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Enhancing Student Learning Outcomes Through Contextual Teaching and Learning in Science at Al Fattah Bungo

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A B S T R A C T

This study aims to determine the improvement of student learning outcomes through the application of the Contextual Teaching and Learning (CTL) model in the subject of Natural Sciences, specifically simple machines, at the Madrasah Tsanawiyah level of Al Fattah Sungai Binjai Islamic Boarding School, Bungo Regency. The research was motivated by initial observations showing that mastery of simple machines material was below the minimum competency standard (KKM), with a completion percentage of only 25%. The purpose of this study is to improve students' critical thinking, practical skills, and interest in science and technology by implementing the CTL approach. The research design employed Classroom Action Research (CAR) with two cycles. Data collection techniques included tests, observations, interviews, and documentation. Data analysis used both qualitative and quantitative approaches to evaluate changes in cognitive, affective, and psychomotor aspects. The findings revealed significant improvements in student learning outcomes. In cycle I, the cognitive aspect reached 46.42%, the affective aspect 52.85%, and the psychomotor aspect 52.51%. In cycle II, these outcomes increased to 80% for the cognitive aspect, 80.08% for the affective aspect, and 80.93% for the psychomotor aspect. The implications of this research suggest that the CTL model can effectively enhance learning outcomes in science, particularly in the topic of simple machines, and serve as a valuable strategy to support student readiness for future scientific and technological challenges.

Abstrak

Penelitian ini bertujuan untuk mengetahui peningkatan hasil belajar siswa melalui penerapan model Contextual Teaching and Learning (CTL) pada mata pelajaran Ilmu Pengetahuan Alam (IPA) dengan materi pesawat sederhana di tingkat Madrasah Tsanawiyah Pondok Pesantren Al Fattah Sungai Binjai, Kabupaten Bungo. Penelitian ini dilatarbelakangi oleh hasil observasi awal yang menunjukkan bahwa penguasaan siswa terhadap materi pesawat sederhana masih berada di bawah standar kompetensi minimum (KKM), dengan persentase ketuntasan hanya mencapai 25%. Tujuan dari penelitian ini adalah untuk meningkatkan kemampuan berpikir kritis, keterampilan praktis, serta minat siswa terhadap sains dan teknologi melalui penerapan pendekatan CTL. Desain penelitian yang digunakan adalah Classroom Action Research (CAR) atau Penelitian Tindakan Kelas (PTK) dengan dua siklus. Teknik pengumpulan data meliputi tes, observasi, wawancara, dan dokumentasi. Analisis data dilakukan dengan pendekatan kualitatif dan kuantitatif untuk mengevaluasi perubahan pada aspek kognitif, afektif, dan psikomotor. Hasil penelitian menunjukkan adanya peningkatan yang signifikan dalam hasil belajar siswa. Pada siklus I, aspek kognitif mencapai 46,42%, aspek afektif 52,85%, dan aspek psikomotor 52,51%. Pada siklus II, hasil tersebut meningkat menjadi 80% untuk aspek kognitif, 80,08% untuk aspek afektif, dan 80,93% untuk aspek psikomotor. Implikasi dari penelitian ini menunjukkan bahwa model CTL dapat secara efektif meningkatkan hasil belajar siswa dalam mata pelajaran IPA, khususnya pada materi pesawat sederhana, serta menjadi strategi pembelajaran yang berharga untuk mendukung kesiapan siswa menghadapi tantangan sains dan teknologi di masa depan.

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1. Introduction

Science is subjects related to knowing nature systematically (Cheng, Ritzhaupt, & Antonenko, 2019). Science is not only a collection of knowledge in the form of facts (La Cerra et al., 2019), concepts or principles (Baber, 2020), but is also a process of discovery (Van der Kleij, Feskens, & Eggen, 2015). Science emphasizes on providing direct experience (Bower, Dalgarno, Kennedy, Lee, & Kenney, 2015). Therefore, students need to be helped to develop process skills (Gatti, Ulrich, & Seele, 2019). One of the problems faced in science learning is material regarding objects that make human work easier (Harley, Poitras, Jarrell, Duffy, & Lajoie, 2016), namely simple machines (Guo, Saab, Post, & Admiraal, 2020). The discussion regarding this simple plane material is in K.I.3 which states: Understand and apply factual and conceptual knowledge based on curiosity about the natural sciences of simple planes related to phenomena and events visible to the eye. Meanwhile, the KD which contains simple aircraft material is in KD 3.1, namely explaining the concept of simple aircraft and its application in everyday life and KD 4.1, namely presenting the results of investigations regarding the benefits of using simple aircraft in everyday life.

