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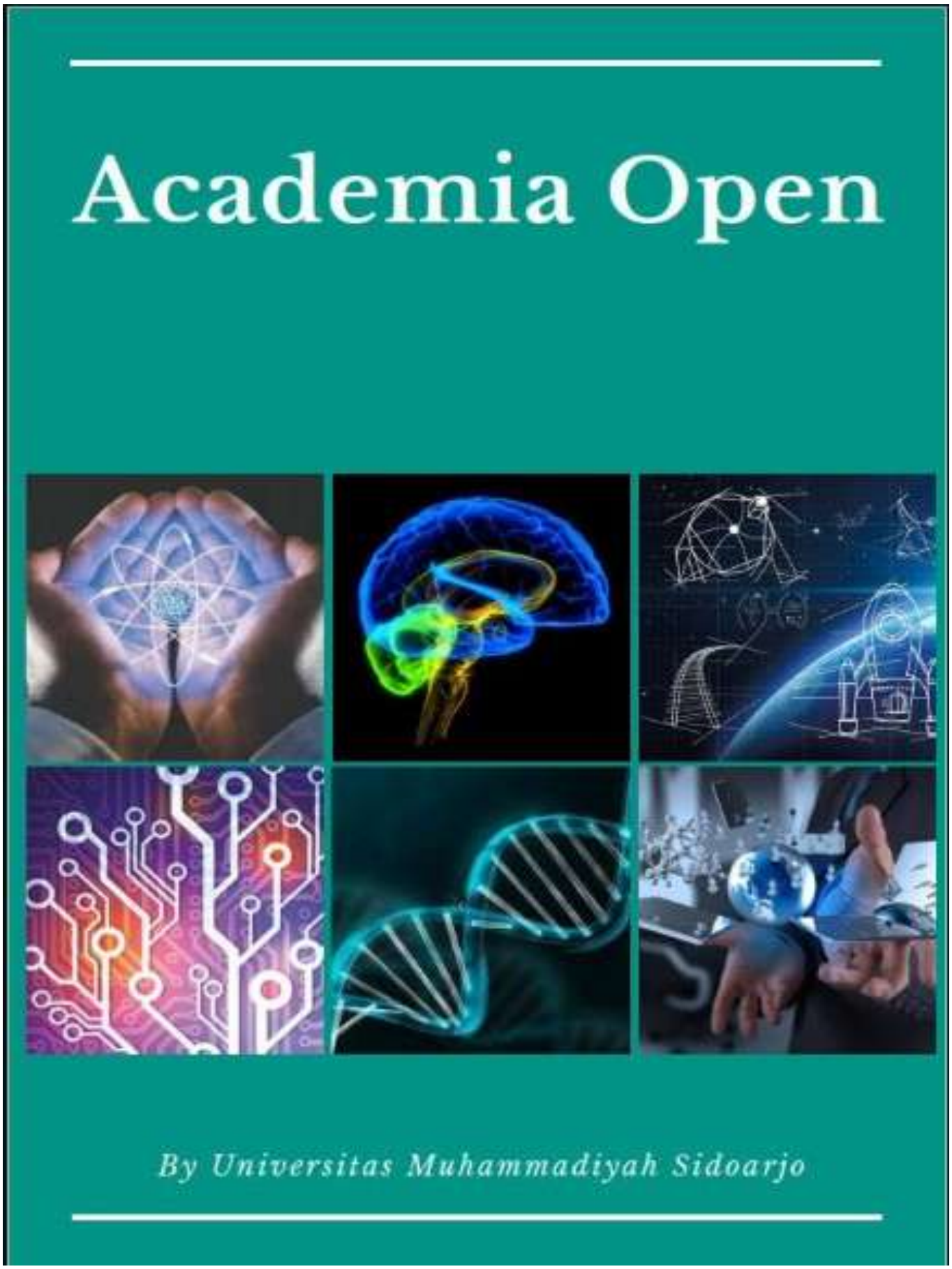

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Universal Design For Learning In Enhancing Independent Mathematics Instruction Among Inclusive Students: Desain Universal Untuk Pembelajaran Dalam Meningkatkan Instruksi Matematika Mandiri Di Antara Siswa Inklusif

