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Exploring and analyzing mathematics learning activities through a constructivist approach: A case study

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Abstract: This study aims to explore and analyze the application of a constructivist approach in mathematics learning at SMA Negeri 1 Lalolae. The research employed a descriptive qualitative method with data triangulation through classroom observations, teacher interviews, and student questionnaires. The findings indicate that constructivist elements have been partially implemented, as reflected in classroom discussions, opportunities for students to express arguments, and activities that encourage independent problem solving. Students showed positive responses in terms of increased motivation and learning engagement, although some students remained passive and experienced difficulties in constructing concepts independently. In conclusion, the implementation of a constructivist approach in mathematics learning at SMA Negeri 1 Lalolae has not yet been optimal and requires support in the form of improved learning facilities and teacher training to enhance its effectiveness and sustainability.
Keywords: constructivist; mathematics learning; student involvement

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INTRODUCTION

The constructivist approach in mathematics learning emphasizes that knowledge is not given directly by the teacher, but is actively built by students through learning experiences and interactions with their environment (Luthfiyani et al., 2025). The constructivist approach is used as a foundation for understanding how students relate new knowledge to previously owned concepts, so that learning becomes more meaningful (Julia et al., 2024). The teacher acts as a facilitator who guides students to discover, construct, and reflect on mathematical concepts through discussion activities, problem solving, and collaborative work (Yuliawati, 2025).

Mathematics learning encourages students logical, analytical, and systematic thinking skills (Jannah et al., 2024). However, in reality, mathematics learning in Indonesia faces significant challenges, especially in teaching approaches that are still dominated by teachers (Kurnianto et al., 2025). This often results in students only being able to memorize formulas without understanding basic concepts, which in turn triggers low interest and motivation to learn (Permatasari, 2021). In addition, mathematics is often considered difficult and abstract so that students have difficulty in relating concepts to real experiences (Baharuddin, 2020).

These conditions require a change in the view of learning from conventional to a more student-centered approach (Magdalena et al., 2020). One approach that is relevant and proven effective is the constructivist approach (Elissanriani et al., 2020). In the context of mathematics

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learning, constructivist encourages students to find patterns, construct concepts, and solve problems by linking them to prior knowledge and the surrounding environment (Yuliawati, 2025). This approach is also seen as being able to increase students activeness, motivation, and critical thinking skills in understanding mathematical concepts more deeply (Azzahra et al., 2025).

Several previous studies have shown that the constructivist approach is effective in improving the quality of learning. For example, research by Pramana et al. (2024) shows that the integration of constructivist learning theory with guided inquiry models is relevant and effective in supporting the improvement of the quality of the educational process. Meanwhile Elissanriani et al. (2020) in their research found that the constructivist learning model effectively improves mathematical problem solving skills. As for Romadhona et al. (2023) found that the effectiveness of constructivist, where active teacher-student interaction encourages students to develop knowledge independently. Dhani et al. (2022) also found that the constructivist approach is considered effective and useful in improving the quality of learning in the classroom. Not only does it support the development of modules and Learner Worksheets, but it is also proven to be able to improve students concept understanding, learning outcomes, and mathematical communication skills in various mathematics learning contexts. Similar findings were also found Arafah et al. (2023) which shows that constructivist plays an important role in shifting the orientation of learning from teacher-centered to student-centered. In the context of mathematics learning, students are encouraged to build knowledge through direct experience, so that knowledge is more meaningful, difficult to forget, and easy to recall.

The constructivist approach will be used to explore and analyze in depth the entire mathematics learning process at SMA Negeri 1 Lalolae, East Kolaka Regency. The focus of the research includes the design, implementation, and perceptions of various related parties, which have not been widely researched contextually. In addition to filling the research gap at SMA Negeri 1 Lalolae, this study also makes a theoretical contribution by examining the relevance of applying the constructivist approach in the context of rural schools that face limited facilities and learning culture challenges.

Based on this, this study aims to conduct in-depth exploration and analysis of mathematics learning activities at SMA Negeri 1 Lalolae, especially in class XII. This research provides a picture of the reality of teachers practices in teaching and students experiences, identifying the extent to which the principles of constructivist are applied in learning. The results of this study are expected to make theoretical and practical contributions to curriculum development and teacher training.