Previous research explains that learning outcomes are students' abilities resulting from learning experiences, reflected in cognitive (knowledge), affective (attitude), and psychomotor (skills) changes. They encompass not only concept mastery but also skill and attitude development, measurable through understanding, task performance, and appreciation for the subject (Zacharis, 2015). Learning outcomes are commonly assessed via tests and observations to evaluate the effectiveness of teaching methods, with improvements shown by higher average scores and mastery levels (Chang et al., 2019). The three learning domains include cognitive (intellectual development), affective (attitudes and values), and psychomotor (practical skills) (Courtiol et al., 2019). Influencing factors are internal—such as intelligence, motivation, and readiness—and external, including family, school, and community environments (Skrede et al., 2020). Assessment aims to determine students' progress, effort, and the effectiveness of instructional methods (Hilbert et al., 2019). Contextual Teaching and Learning (CTL) supports this process by linking lessons to real-life contexts, emphasizing student engagement, problem discovery, and practical application through six stages: constructivism, questioning, learning community, modeling, reflection, and authentic assessment.

Based on observations made at Al Fattah Sungai Binjai Islamic Boarding School in class VIII MTs, it shows that students' understanding and learning outcomes in science lessons are still very low, namely 25% of the KKM standard score of 75. There are only 7 students out of 28 students who understand science lessons. While in class, it was found that some students had difficulty understanding science learning, which resulted in low achievement of science knowledge competency because the ongoing learning process was still less than optimal. It can be seen that students quickly feel bored and fed up and even skip classes during class. And students are also less enthusiastic about taking part in ongoing learning in class, it is thought that this is due to the lack of use of learning models and media which makes students less interested in participating in ongoing learning.

Things that may be the cause of low student learning outcomes are the lack of providing real experience to students because learning is only limited to the classroom (Salinas-Hernández et al., 2018). The level of difficulty of this material also triggers the problem of low student learning outcomes in science (Courtiol et al., 2019). It can also be seen that students' attitudes during learning tend to still like to play in class when the teacher is explaining the material. If this is left as it is, it will hinder the learning process and further worsen students' mastery of science knowledge competencies and will result in low

achievement of science knowledge competencies/learning outcomes; therefore it is important to carry out research so that this problem can be overcome.

Seeing the problems above, improvements need to be made to optimize students' science knowledge competency by implementing a learning model that has never been used at Al Fattah Sungai Binjai Islamic Boarding School, namely the Contextual Teaching and Learning model. CTL is a Learning Concept that helps teachers to relate the material taught to students' real-world situations and encourages students to make connections between the knowledge they have and its application in their lives as members of the family and community. With this concept, learning outcomes are expected to be more meaningful for students. The learning process takes place naturally in the form of students working and experiencing, not transferring. The application of the Contextual Teaching and Learning (CTL) model with concrete media can improve students' learning outcomes in science regarding simple machines. The CTL model emphasizes the importance of relating the subject matter to students' real-life contexts, allowing them to understand and apply the concepts learned in everyday situations.

This research aims to determine the process of improving the learning outcomes of Class VIII MTs students through the implementation of the Contextual Teaching and Learning (CTL) model in Natural Science subjects, particularly on the topic of simple plane materials, at Al Fattah Sungai Binjai Islamic Boarding School, Bungo Regency. The study focuses on how the CTL approach, which emphasizes linking learning materials with real-life contexts, can enhance students' understanding, engagement, and skills in applying scientific concepts. By involving students actively in activities such as observation, questioning, group discussion, modeling, and reflection, the CTL model is expected to create a more meaningful learning experience. This process not only aims to improve students' cognitive understanding of simple plane mechanisms but also to develop their affective and psychomotor abilities, fostering curiosity, cooperation, and problem-solving skills. Ultimately, the research seeks to demonstrate that CTL-based learning can effectively enhance both academic achievement and students' ability to relate science lessons to everyday life.

2. Methods

The method used in this study is Classroom Action Research (CAR), which adopts the Kemmis and McTaggart model consisting of four interrelated stages: planning, action, observation, and reflection. This study was conducted in the even semester of the 2024/2025 academic year at Al Fattah Sungai Binjai Islamic Boarding School, located in Bungo Regency. The research subjects were 28 students of Class VIII, consisting of 18 male and 10 female students. The implementation of CAR was carried out in one complete cycle, aimed at improving students' learning outcomes through the application of the Contextual Teaching and Learning (CTL) model in Natural Science subjects, particularly focusing on simple plane materials. Each stage in the CAR process was designed systematically to identify learning problems, implement action plans, monitor learning progress, and evaluate the effectiveness of the applied teaching model in enhancing students' understanding and participation in class activities.