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Abstract

General Background Equipping diverse learner populations with critical reasoning skills necessitates transitioning from rigid, traditional pedagogy toward flexible, inclusive instructional frameworks. **Specific Background** At SMP Negeri 1 Kombeng, conventional teacher-centered methods limit instructional autonomy, resulting in exceptionally poor academic achievement and dependent behaviors among regular pupils and a student with cognitive learning difficulties. **Knowledge Gap** Although current global literature confirms the broad benefits of multimodal instruction, empirical classroom action research explicitly examining how differentiated options foster autonomous reasoning and self-regulation in rural Indonesian junior high mathematics settings remains sparse. **Aims** This study investigates how implementing multimodal representations and differentiated choice boards transforms instructionalautonomy and problem-solving achievement in a heterogeneousmathematicsclassroom.**Results**Followingatwo-cycleintervention,observationaland quantitative data indicated that overall learning autonomy escalated from a 24.8% baseline to 80.26%. Concurrently, class-wide mathematics achievement progressed from 55.1 to 81.2, achieving a 100% classical mastery rate. The student requiring special education exhibited marked academic progression, elevating their individual assessment score from 30 to 72. **Novelty** This research provides direct empirical evidence on how combining differentiated choice boards with multimodal geometric representations specifically resolves self-regulation deficits and cognitive dependency in marginalized learner demographics. **Implications** Educational institutions mustsystematicallyadopt customizable instructional frameworks and provide comprehensive professional training, ensuring that all pupils develop the self-regulation necessary for sustained, independent academic achievement.

Highlights

- Differentiated choice boards substantially elevate student self-regulation and instructional autonomy.
- Multimodal geometric representations mitigate cognitive dependency among pupils with learning difficulties.
- Flexible pedagogical frameworks secure 100% academic mastery within heterogeneous rural classrooms.

Keywords

Universal Design For Learning; Inclusive Education; Learning Independence; Mathematics

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Achievement; Classroom Action Research

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INTRODUCTION

Inclusive education is one of the major agendas in pursuit of quality and equitable education globally. The fourth goal of the Sustainable Development Goals (SDGs) is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. UNESCO also points out that inclusive education must remove obstacles that prevent learners from participating fully in education, irrespective of their physical, cognitive, social, emotional or cultural background. Inclusive education is not just about putting students with special needs in regular classrooms; it is about creating learning environments that are flexible, accessible and responsive to learner diversity. However, recent global reports show that although there has been great progress in educational access, many students with disabilities still face inequalities in classroom participation due to rigid curricula, limited instructional flexibility, and insufficient teacher preparedness, especially in developing countries.

In Indonesia, the implementation of inclusive education has been strengthened by Law Number 8 of 2016 concerning Persons with Disabilities and Minister of National Education Regulation Number 70 of 2009 concerning Inclusive Education, which guarantees equal educational opportunities for students with disabilities in general schools. However, the successful implementation of inclusive education means not only policy support but teachers' ability to design learning experiences that meet diverse student characteristics. Previous research has shown that many inclusive classrooms still rely on teacher-centered instruction, standardized learning materials, and uniform assessment methods that limit meaningful participation for students with special needs . This means that instructional practices are often not structured to provide equal learning opportunities, especially in areas that require higher-order thinking and abstract reasoning such as mathematics.

Mathematics remains one of the most challenging subjects for students with special needs because it involves conceptual understanding, logical reasoning, problem-solving skills, and abstract thinking. Students with intellectual disabilities or cognitive learning difficulties often have problems with understanding mathematical symbols, understanding abstract concepts and applying mathematical reasoning on their own. These challenges are exacerbated where teachers place much emphasis on traditional teaching methods such as lectures and textbook exercises at the expense of the individual learning styles and mental attributes of their students. Preliminary observations in Class IX.C SMP Negeri 1 Kombeng also showed similar conditions. The student with special needs showed low learning independence. The student was heavily dependent on teacher's assistance, limited initiative in completing mathematical tasks, and low confidence in participating in classroom activities. The results indicate that mathematics teaching has not yet fully accommodated the diversity of learners and thus limits students' possibilities to develop independent learning behaviors.

A central aim of inclusive mathematics education is to foster learning independence, so that students can control, oversee and assess their own learning processes. Barry J. Zimmerman says that learning independence is closely related to self-regulated learning, which is a process of active planning, implementation, monitoring, and reflection on the learner's strategies to achieve academic goals. Students with a high level of learning independence tend to show higher motivation, higher perseverance in problem solving, and better academic achievement. Students with a low learning independence tend, on the contrary, to over-rely on external help and to have difficulties in the transfer of knowledge to new situations. Therefore, it is of particular importance to foster learning independence in students with special needs as it promotes not only academic achievement but also confidence, autonomy and life-long learning skills.

