learning styles might vary from passive to active.

A GeoGebra-based learning medium may promote students' critical thinking. GeoGebra solves math, algebra, statistics, and geometry. (Mahmudi, 2018) asserts that GeoGebra can serve as a tool for teaching geometry, visualizing geometric concepts, and developing geometric ideas. To enhance critical thinking and numerical problem-solving independence among children. GeoGebra can represent geometric objects and communicate geometric issues, making ideas simpler to grasp. GeoGebra may be utilized for teacher practice in the classroom. Previous research by Purwanti, (Purwanti, R. D., Pratiwi, D. D., & Rinaldi, 2017) found that GeoGebra-assisted learning improved students' mathematical concept knowledge.

According to (Suryawan, I. P. P., & Permana, 2020), excellent GeoGebra-based online learning media may increase students' mathematical concept comprehension. This research found that media experts gave learning media a 4.2 rating, which is quite valid, while material experts gave it a 4.5 rating. According to (Anggraeni, E.R., Ma'rufi, 2021), GeoGebra-based mathematics learning media improved students' conceptual comprehension and satisfied validity, practicality, and effectiveness requirements. Media and material specialists scored 3.53 and 3.47 in the high category with a valid category.

The questionnaire on media usage implementation found 89% of learning media that could be applied in the high category, indicating that the media was practical. The content mastery exam showed that 81.81% of pupils satisfied learning completeness, 71.47% had appropriate conceptual knowledge, and 94.27% met effective requirements.

B. Research Method

Research and development are used in this study. Research and development is used to create a product and verify its validity, practicality, and efficacy before usage. This study proposes redeveloping an existing product. (Sugiyono, 2018) The ADDIE development paradigm will be used in this study. The Analyze, Design, Develop, Implement, and Evaluate (ADDIE) paradigm creates GeoGebra learning tools for linear equations and important research tools through five steps: analysis, design, development, implementation, and assessment. As for the selection of Geogebra, to help students in the learning process and image animation to improve learning. This study was done at MTSS Madinatussalam Percut Sei Tuan, Deli Serdang Regency, for class VIII students in the 2024/2025 even semester. This research examines

contextual mathematics learning media supplemented by GeoGebra on linear equations to promote students' critical thinking and learning independence. The stages of the ADDIE development model that researchers will use are as follows:

Analysis

At this stage, researchers will analyze the need for the development of learning media and the feasibility and requirements for development.

Design

After the product to be developed is known, the product design is carried out. In this study, the product to be designed and developed is the geogebra learning media which is expected to be able to improve students' critical mathematical thinking skills which contain learning objectives, materials and examples of questions, and practice questions.

Development

After the product design in the form of learning media is complete, the product is tested for its feasibility by the validators. The feasibility test will be carried out to see whether the product that has been developed is feasible for use in learning. The expert validators who test the feasibility of the product are material experts who aim to measure the feasibility of the content and objectives, learning strategies, and media design.

Implementation

After the product is said to be feasible by the validator, the product is applied on a limited basis to the school that has been selected as the research site. This researcher conducts learning with the help of learning media that has been developed and also observations that can be used as material for improving learning media. After the learning process is complete, students must take the mathematical critical thinking ability test that has been provided. The questions must be arranged based on indicators of mathematical critical thinking skills to see the level of effectiveness of the use of the developed learning media.

Evalution

In this final stage, the researcher makes a final revision to the developed media based on input obtained from the response questionnaire and observation results. This aims to ensure that the developed media is truly in accordance with the objectives to be achieved and can be disseminated (Mulyatiningsih, 2012).

C. Result and Discussion

This research design was carried out through 5 main stages, namely: analysis stage (analysis), design (design), development (development), implementation (implementation) and evaluation (evaluation) as described as follows:

Analysis

According to initial observations on the availability of learning media at MTSS Madinatussalam Percut Sei Tuan Deli Serdang, the lack of mathematics learning media in the classroom, especially for linear equations, indirectly affects students' low critical thinking skills and learning independence. Students have trouble learning linear equations since hand drawings on the board don't assist them in envisioning the learning material. Teachers have struggled to design engaging linear equation instructional tools. Teachers only teach arithmetic using basic media.