METHODS

This study employed a descriptive qualitative method to provide an in-depth description of the learning process, teacher–student interactions, and students learning experiences in constructing mathematical knowledge. The research was conducted from June 9 to August 29, 2025 at SMA Negeri 1 Lalolae, East Kolaka Regency, Southeast Sulawesi Province, involving a mathematics teacher and 54 twelfth-grade students selected through purposive sampling. The instruments used included observation sheets, teacher interview guides, and student questionnaires.

Data analysis was carried out in three stages: data reduction, data presentation, and conclusion drawing. Data reduction involved selecting and focusing information from observations, interviews, and questionnaires according to the research objectives. The reduced data were then presented in tables and descriptive narratives to identify patterns and trends. The final

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stage, drawing conclusions, was completed by considering the alignment between the findings and the theoretical framework underlying the study.

RESULTS AND DISCUSSION

Observation Results

Based on the results of observations carried out at SMA Negeri 1 Lalolae, information was obtained about the teacher's teaching activities in the classroom, student activities in the learning reception process, teacher and student interactions in the learning process, and classroom environmental conditions. The data obtained through the observation instrument provides a real picture of how the mathematics learning process takes place in the classroom and the extent to which the principles of constructivist have been applied.

Table 1. Learning Process Observation Results

No.	Aspects Observed	Observation Result
1.	Teacher Activity	The teacher has played an active role as a facilitator in learning. The teacher facilitates discussion and collaboration among students and provides opportunities for them to build their own understanding although still accompanied by direction. The teacher also links mathematical concepts with students prior knowledge and opens questions that provoke critical thinking. In learning activities, teachers use simple media such as printed books and blackboards to support students knowledge construction. In addition, the teacher responds well to students questions and ideas and encourages them to explore further. Teachers also provide opportunities for students to correct each other and give feedback in the learning process.
2.	Student Activity	Students play an active role in solving problems independently and in groups. They show good participation in learning, for example by asking questions, completing practice problems, and expressing understanding both orally and in writing. In addition, students also try to overcome learning difficulties independently or through the help of friends. This shows that students are sufficiently involved as active learners in the learning process.
3.	Teacher-Student Interaction	Teacher-student interaction is effective through two-way communication. Teachers give constructive feedback to students' answers, thus creating a more interactive learning atmosphere and supporting students active involvement.
4.	Classroom Environment	The classroom environment is quite supportive of the learning process, although the seating arrangements are not yet fully geared towards collaboration. Learning resources that students can access are still limited to printed books, while the utilization of technology is not yet optimal. Nevertheless, the classroom atmosphere remains conducive because students pay attention to learning well and actively answer questions when given the opportunity.

Based on the observation, the teacher has played an active role as a facilitator by facilitating discussions, encouraging collaboration, asking open questions, and linking the material with students prior knowledge. The teacher also provided space for students to correct and provide feedback, although the use of learning media was still limited to printed books and whiteboards. Students activities seem quite active through involvement in problem solving, group discussions, asking questions, and conveying understanding both orally and in writing, although some still need teacher direction. Teacher-student interaction is two-way with cons-

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tructive feedback, creating an interactive learning atmosphere. The classroom environment is generally conducive, students pay attention to learning well, but limited learning resources and minimal utilization of digital media make variations in learning strategies not optimal.

The application of the constructivist approach in SMA Negeri 1 Lalolae is seen through various teacher and student activities in learning. The teacher acts as a facilitator who provides opportunities for students to build knowledge, collaborate, and express ideas. This pattern is in accordance with the principle of student-centered learning which is the basis of constructivist (Azzahra et al., 2025). Students active activities in asking questions, solving problems, and conveying understanding show that they are constructing knowledge through meaningful learning experiences.

This finding is consistent with research Romadhona et al. (2023) which states that the stages of constructivist ranging from apperception, exploration, discussion, to application can improve students ability to build knowledge independently. Research Dhani et al. (2022) also confirms that constructivist is effective in improving learning outcomes and can be applied in the development of innovative learning media such as modules and student worksheet.

The limited learning facilities at SMA Negeri 1 Lalolae are a factor inhibiting the optimization of constructivist. Teachers still rely on conventional media in the form of printed books and blackboards, so learning is not fully varied. These results are in line with the findings of Arafah et al. (2023) which emphasize that the effectiveness of constructivist is influenced by the teacher's ability to facilitate exploration through diverse learning media.

The results showed that the application of constructivist approach at SMA Negeri 1 Lalolae began to be seen in the process of learning mathematics, especially through student involvement in discussions, problem solving, and opportunities to express ideas independently. This application is not yet fully optimal due to limited facilities, lack of utilization of digital media, and teachers skills in developing innovative strategies that support constructivist still need to be improved.