Universal Design for Learning (UDL) is one of the instructional frameworks that has attracted a lot of attention in facilitating inclusive learning. UDL is a research-based framework developed by CAST that proactively designs instruction to meet learner variability rather than providing accommodations after barriers to learning are identified. UDL is based on three related principles: multiple means of engagement, which increases learner motivation and participation; multiple means of representation, which provides a variety of ways of presenting information; and multiple means of action and expression, which allows students to demonstrate their understanding in a variety of ways. The most recent update to the UDL Guidelines emphasizes the importance of designing curriculum with instructional flexibility so that all learners, regardless of ability, can participate in meaningful educational experiences (CAST, 2024). As a result, UDL has increasingly been recognized as one of the most comprehensive instructional frameworks for implementing inclusive education in a variety of educational contexts.

Empirical research has demonstrated UDL's effectiveness to improve educational outcomes repeatedly. Flexibility in instructional strategies can lead to improvements in academic performance and accessibility for students with disabilities, as illustrated by a systematic review by Rao, Ok, and Bryant (2014) that considered the use of UDL. Also, Ok et al. (2017) found that the consistent application of UDL principles significantly enhances student engagement, participation and learning achievement in Pre-K to Grade 12 classrooms. Basham and Marino (2013) also reported that the use of UDL in STEM education improves conceptual understanding with multiple representations and technology-enhanced instructions. In addition, Katz (2012) stressed that students' self-efficacy, engagement and independent learning behaviors improve when they are offered the choice of how they learn and how they demonstrate what they know. In the Indonesian context, Murtadho, Sunaryo, and Ragil (2021) found that curriculum adaptation based on UDL helped increase student participation and gradually helped develop students' learning independence in inclusive schools with students with special needs. In sum, these studies reveal the great benefits of UDL for inclusive education. However, most studies have concentrated on curriculum accessibility, academic success, or teacher implementation rather than on directly exploring students' learning independence in mathematics classrooms.

Past research has consistently supported the effectiveness of Universal Design for Learning, but several important gaps in research persist. First, there remains limited empirical evidence investigating the implementation of UDL in Indonesian

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junior high school mathematics classrooms. Secondly, previous studies have mainly focused on academic achievement, student engagement, or teacher perceptions, while the development of learning independence of students with special needs has been much less targeted. Third, little is known about how UDL is being implemented in inclusive public schools in rural or geographically remote areas where the educational resources and instructional support are quite different from urban areas. So, this study aims to examine the implementation of Universal Design for Learning in mathematics learning to improve the independent learning of students with special needs in Class IX.C of SMP Negeri 1 Kombeng. The results are expected to contribute to the growing body of knowledge on inclusive mathematics education as well as provide practical guidance for teachers to develop flexible, equitable and learner-centered instructional practices that are suitable for a variety of classroom contexts.

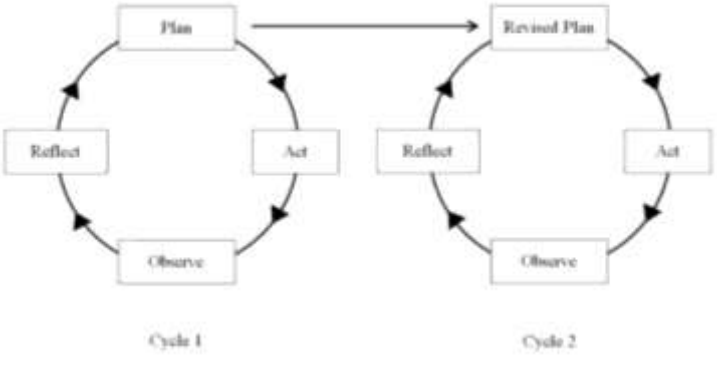
METHOD

This study used descriptive qualitative method with Classroom Action Research (CAR) as the research design. The qualitative approach was selected because it provides a more profound understanding of the process of the implementation of Universal Design for Learning (UDL) in the mathematics instruction and the changes of the students' independence of learning with special needs during the learning process. Qualitative research is designed to understand phenomena holistically experienced by research participants through systematic descriptions of phenomena in their natural settings (Moleong, 2017). The selection of Classroom Action Research is because it is a reflective process carried out by teachers to improve the quality of teaching and learning through a sequence of planned actions in iterative cycles (Arikunto et al., 2015). The Classroom Action Research (CAR) model used in this study was developed by Kemmis and McTaggart, which comprises four interconnected stages, namely planning, acting, observing, and reflecting. These steps are repeated over and over again until the pre-determined measures of success are achieved.

This research was conducted at SMP Negeri 1 Kombeng on the second semester of the 2025/2026 academic year. The research participants were 28 students of Class IX.C, which included 27 students regular students and 1 student with special needs. The class was selected purposively as it was a heterogeneous inclusive classroom for which the Universal Design for Learning framework was suitable for implementation. The intervention was developed in two action cycles, with two instructional meetings in each cycle. Mathematics instruction during the intervention was developed based on the three principles of UDL, including multiple means of engagement, multiple means of representation, and multiple means of action and expression (CAST, 2024). The principles offered students multiple opportunities to access the learning materials, engage in classroom activities, and show their understandings based on their individual characteristics and learning needs.