The discussion above shows numerous primary challenges in the learning process connected to material availability in mathematics. This affects kids' poor critical thinking and learning freedom. We must create a legitimate, practical, and successful mathematics learning medium to address this challenge. MTSS Madinatussalam Percut Sei Tuan Deli Serdang pupils' critical thinking and learning independence should improve after utilizing the produced learning material. Overall, the analysis produced in the research can be seen in Figure 2.

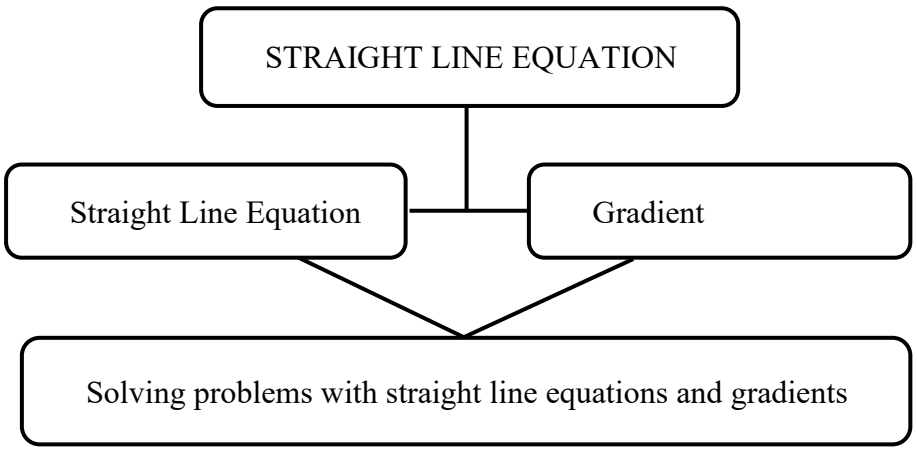

Figure 2 .Concept Analysis Results for Straight Line Equation Material

Design

This step designs learning material to create a prototype for the straight line equation. This level involves creating student workbooks, instructional modules, critical thinking exams, and learning freedom. The flowchart of the media design that was developed can be seen as follows:

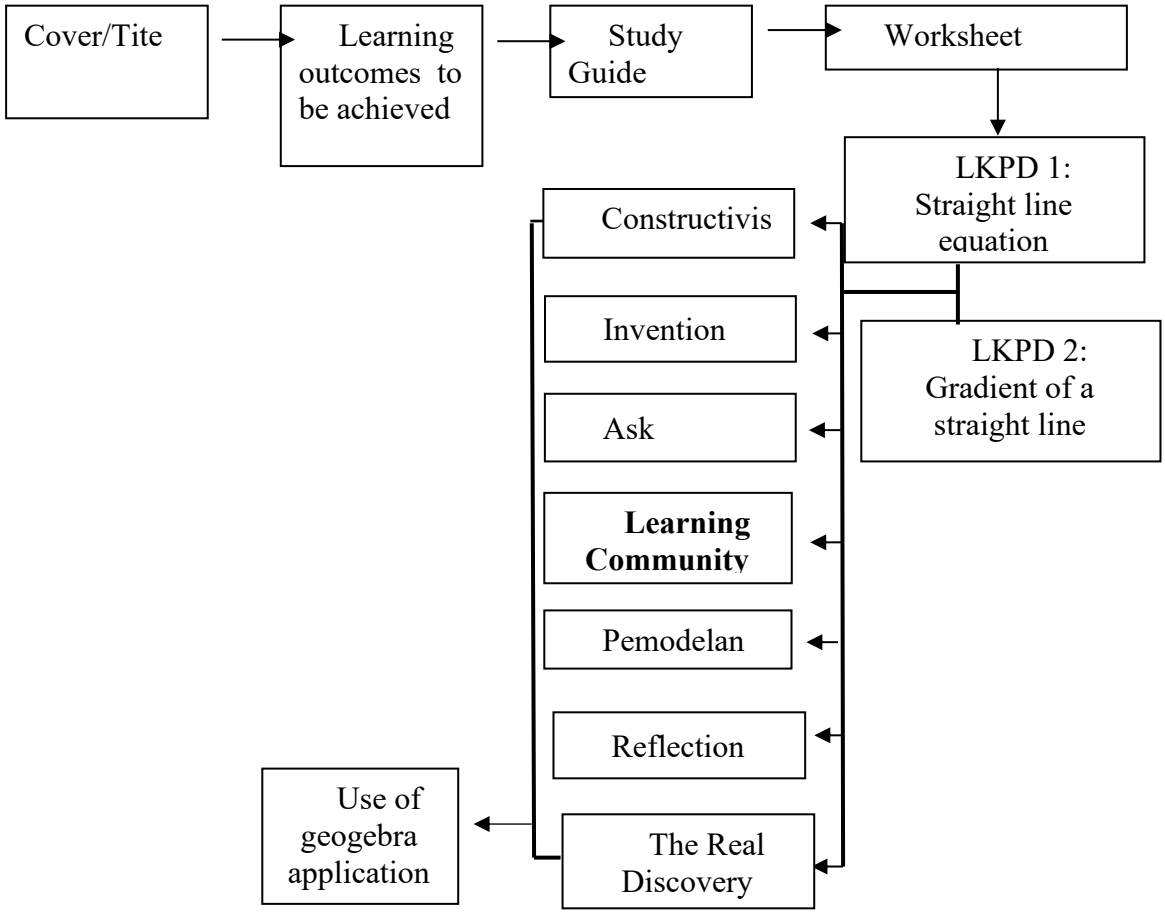

Figure 3 .Developed media design

Development

Initial observations at MTSS Madinatussalam Percut Sei Tuan Deli Serdang show that the lack of mathematics learning media in the classroom, especially for linear equations, indirectly affects students' critical thinking skills and learning independence. Students have trouble learning linear equations since hand drawings on the board don't assist them in envisioning the learning material. Teachers have struggled to create engaging instructional tools for teaching linear equations. Teachers only teach arithmetic using basic media. The discussion above shows numerous primary challenges in the learning process connected to material availability in mathematics. This contributes to kids' poor critical thinking skills and limits their learning freedom. We must create a legitimate, practical, and successful mathematics learning medium to address this challenge. MTSS Madinatussalam Percut Sei Tuan Deli Serdang pupils' critical thinking and learning independence should improve after utilizing the produced learning material.

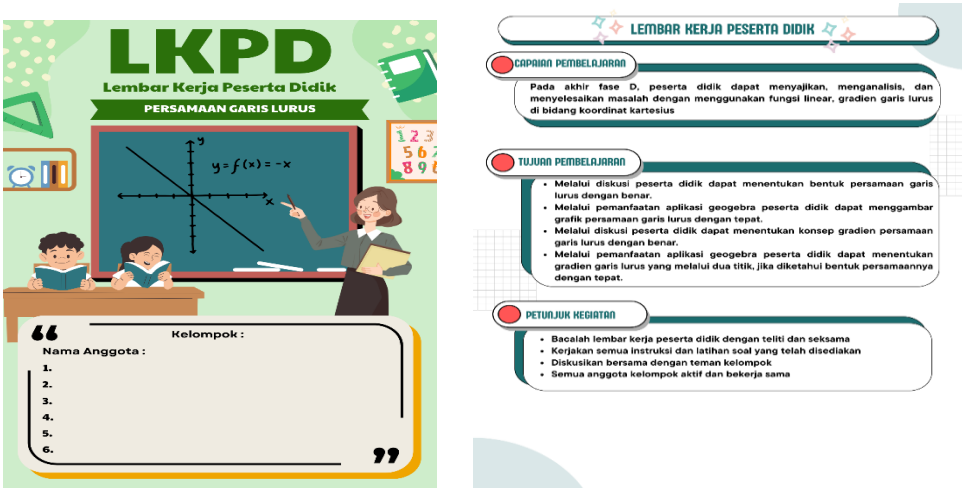

Figure 4. Student Worksheet Display

The research development phases show the validity, practicality, and effectiveness test outcomes. Research instrument data analysis findings.