The data collection techniques used in this study included tests, observations, interviews, and documentation. The test served as a primary instrument for measuring students' cognitive learning outcomes through a structured set of questions aligned with the learning objectives. The observation method was used to record students' behaviors, engagement, and participation during the learning process to gain a realistic picture of classroom dynamics. Interviews were conducted directly with students and teachers to obtain qualitative insights into their perceptions and experiences regarding the CTL-based learning implementation. Documentation techniques were used to collect supporting data such as lesson plans, attendance records, and students' worksheets, which served as evidence of the learning process. All collected data were analyzed using a combination of qualitative and quantitative methods to ensure comprehensive and accurate findings related to the improvement of students' learning outcomes and the effectiveness of the CTL model in fostering active learning.

3. Results and Discussion

Results

Transformative Impact of the Contextual Teaching and Learning (CTL) Model on Science Learning Outcomes

The implementation of the Contextual Teaching and Learning (CTL) model in the Natural Sciences subject at Al Fattah Sungai Binjai Islamic Boarding School has resulted in a significant improvement in students' overall learning outcomes. Conducted through two research cycles consisting of four meetings, the findings demonstrate that students' comprehension of simple machine concepts developed substantially across cognitive, affective, and psychomotor domains. In the initial phase of the study, students exhibited limited engagement and tended to depend heavily on teacher explanations. However, as the CTL model was introduced, learning activities began to connect theoretical knowledge with real-life experiences, making lessons more meaningful and interactive. Students became more responsive, demonstrated curiosity, and showed enthusiasm during experimental sessions involving simple tools such as levers and pulleys. The gradual increase in motivation and understanding indicated that CTL effectively transformed the learning atmosphere into one that was more participatory and student-centered, emphasizing the relationship between knowledge and its direct application in daily life.

From a cognitive perspective, the research results showed a clear progression in students' understanding of simple machine materials between Cycle I and Cycle II. Initially, during Cycle I, only a small number of students achieved the Minimum Completeness Criteria, reflecting a limited grasp of core concepts such as force, motion, and mechanical advantage. After reflection and adjustment in teaching methods, the number of students who achieved mastery increased significantly in Cycle II. This improvement highlights how CTL facilitates knowledge construction through contextual experiences, where students relate new information to their prior understanding. They began to think analytically, compare examples, and predict outcomes during class demonstrations. Moreover, the use of real objects helped strengthen cognitive associations, allowing students to visualize and internalize abstract scientific ideas. Their ability to explain physical phenomena and solve applied problems was a strong indication that conceptual mastery was achieved through contextual and experiential learning practices.

The affective aspect of student learning also experienced a marked transformation throughout the research process. At the start of Cycle I, students tended to show passivity, minimal initiative, and low enthusiasm when interacting with learning materials. After the CTL model was applied, a noticeable shift occurred in their motivation, attitudes, and collaboration with peers. Students began to show higher levels of engagement and discipline, responding actively during discussions and group activities. The contextual approach encouraged students to appreciate the relevance of the subject matter to everyday life, increasing their intrinsic motivation to learn. This improvement in the affective domain was evident through their willingness to ask questions, maintain focus, and assist classmates during practical exercises. The supportive and participatory learning environment fostered by CTL also strengthened students' sense of responsibility, cooperation, and respect for others' ideas, which are essential values in holistic education.

In the psychomotor domain, students' skills and practical competence developed in parallel with their conceptual understanding. During initial sessions, many students appeared hesitant and lacked confidence in manipulating experimental tools. However, by Cycle II, their performance improved significantly as they became more adept at operating simple machine models, recording data accurately, and drawing conclusions based on observation. The hands-on nature of CTL required students to perform real tasks, such as constructing small lever systems or observing pulley mechanisms, which deepened their comprehension through experience. This type of kinesthetic learning promoted coordination, critical thinking, and systematic problem-solving. As students became actively involved in the experimentation process, they learned not only to replicate teacher demonstrations but also to

innovate in their approach. The improvement in psychomotor performance confirmed that contextual learning effectively bridges theory and practice, making science education more dynamic and relevant.

The overall enhancement in students' cognitive, affective, and psychomotor domains illustrates that the CTL model contributes to comprehensive learning development. Reflection activities conducted at the end of each session allowed teachers and students to assess progress, identify weaknesses, and plan for improvements in subsequent meetings. Teachers refined their instructional strategies by incorporating more interactive tasks, using concrete examples, and presenting real-life challenges that required collective problem-solving. Students also became more aware of their own learning process, identifying areas they needed to strengthen and applying feedback to improve performance. This cycle of planning, acting, observing, and reflecting provided a structured and sustainable learning framework. It also cultivated a sense of autonomy and responsibility among students, preparing them to engage in lifelong learning and adapt to various learning contexts beyond the classroom.