Data were collected through classroom observation, semi-structured interviews, learning outcome tests (pre-test and post-test), documentation, student portfolios and field notes. Classroom observations were used to evaluate the application of UDL principles and students' learning independence development, and interviews were performed to better understand the experiences of teachers and students during the implementation of UDL. The data were analyzed by the interactive analysis model proposed by Miles, Huberman and Saldaña (2014) which consists of data collection, data reduction, data display and conclusion drawing and verification. The quantitative data were analyzed descriptively by percentage and Normalized Gain Score to find out the improvement of students' learning independence and mathematics achievement in the research cycles. The credibility of the findings was guaranteed by the credibility of data through technique triangulation, source triangulation, member checking, peer debriefing, and prolonged engagement (Moleong, 2017; Sugiyono, 2019; Creswell, 2021).

Figure 1. *Classroom Action Research Procedure Based on the Kemmis and McTaggart Model*



RESULT AND DISCUSSION

This research is Classroom Action Research (CAR) with the aim of improving the learning independence of students with special needs through the application of Universal Design for Learning (UDL) in Mathematics learning in class IX.C SMP Negeri 1 Kombeng. CAR was chosen because it is an effective method of addressing learning problems by means of a series of reflective actions directed towards improving classroom learning practices especially in the context of inclusive education. This study was carried out for six weeks divided into the pre-cycle stage, Cycle I, and Cycle II. Each cycle consisted of two meetings of planning stage, action, observation, and reflection. The research data were collected by observing the learning process, administering a questionnaire on learning independence, interviewing teachers and students, and administering a learning outcome test to determine the changes that occurred during the implementation of UDL. The results of research in this chapter are presented systematically based on each action stage. These include the

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findings of observations, the results of interviews, the development of student learning independence, and the improvement of mathematics learning outcomes as an indicator of the effectiveness of the application of Universal Design for Learning in supporting more inclusive and student-centered learning.

Description of the Initial Condition Before the Intervention (Pre-Cycle)

The pre-cycle stage was carried out to collect the baseline data of learning independence and mathematics learning outcomes of students before the implementation of Universal Design for Learning (UDL) approach. This stage consisted of planning, traditional instruction, observation and reflection on which the design of the following action cycles was based. During the planning phase, the researcher worked with the classroom teacher to develop traditional lesson plans, observation instruments to assess learning independence like learning initiative, identification of learning needs, goal setting, self-regulation, and self-evaluation, and pre-test and post-test instruments concerning the similarity of plane figures.

Pre-cycle implementation was carried out through two learning meetings with a teacher-centered approach, where the learning activities were dominated by lectures and explanations written on the whiteboard without the support of instructional media or differentiated learning strategies. Most students were passive in the instructional process and just followed the teacher's directions. Meanwhile, the student with special needs was highly dependent on the teacher and classmates, had difficulty in understanding abstract mathematical concepts, and showed low initiative in learning to do things independently. At the end of each meeting, the students completed a pre-test and a post-test to measure their initial understanding of the learning materials. In addition, classroom observations were made and interviews were held with the teacher and students to identify the initial conditions of learning. The results showed that students' learning independence was still relatively low, so a flexible and adaptive instructional approach that could accommodate learner diversity, especially the needs of students with special needs was needed. The results of the observation on students' learning independence in the pre-cycle stage are presented in Table 1 .

Table 1. *Students' Learning Independence in the Pre-Cycle Stage*

No	Learning Independence Indicator	Percentage	Category
1	Learning Initiative	28,5%	Rendah
2	Identifying Learning Resource Needs	21,2 %	Sangat Rendah
3	Goal Setting (Choice)	20,5%	Sangat Rendah
4	Self-Regulation (Task Focus)	29,4%	Rendah
5	Self-Evaluation (Checklist)	24,4%	Sangat Rendah
Classical Average		24,8%	Sangat Rendah

As shown in Table 1, the average level of students' learning independence during the pre-cycle stage was only 24.8%, indicating a very low level of independence. Specifically, the learning initiative indicator reached 28.5% (low), suggesting that most students lacked the motivation to study or complete learning tasks without explicit guidance from the teacher. The identification of learning resource needs indicator scored only 21.2% (very low), indicating that students relied heavily on the teacher's explanations and did not actively seek alternative learning resources. Likewise, the goal-setting indicator reached 20.5% (very low), reflecting that students had not established clear learning objectives and merely followed the teacher's instructions. Furthermore, the self-regulation indicator reached 29.4% (low), demonstrating that students experienced difficulty maintaining attention and managing their own learning activities. Meanwhile, the self-evaluation indicator achieved 24.4% (very low), indicating that students were unable to assess or improve their own work independently.