Table 1. Validation Results

No	Aspect	Average	Category
1	Teaching Module	4,8	Valid
2	Student Worksheets	4,8	Valid
3	Mathematical Critical Thinking Ability Test	4,5	Valid
4	Learning Independence	4,5	Valid

Table 1 indicates a 4.5 "valid" average for the learning device. This research used descriptive statistics. Sheskin (2004) recommends descriptive statistics for data analysis without judgments or predictions. Descriptive statistics uses tables, graphs, diagrams, and computations in data centres and spreads.

Implementation

Results of Analysis of Mathematical Critical Thinking Ability Test

The level of mastery of mathematical critical thinking skills in the implementation results can be seen in table 2 below.

Table 2 Mastery of Mathematical Critical Thinking Skills Test

No	Value Interval	*Pretest*		*Posttest*		Category
		Number Students	Percentage	Number Students	Percentage	
1	90 ≤ KBKM ≤ 100	0	0%	Very High	37,50%	Very High

2	80 ≤ KBKM < 90	16	50%	High	56,25%	High
3	70 ≤ KBKM < 80	4	12,50%	Fair	0%	Fair
4	60 ≤ KBKM < 70	6	18,75%	Low	6,25%	Low
5	0 ≤ KBKM < 60	6	18,75%	Very Low	0%	Very Low

In the pretest of 32 students, no students had very high mathematics critical thinking abilities (0%), 16 students (50%) had excellent mastery, 4 students (12.50%) had adequate competence, 6 students (18.75%) had poor mastery, and 6 (18.75%) had very low mastery. After learning using contextual-based LKPD media supplemented by GeoGebra, 12 students (37.50%) had very high mastery, 18 (56.25%) had high mastery, 0 (3.13%) had adequate mastery, 2 (6.25%) had poor mastery, and none (0%) had low mastery in the posttest.

Analysis of Student Learning Independence Results

In the pretest of 32 students, no students had very high mathematics critical thinking abilities (0%), 16 students (50%) had excellent mastery, 4 students (12.50%) had adequate competence, 6 students (18.75%) had poor mastery, and 6 (18.75%) had very low mastery. After learning using contextual-based LKPD media supplemented by GeoGebra, 12 students (37.50%) had very high mastery, 18 (56.25%) had high mastery, 0 (3.13%) had adequate mastery, 2 (6.25%) had poor mastery, and none (0%) had low mastery in the posttest.

Table 3. Results of Student Learning Independence Questionnaire

No	Interval	Category	*Pretest*		*Posttest*	
			Number Students	Percentage	Number Students	Percentage
1	76-100	Very Good	4	12,50%	13	40,63%
2	51-75	Good	18	56,25%	18	56,25%
3	26-50	Quite Good	10	31,25%	1	3,13%
4	0-25	Not Good	0	0%	0	0%
Total			32	18,75%	32	100%

Table 3 shows that before treatment, 4 students (12.50%) were very good, 18 were good, 10 were fairly good, and 0 were less good. After therapy, 13 kids (40.63%), 18 students (56.25%), 1 student (3.13%), and 0 students (0%), were very good, good, pretty good, or less good.

Analysis of the Improvement of Mathematical Critical Thinking Skills

The N-Gain formula from the implementation test pretest and posttest findings shows the effectiveness test improvement in mathematical critical thinking. Table 4.shows N-Gain findings on mathematical critical thinking:

Table 4. Summary of KBKM N-Gain Results

N-Gain	Interpretation	Number of Students
$g > 0,7$	High	6
$0,3 < g \leq 0,7$	Medium	15
$g \leq 0,3$	Low	11

Table 4 shows 6 large increases, 15 moderate increases, and 11 low increases. At the analysis stage, the teacher said that on average, class VIII-2 MTSS Madinatussalam Percut Sei Tuan students have a visual learning style, but there are several students with different learning styles and different initial ability levels in mastering new material. The average N-gain score is 0.42 out of 32 pupils, indicating a modest rise.