Teacher Interview Results

Based on the results of interviews with mathematics teachers at SMA Negeri 1 Lalolae, information was obtained about the understanding, strategies, and obstacles faced in the learning process. The results of this interview are an important basis for assessing the extent to which the constructivist approach has been recognized and started to be applied in learning activities at the school (see Table 2).

The results of interviews with mathematics teachers at SMA Negeri 1 Lalolae show that the role of the teacher as a facilitator has begun to be implemented in learning. Learning activities begin with a brief apperception combined with ice breaking to create a more conducive classroom atmosphere, then continued with the delivery of the core material through the blackboard. These efforts show attention to students learning readiness. Concept understanding is strengthened by giving contextual problems, although the dominant strategy still leads to traditional formula-based methods so that students independence in constructing knowledge has not developed optimally. Teachers also provide opportunities for students to try to solve problems before explanations are given, although most still depend on direction. Group discussions are occasionally held with limited time, but students are still given space to convey arguments and re-explain concepts in their own language. This reflects the initial application of the principle of constructivist through active participation and two-way communication in the learning process (Lathifah et al., 2024).

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Table 2. Results of Interview with Mathematics Teacher

No.	Aspects interviewed	Interview Result
1.	How do you usually start the lesson?	The teacher usually starts the lesson by giving a brief apperception, accompanied by light ice breaking to break the ice, then writes the main material on the blackboard.
2.	What do you do so that students do not just memorize formulas, but really understand the concepts?	The teacher explains the concept with examples of contextual problems, although most students are still directed directly to the formula.
3.	Do you often ask students to find out for themselves or try to solve problems before you explain?	The teacher occasionally provides opportunities, but students still tend to wait for the teacher's explanation first.
4.	How do you encourage students to discuss or cooperate with their friends when learning math?	Group discussions are sometimes conducted, but are limited due to the short allocation of learning time.
5.	When students have different ideas or answers, how do you let them argue or correct them immediately?	Teachers usually give space for students to argue and compare answers before giving explanations.
6.	Do you often ask students to re-explain concepts in their own language or present how they solved the problem?	The teacher often asks students to re-explain their work in front of the class or in their own language.
7.	How do you plan math learning activities to be more active?	Planning is done by preparing materials and practice problems from textbooks and internet sources, but when in class more use the blackboard.
8.	What learning resources or media do you use in class?	The main source is the textbook, while the internet is used for preparation. Digital learning media is still very rarely used.
9.	How do you relate math material to everyday life or students experiences in the surrounding environment?	Teachers relate the material to simple examples, such as buying and selling calculations or students daily activities at home. However, this linking is still simple and does not deeply connect mathematical concepts with the cultural context or students surrounding environment.
10.	What are the biggest challenges you face in teaching mathematics at SMA Negeri 1 Lalolae? And how do you overcome them?	The main challenges are limited facilities and students learning motivation. To overcome this, teachers provide additional explanations, insert simple games related to the material, and motivate students to be more enthusiastic.
11.	Have you ever participated in training or discussions about more innovative teaching methods?	Teachers have never participated in special training related to innovative methods.
12.	Have you ever heard of constructivist approach/learning?	Teachers do not know clearly what constructivist approach is.

Learning planning is carried out by utilizing package books as the main source and additional material from various references. Implementation in the classroom is still limited to the use of the blackboard due to limited digital media. Mathematical materials are connected to everyday life through contextual examples, such as buying and selling calculations and students daily activities. Challenges faced by teachers include the lack of supporting facilities and students low motivation to learn. Efforts made include providing additional explanations, motivating students, and inserting simple games to attract attention. This finding is in line with

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research showing that limited facilities require teachers to apply a variety of learning strategies to keep students actively involved (Yanuari et al., 2025). Teachers also said that they had never attended training related to innovative learning methods and did not fully understand the constructivist approach. This condition emphasizes the importance of support in the form of professional development and continuous training so that the application of constructivist can be more effective in the classroom (Miramadhani et al., 2024).

Overall, the interview results indicate that although teachers learning practices at SMA Negeri 1 Lalolae still tend to be traditional, there are indications of the application of constructivist principles, especially in providing space for discussion, opportunities for argument, and student involvement in re-explaining concepts. However, this implementation has not been maximized due to limited learning media, passive learning habits of students, and lack of training for teachers. This reinforces the finding that the success of the constructivist approach is not only determined by the teacher's strategy, but also influenced by the support of facilities and continuous development of teacher competence (Meilina, 2025).