This condition was even more evident for the student with special needs, who achieved a learning independence score of only 12.5%, considerably lower than the class average. These findings suggest that the student demonstrated almost no learning initiative, was unable to identify individual learning needs, establish learning goals, maintain attention during classroom activities, or evaluate learning performance independently. Overall, the findings confirm that the conventional instructional approach had not yet fostered students' learning independence, thereby emphasizing the need for a more flexible and inclusive instructional strategy, such as the Universal Design for Learning (UDL) framework, to better accommodate learner diversity and promote independent learning.

Description of the Implementation and Results of Cycle I

The implementation of cycle I was carried out as a follow-up to the findings of the reflection phase in the pre-cycle stage, which stated that the conventional learning method had not effectively improved students' learning independence and students' mathematics learning outcomes. Thus, the researcher and the collaborating teacher designed a learning intervention using the Universal Design for Learning (UDL) framework, incorporating its three core principles: multiple means of representation, multiple means of engagement, and multiple means of action and expression. During the planning stage, lesson plans were redesigned and several instructional materials developed, including cube and rectangular prism models, three-dimensional manipulatives, illustrated learning cards, tiered student worksheets, and simplified instructional materials supported by visual illustrations. Also, the observation checklist, interview guidelines, and learning achievement tests were refined to better fit the characteristics of all students including the student with special needs. The classroom seating arrangement was also reorganized into small collaborative groups. The student with special needs was seated in a strategic position to allow for easy access to both the teacher and instructional media.

The intervention was delivered over two instructional sessions on the topic of three dimensional geometric solids including the elements and properties of cubes and rectangular prisms and then concepts of surface area and problem solving activities. The learning process was structured to be much more flexible than the pre-cycle stage using various instructional media, concrete manipulatives, collaborative group discussions and a Choice Board that enabled students to choose learning activities based on their preferences and learning needs. Most students preferred to learn through observation and

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discussion with their peers and the student with special needs preferred to observe the concrete models and to study simplified learning materials with minimal peer support. The teacher served as a Facilitator in the learning process, offering guiding questions, constructive feedback and positive reinforcement rather than direct answers. In the second meeting students did differentiated worksheets with three levels of difficulty so they could choose tasks according to their learning capacities. This instructional design led to increased classroom participation, better students' confidence and progressively increased responsibility for their own learning.

Observations were conducted to examine the students' learning activities, learning independence, academic achievements, and the responses of the students and collaborating teacher to the application of the UDL approach during Cycle I. Overall significant improvements were noticed in the learning behavior as compared to the pre-cycle stage. Students became more actively involved in asking questions, participating in discussions and using instructional media provided. In the meantime, the student with special needs began to show more confidence in attempting learning tasks on his own, although from time to time he still needed guidance. Besides, the collaborative teacher indicated that the use of flexible instructional strategies and various forms of content representation improved the interactive characteristic of the learning process and better accommodated the diverse characteristics of students. The results of the observation on the students' learning independence in Cycle I can be seen in the following table and figure.

Table 2. *Students' Learning Independence in Cycle I*

No	Learning Independence Indicator	Percentage	Category
1	Learning Initiative	58,2%	Cukup
2	Identifying Learning Resource Needs	52,7%	Cukup
3	Goal Setting (Choice)	54,4%	Cukup
4	Self-Regulation (Task Focus)	61,3%	Cukup
5	Self-Evaluation (Checklist)	49,8%	Rendah ke Cukup

As seen in Table 2, the average percentage of students' learning independence increased to 55.28% which is at the fair category, showing a great improvement compared to the pre-cycle stage. Of the five indicators, the indicator of self-regulation received the highest percentage (61.3%), which means that the students were better at maintaining attention and being involved in learning tasks without the teacher always watching. The learning initiative indicator also increased to 58.2% which indicates that students started to have more initiative in learning and doing tasks on their own. Likewise, the indicator for setting goals reached 54.4%, showing that students had begun to set their own learning goals and choose learning activities suitable for their abilities. The indicator of identifying needs for learning resources increased to 52.7% indicating that students are more conscious of using available instructional media to improve their understanding. The self-evaluation indicator was still the lowest at 49.8%, but the students had started to review their own work, but still needed occasional confirmation from teachers or peers. Importantly, the student with special needs also made significant progress with a learning independence score of 38.5% (low to fair category). Students have become more active in completing learning tasks and more willing to ask questions when they encounter difficulties, and they pay more attention to the learning activities in the class, especially when concrete instructional media are used in the learning process.