Analysis of Increasing Students' Learning Independence

The N-Gain formula from the pretest and posttest in the implementation test shows students' learning independence increasing in the effectiveness test. Table 5 shows N-Gain findings on students' learning independence:

Table 5.N-Gain Results of Student Learning Independence

N-Gain	Interpretation	Number of Students
$g > 0,7$	High	2
$0,3 < g \leq 0,7$	Medium	20
$g \leq 0,3$	Low	10

Table 5 reveals that 2 pupils have increased their learning independence, 20 have moderated it, and 10 have decreased it. Because students have varying beginning skill levels toward learning independence and some are used to working together on activities and courses, 10 low-level students increased their learning freedom. The average N-gain score is 0.32 out of 32 pupils, indicating a modest rise. So contextual-based LKPD media with GeoGebra may promote student learning independence.

Evalution

This assessment level evaluates learning-process LKPD media quality. Researchers assess learning progress and suggest media and learning enhancements in this period. All stages of analysis, design, development, and implementation are evaluated. Several assessments are done during implementation to ensure the medium is legitimate, practical, and successful. In implementation, time restrictions in the learning process are typically an issue. This occurred during the first meeting in this research because students were puzzled about student-centred

contextual learning. Most pupils didn't know the GeoGebra software; thus, several had trouble using it. Students may study and apply GeoGebra by extending discussion group references. In this study, using class VIII-2 MTSS Madinatussalam Percut Sei Tuan with 32 students, the researcher needed help from several teachers to ensure proper learning, such as covering pretest and posttest tests to prevent damage.

DISCUSSION

Learning media specialists validated context-based LKPD media helped by GeoGebra with a validity rating of 4.82 or above, indicating that the media satisfied validity markers. Contextual learning media may assess students' critical thinking and learning independence. This study's media validity is greater than (Nababan, 2020) 4.2 media validity threshold for geogebra-based learning media using the ADDIE model on 33 grade XI students of SMA Negeri 3 Medan. According to (Siswono, 2018), Instagram-based mathematics learning media for the SMP circle has a media validity rating of 3.40. According to (Fitriyani, Y., Supriantna, N., & Sari, 2021), mathematics learning media may increase learning outcomes and student involvement, with a media validity of 4.24.

This study's score for how well learning was carried out is better than (Nababan, 2020) score of 3.38 for creating geogebra-based learning media using the ADDIE model with 33 grade XI students at SMA Negeri 3 Medan. The implementation observation score of 89% by (Anggraeni, E.R., Ma'rufi, 2021), on geogebra-based mathematics learning media to increase students' conceptual understanding is higher.

This study has a student response score of 80%, lower than (Rangkuti, 2023) research on geogebra-assisted mathematics learning media to increase students' mathematical concept comprehension. However, it is higher than study on GeoGebra-based learning media using the ADDIE model on 33 grade XI students of SMA Negeri 3 Medan with an 89% student response score. According to the implementation test on grade VIII-2 students, contextual-based LKPD assisted by GeoGebra is effective because 30 (93.75%) of 32 students who used the developed media were classically successful with a very high or high value category. This study outperformed (Suryawan, I. P. P., & Permana, 2020), in the development of geogebra-based online learning media to improve mathematical concept understanding with a completion score of 93.33%;, in the development of geogebra-assisted mathematics learning media with a score of 80%; and research.

D. Conclusion

Based on the results of the research and discussion in this study, the following conclusions can be concluded: The validity of contextual-based geogebra-assisted learning media in improving students' critical mathematical thinking skills and independent learning is included in the valid, practical and effective categories. The increase in students' critical mathematical thinking skills and independent learning who were given treatment using contextual-based

LKPD media assisted by geogebra has increased. The suggestion of this study is that the contextual-based LKPD media assisted by geogebra developed in this study only focuses on the material of straight line equations with sub-materials of straight line equations and straight line gradients, so it is recommended to expand to other sub-materials such as straight line equations and straight line gradients to expand the coverage of LKPD material as a whole according to the needs and conditions of students. And in order to be able to develop contextual-based LKPD media assisted by geogebra with different materials in order to create references for use in the learning process in schools.

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