Results of Student Questionnaire Analysis

Based on the results of the questionnaire of students of class XII SMA Negeri 1 Lalolae, a description of the mathematics learning experience, active involvement, benefits and difficulties, as well as the context and expectations of students in constructivist-based learning was obtained.

Mathematics Learning Experience

Table 3. Results of Student Questionnaire (Mathematics Learning Experience)

No.	Statement	1 (STS)	2 (TS)	3 (N)	4 (S)	5 (SS)
1.	I like math lessons.	5,56%	3,70%	55,56%	27,78%	7,41%
2.	I find math lessons difficult.	1,85%	7,41%	55,56%	29,63%	5,56%
3.	I feel that the math material taught is relevant to everyday life.	3,70%	12,96%	38,89%	38,89%	5,56%
4.	I feel motivated to learn math.	1,85%	11,11%	35,19%	31,48%	20,37%

The aspect of mathematics learning experience shows that students have a positive attitude. The results of the questionnaire showed that 55.56% of students stated that they were neutral and 35.19% agreed to strongly agreed that they liked math, although there were still 35.19% of students who thought that this subject was relatively difficult. A total of 44.45% of students considered the mathematics material relevant to their daily lives, while 51.85% stated that they were motivated to learn. This finding indicates that learning that is linked to real contexts can encourage increased student interest and motivation, in line with research that confirms that constructivist-based learning emphasizes the relevance of material to students direct experience to increase active participation and involvement in the learning process (Azzahra et al., 2025).

Active Engagement in Learning

The questionnaire results show that the elements of constructivist have begun to be applied in mathematics learning, although not yet fully optimized. A total of 46.30% of students stated neutrally and another 46.29% agreed to strongly agreed that they were often asked to solve problems independently, which shows the teacher's effort in providing space for exploration. Group discussions received a positive response with 68.52% of students agreeing to strongly agreeing, and the opportunity to express different ideas was also appreciated by 61.11% of students. However, students' courage to ask questions is still low, with 55.56% choosing neutral,

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and the ability to explain concepts in their own language has not been developed optimally. This condition indicates that the application of constructivist is starting to be seen in learning activities, but it is still limited to certain aspects. A more systematic strategy is needed so that the active involvement of students is truly realized according to the principles of constructivist. This is in line with research Pramana et al. (2024) which shows that the integration of constructivist with the guided inquiry model can provide a balance between student independence in learning and teacher support needed so that active participation can be realized more optimally.

Table 4. Student Questionnaire Results (Active Engagement in Learning)

No.	Statement	1 (STS)	2 (TS)	3 (N)	4 (S)	5 (SS)
1.	The teacher often asks me to try to solve problems by myself.	3,70%	3,70%	46,30%	33,33%	12,96%
2.	The teacher encouraged me to discuss with my friends in class.	0%	11,11%	20,37%	55,56%	12,96%
3.	The teacher allows me to come up with ideas or answers that are different from others.	0%	3,70%	35,19%	29,63%	31,48%
4.	I dare to ask questions or express my opinion in class.	5,56%	9,26%	55,56%	14,81%	14,81%
5.	I am often asked by the teacher to re-explain concepts in my own language.	1,85%	7,41%	50%	18,52%	22,22%

Benefits and Difficulties

The results of the questionnaire on the benefits and difficulties aspects showed that discussion activities played an important role in facilitating understanding of the material, where 64.82% of students stated that the discussion helped them understand the concepts better. In addition, 75.93% of students felt more confident after successfully solving the problems given. As many as 38.89% of students considered their critical thinking skills to have improved, although there were still 53.70% who were neutral about this. Difficulties also arose when students were asked to find answers independently without initial direction, with 64.81% of respondents choosing a neutral answer. This finding confirms that although the constructivist approach is starting to be seen in learning, students still need support through scaffolding strategies in order to be able to build knowledge gradually. This is in line with studies that emphasize the role of teachers as facilitators and scaffolders in supporting students actual and potential development in the context of learning (Sayfullooh et al., 2023).