Description of the Implementation and Results of Cycle II

While in Cycle II, the instructional strategies were revised through the reflection results of Cycle I. The general objective of this cycle was to improve the aspects of learning independence that have not yet reached the expected level, especially the self-evaluation indicator, and to strengthen students' overall learning independence and mathematics learning outcomes. In the planning stage, the researcher and cooperating teacher improved the lesson plans by focusing more on students' self-assessment skills, developing more interactive instructional media on prisms and pyramids, improving the tiered student worksheets and adding a "check your answer" section to prompt students to evaluate their own work. Moreover, more varied learning options, peer teaching activities, and more positive reinforcement and scaffolding strategies were implemented in the Choice Board to help gradually decrease students' dependence on teacher assistance.

The intervention consisted of two lessons on the surface area and volume of prisms and pyramids. The teaching activities continued to be guided by the three fundamental principles of the Universal Design for Learning (UDL) framework, which are: representing concepts through multiple representations, fostering active student engagement, and providing multiple opportunities for students to demonstrate their understanding. Students had more confidence and involvement during the learning process than in the Cycle I. Most students were able to choose learning activities at their own level, complete differentiated assignments with little support, and use the self-assessment checklist to evaluate their own work. The student with special needs also showed significant improvement in participation in class discussions, doing basic level tasks independently before asking for feedback, and confidence in using concrete learning materials. Classroom observations show a significant boost in students' general learning autonomy and involvement. This shows that the improvements made in Cycle II were effective to improve the effectiveness of the mathematics learning using UDL. Table 3. The result of observation of students' independence in learning in Cycle II

Tabel 3. *Student Participation Observation Results in Cycle II*

No	Learning Independence Indicator	Percentage	Category
1	Learning Initiative	84,2%	Tinggi
2	Identifying Learning Resource Needs	78,6%	Tinggi
3	Goal Setting (Choice)	80,1%	Tinggi
4	Self-Regulation (Task Focus)	85,7%	Tinggi
5	Self-Evaluation (Checklist)	76,3%	Tinggi
Classical Average		80,26%	Tinggi

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As shown in Table 3, the independence of the student's learning in Cycle II experienced a significant increase of 80.26% in the classical average, in the high category. Self-regulation was the highest (85.7%) among the five indicators. This suggests that the students were able to stay on task, regulate their learning activities and work on assigned tasks with more responsibility and less supervision. The self-evaluation indicator also experienced a significant increase from 49.8% in Cycle I to 76.3% in Cycle II. This result suggests that the implementation of self-assessment strategies using answer keys and self-check checklists have been effective in motivating students to independently evaluate and revise their own work. In addition, the student with special needs showed substantial improvement with a learning independence score of 68.5% , low to high . The student was more ready to start learning activities, selected learning resources well and showed more confidence to ask questions when difficulties were encountered. The results of this study indicate that the improvements made to the Universal Design for Learning (UDL) method during Cycle II successfully promoted the independence of students learning and improved the active participation of both regular students and children with special needs in learning mathematics.

Overall Summary of Research Findings

The results of students' learning independence in the pre-cycle, Cycle I and Cycle II were compared in order to give a complete picture of the effectiveness of the Universal Design for Learning (UDL) approach. The comparison shows a persistent growth of students' learning independence during the implementation of the intervention. The total results are given in Table 4.

Table 5. *Comparison of Post-Intervention Results Between Cycle I and Cycle II*

No	Research Stage	Average Learning Independence (%)	Category
1	Pre-Cycle	24.8%	Very Low
2	Cycle I	55.28%	Fair
3	Cycle II	80.26%	High

Source: Research Data Processed by the Authors (2026).

The results of the pre-cycle stage showed that the learning independence of students was at a very low level with a classical average of 24.8% and the average mathematics achievement was only 55.1 with a classical mastery level of 10.7%. The results show that the traditional teaching method before the intervention was not effective in improving independent learning and academic achievement of the students. The learning activities were mostly teacher-centered and mostly used lectures and written explanations on the whiteboard with no differentiated instructional strategies or multiple forms of learning representation. As a result, students were more likely to be passive learners who relied heavily on the teacher's instruction rather than actively regulating their own learning. This finding is in line with Suprijono (2013) who states that conventional instruction typically makes students passive recipients of knowledge, thus reducing their initiative, responsibility and autonomy in the learning process.

The learning barriers were higher for the special needs student with a score of 30 on mathematics and the least level of learning independence. The student had difficulty with abstract mathematical concepts because the instructional materials were presented primarily verbally, rather than being supported by visual, concrete or tactile means. This finding is consistent with the Universal Design for Learning (UDL) framework (Rose & Meyer, 2006; CAST, 2024), which suggests that delivering information in a single mode of instruction constitutes a barrier for students with a variety of cognitive and learning characteristics. The learning materials should be presented in a variety of formats following the UDL principles so that all learners (especially learners with disabilities or special educational needs) have equal access to the material.

The pre-cycle findings are also in line with the concept of self-regulated learning proposed by Dimyati and Mudjiono (2013), which states that learning initiative, goal setting, self-regulation, and self-evaluation are important components of independent learning, in terms of learning independence. The very low performance in these indicators indicates that students did not yet have effective self-regulated learning skills. Hence, the pre-cycle stage findings validated the necessity of adopting a more adaptable and learner-centred instructional framework. These baseline conditions gave a strong reason to implement the Universal Design for Learning (UDL) approach in the next action cycles to improve the learning independence and mathematics learning outcomes in the inclusive classroom.

To provide a clearer illustration of the development of students' learning independence throughout the study, a comparison was made of the observation results across the three research stages, namely the pre-cycle, Cycle I, and Cycle II. This comparison was intended to demonstrate the effectiveness of implementing the Universal Design for Learning (UDL) approach in progressively improving students' learning independence throughout each action cycle. The overall improvement is illustrated in Figure 2.

Figure 2. *Improvement in Students' Learning Independence Across the Pre-Cycle, Cycle I, and Cycle II*

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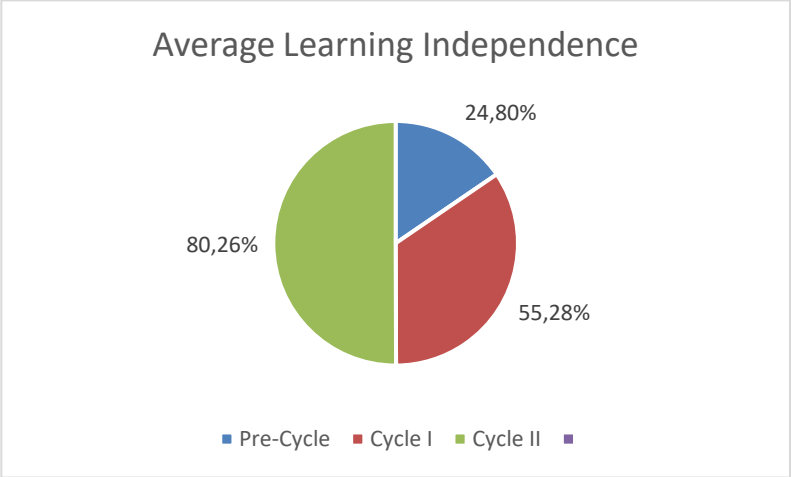

Figure 2 shows that the learning independence of students has been constantly and significantly improved in the various stages of the research. The mean level of learning independence in the pre-cycle was only 24.8% that was rated as very low, which means that most of the students were very dependent on the teacher for guidance throughout their learning process. The average score of Cycle I was 55.28%, in the fair category, after applying the approach of Universal Design for Learning (UDL). This improvement indicates that students started to be more proactive in their learning, use a variety of teaching resources and improve their self-regulation skills. The most significant progress was achieved in Cycle II, which reached an average of 80.26% of learning independence, in the high category. These findings showed that the continued use of the UDL principles was effective in creating a more inclusive, flexible and learner-centred learning environment that enabled the students to have greater independence in learning for both the regular students and the student with special needs. Overall, the results show that the intervention achieved the research objectives and success indicators that were defined a priori.

Discussion

The pre-cycle result shows that the learning independence of students of Class IX.C SMP Negeri 1 Kombeng is still in the very low category which is equal to 24.8%. While the average mathematics achievement is 55.1 and classically only 10.7%. The condition revealed that the traditional teacher-centered instruction was not enough to foster students' independent learning. The main reason for this was that the material was presented in an abstract manner through lectures and whiteboard explanations without concrete, visual or differentiated learning support. This finding is consistent with Suprijono (2013) who stated that conventional instruction tends to make students as passive recipients of information, so that it limits the development of learning initiative, self-regulation, and responsibility for learning. The student with special needs had more obvious barriers, had difficulty grasping abstract mathematical concepts and scored a mere 30. This is consistent with the principles of Universal Design for Learning developed by Rose and Meyer (2006) and CAST (2024) which highlight how presenting learning materials in only one mode may limit access for the students who have cognitive barriers or special learning needs. Thus, the low level of learning independence in the pre-cycle stage became the basis for implementing a more flexible, adaptive, and inclusive instructional intervention.