Table 5. Student Questionnaire Results (Benefits and Difficulties)

No.	Statement	1 (STS)	2 (TS)	3 (N)	4 (S)	5 (SS)
1.	Learning methods that involve discussion make it easier for me to understand the material.	1,85%	3,70%	29,63%	38,89%	25,93%
2.	I find it difficult when asked to find my own answers.	1,85%	9,26%	64,81%	11,11%	12,96%
3.	I feel more confident after successfully solving the problem.	0%	1,85%	22,22%	38,89%	37,04%
4.	I feel that my critical thinking skills have improved with this way of learning.	1,85%	5,56%	53,70%	20,37%	18,52%

Context and Expectations

In the context and expectation aspect, the limited school facilities are considered to have affected the learning process, although most students did not give a firm assessment. A total

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of 50% of students chose neutral answers, 22.22% agreed to strongly agreed that the limited facilities were an obstacle. This condition shows that the limitations of facilities do exist, but are not fully considered as a dominant factor by the majority of students. Regarding teachers efforts in dealing with limitations, 57.41% of students gave a neutral response, indicating that teachers creativity has not been fully realized in learning. Students expectations are quite clear, where 66.67% want math learning to be more interesting and 48.15% want more time for practical activities or projects. Meanwhile, the linking of materials with local culture is still weak, as evidenced by the 48% of students who gave neutral answers, although the use of daily life examples is more appreciated with 59.26% of students agreeing to strongly agree. These results emphasize the need for more varied and contextualized learning innovations. This finding is consistent with the results of research showing that the application of ethnomathematics-based mathematics learning, which links concepts with local culture and students daily experiences, is able to increase their engagement, understanding, and learning motivation (Prastica et al., 2025).

Table 6. Student Questionnaire Results (Context and Expectations)

No.	Statement	1 (STS)	2 (TS)	3 (N)	4 (S)	5 (SS)
1.	Limited facilities at school (e.g. books or digital media) prevent me from learning.	9,26%	18,52%	50%	12,96%	9,26%
2.	The teacher manages to work around the limited facilities with creative methods.	0%	5,56%	57,41%	27,78%	9,26%
3.	I hope that learning math can be more fun and interesting.	5,56%	3,70%	24,07%	35,19%	31,48%
4.	I wish teachers could spend more time on practical or project activities.	0%	7,41%	44,44%	31,48%	16,67%
5.	The teacher relates the material to local culture	7,41%	14,81%	48,15%	24,07%	5,56%
6.	The teacher gives examples using daily life	5,56%	3,70%	31,48%	35,19%	24,07%

Overall, the questionnaire results show that the constructivist approach is starting to be seen in mathematics learning at SMA Negeri 1 Lalolae, although its application is not yet fully optimal. Teachers have provided space for discussion, opportunities for argument, and encouraged students to solve problems independently. The impact can be seen in the increase of students motivation, involvement, and confidence. However, the aspect of students' courage in asking questions, the variety of learning strategies, and the availability of supporting facilities are still obstacles that limit the effectiveness of constructivist implementation. Thus, the results of this study strengthen the research of Sukroyanti et al. (2024) which states that constructivist is effective in improving learning outcomes, but its implementation is strongly influenced by facility support, teacher strategies, and student learning culture.

CONCLUSION

This study shows that the application of constructivist approach in learning mathematics at SMA Negeri 1 Lalolae has begun to be applied, although it is not fully optimal. Teacher and student activities indicate the presence of constructivist elements, such as providing opportunities for discussion, independent problem solving, and space to express opinions and arguments. The results of observations, interviews and questionnaires show that students begin to be actively involved in the learning process, feel more confident, and show increased motivation to learn when learning is linked to real experiences.

The main obstacles faced are limited learning facilities, students lack of courage in expressing their opinions, and teachers' limited skills in implementing innovative strategies. Teachers

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have also not received special training related to the constructivist approach so that their understanding and implementation have not been maximized.

This research confirms that the implementation of constructivist requires stronger support, both in terms of learning facilities and teacher competency development. Recommendations include the provision of more varied learning facilities, the use of digital media, and teacher training programs to deepen understanding of the constructivist approach. With adequate support, the application of constructivist in mathematics learning at SMA Negeri 1 Lalolae has the potential to have a more significant impact on student motivation, engagement and learning outcomes.

This study was limited to one school with teachers and 12th grade students as subjects, so the results cannot yet represent a broader context, and the findings were greatly influenced by the learning conditions and limited facilities available during the study. In addition, this study has not explored the use of digital media and more diverse learning models. For further research, it is recommended to involve more schools, explore in greater depth the application of constructivist through media and innovative learning strategies, and analyze the supporting and inhibiting factors of constructivist application in order to obtain a more comprehensive and in-depth picture.

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