After the implementation of the Universal Design for Learning (UDL) approach in Cycle I, the learning independence of students increased to 55.28% which is in the fair category and the average learning result increased to 68.4 with classical completeness of 67.8%. This improvement suggests that the use of multiple forms of representation, such as concrete manipulatives, pictures, step-by-step explanations, tiered worksheets, and a Choice Board, began to help the students understand the material and choose learning strategies that fit their abilities. This result is consistent with Hall, Meyer and Rose (2014) who posit that the utilization of visual, auditory and tactile representations of material can help students to understand abstract ideas more successfully. In addition, offering learning options is consistent with Woolfolk's (2009) argument that giving autonomy to choose learning tasks could improve students' motivation and responsibility to their learning process . But the results of Cycle I are not yet optimal as the self-evaluation indicator is still 49.8% which means that students still need help in checking and evaluating their own work. This shows that self-evaluation skills need to be continuously practiced. As stated by Sudjana (2011) that self-evaluation is an important component in developing learning independence.

The enhancement of the intervention in Cycle II produced more optimal results, the learning independence of students increased by 80.26% (high), the average learning outcomes were 81.2, and classical mastery was 100%. This improvement was due to the more systematic implementation of the UDL strategy in more interactive concrete media, worksheets in tiers, a check-your-answer section, simple answer keys, peer tutoring, and more flexible learning time. These strategies assisted students with developing self-regulation, self-review and accomplishing tasks more independently. This finding is in line with Arsyad (2014) which states that instructional media can simplify the learning material so that it is easier to understand by students. Furthermore, the results support Zimmerman's (2002) theory of self-regulated learning that explains independent learners are able to manage learning strategies, monitor the learning process, evaluate the outcome and try to complete the task before asking for help. The student with special needs' score improvement from 30 in the pre-cycle to 72 in Cycle II means that UDL has successfully brought more equitable learning access and has allowed the inclusive student to achieve mastery with the regular students. Therefore, the action hypothesis was accepted because the implementation of UDL was proven to be effective to improve the students' learning independence and the mathematics learning outcomes in Class IX.C

of SMP Negeri 1 Kombeng.

CONCLUSION

Based on the results of this Classroom Action Research conducted through the pre-cycle, Cycle I, and Cycle II, it can be concluded that the implementation of the Universal Design for Learning (UDL) approach in mathematics learning on the topic of three-dimensional geometric shapes successfully improved both the students' learning independence and mathematics learning outcomes in Class IX.C of SMP Negeri 1 Kombeng, including the student with special needs. In the pre-cycle, the students' learning independence was categorized as very low (24.8%), with an average mathematics achievement score of 55.1 and a classical mastery rate of 10.7%. After the implementation of UDL, the learning independence of the students increased to 55.28% in Cycle I and reached 80.62% in Cycle II, which is in the high category. Similarly, the mathematics learning outcomes of students improved from an average score of 55.1 in pre-cycle to 68.4 in Cycle I and 81.2 in Cycle II with 100% classical mastery. The student with special needs also had a great improvement, as the mathematics score went from 30 in the pre-cycle to 72 in Cycle II, reaching the minimum mastery criterion. The results demonstrate the effectiveness of the Universal Design for Learning (UDL) approach to offer multiple means of representation, engagement, and action and expression, which lead to the development of a more inclusive, flexible, and learner-centered instructional environment to meet various learning needs, as well as to foster learning independence and academic achievement.

The findings of this study suggest that mathematics teachers may consider the Universal Design for Learning (UDL) approach as an alternative instructional strategy in inclusive classrooms, as it has been proved effective in improving students' learning independence and mathematics achievement. Teachers are also encouraged to develop creative instructional media including concrete, visual, tactile and technology-supported learning resources together with varied learning activities that accommodate diverse learning characteristics. School principals are expected to provide adequate learning facilities, instructional media and continuous professional development for teachers to support the implementation of inclusive instructional practices. Students are encouraged to take more initiative, to use a range of learning resources, to choose appropriate learning strategies and to independently evaluate their own work, thus maintaining and further developing their learning independence. Parents are also expected to support the development of children's independence through encouragement, supervision and good communication on the part of parents with the school towards children's progress in learning. Finally, future researchers are encouraged to extend this study by adapting the UDL framework to different topics of mathematics, other subject areas, different levels of education, or other variables such as learning motivation, creativity, critical thinking and problem-solving skills. Furthermore, longer-term studies and the use of advanced educational technologies within UDL-based instruction might offer a better insight into the long-term effectiveness and sustainability of the UDL approach in inclusive education.

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