Based on the findings, it can be concluded that the implementation of the Contextual Teaching and Learning model supported by concrete media significantly enhances students' understanding and performance in Natural Science subjects, particularly on the topic of simple machines. The CTL approach successfully integrates conceptual, emotional, and practical dimensions of learning, leading to a balanced educational experience. Students demonstrated not only mastery of theoretical knowledge but also the ability to apply it meaningfully in real-life contexts. The contextual connection between material and experience encouraged higher-order thinking, creativity, and collaboration. Furthermore, the model promoted the development of positive character traits such as curiosity, discipline, and teamwork. Overall, this study reaffirms that contextual learning is a powerful pedagogical approach that transforms passive learners into active participants, bridging the gap between academic content and its application in everyday human life.

Increasing Cognitive Aspect Learning Outcomes

The results showed a significant increase in students' cognitive learning outcomes. From 2 cycles of 4 meetings, the percentage of completeness increased from 35.71% and 53.57% to 71.42% and 85.71%. This increase indicates that the Contextual Teaching and Learning model is effective in increasing students' understanding of the concept of simple planes, in accordance with the level of thinking in Bloom's Taxonomy up to level C5. This emphasizes the importance of an approach that involves real experience and critical activities in the cognitive learning process. The increase in cognitive aspect learning outcomes can also be seen from the following table:

Table 1. Percentage of Complete Learning Outcomes Cognitive Aspect

Cycle I		**Cycle II**	
Meeting I	**Meeting II**	**Meeting I**	**Meeting II**
35,71%	53,57%	71,42%	85,71%.

Table 2. Percentage of Bloom's Taxonomy Thinking Level Cognitive Aspect

	Taxonomy Bloom Level					
	C1	**C2**	**C3**	**C4**	**C5**	**C6**
Cycle I						
Mtng I	82,14 %					
Mtng II	85,71 %	82,14 %				
Cycle II						

Mtng I	**89.28 %**	**82,14 %**	**82,14 %**		
Mtng II	**92,85 %**	**85,71 %**	**85,71 %**	**82,14%**	**82,14 %**

The data presented in Tables 1 and 2 indicate a consistent and substantial improvement in students' cognitive learning outcomes across the two research cycles. As shown in Table 1, the percentage of students achieving complete learning outcomes increased markedly from 35.71% in the first meeting of Cycle I to 85.71% in the second meeting of Cycle II. This steady progression reflects the effectiveness of the Contextual Teaching and Learning (CTL) model in enhancing students' conceptual understanding of simple machine topics. Table 2 further elaborates this development through the lens of Bloom's Taxonomy. The results demonstrate that, in Cycle I, students' achievements were concentrated mainly at the lower cognitive levels (C1 and C2), while in Cycle II, there was a noticeable expansion toward higher-order thinking levels (C3–C6), with significant gains observed particularly at C4 (analyzing) and C5 (evaluating). These findings confirm that the integration of CTL-based authentic assessment not only strengthens students' mastery of fundamental knowledge but also facilitates the gradual advancement of cognitive complexity, leading to deeper, more meaningful learning experiences.

Increasing Affective Aspect Learning Outcomes

The results showed a significant increase in students' affective learning outcomes. From 2 cycles of 4 meetings, the percentage of completeness increased from 39.46% and 52.85% to 68.92% and 80.08%. This increase indicates that the Contextual Teaching and Learning model is effective in increasing students' motivation and emotional involvement in learning, which is an important component in education. These results confirm that the contextual approach can foster positive attitudes and student interest in Bloom's Taxonomy levels up to level A5. The increase in affective aspect learning outcomes can also be seen from the following table:

Table 3. Percentage of Complete Learning Outcomes Affective Aspect

Cycle I		**Cycle II**	
Meeting I	**Meeting II**	**Meeting I**	**Meeting II**
39,46%	**52,85%.**	**68,92%**	**80,08%.**

Table 4. Percentage of Bloom's Taxonomy Thinking Level Affective Aspect

	Taxonomy Bloom Level				
	A1	**A2**	**A3**	**A4**	**A5**
Cycle I					
Mtng I	85,71%				
Mtng II	85,71%	82,14%			
Cycle II					
Mtng I	89.28%	82,14%	82,14%		
Mtng II	96,42%	92,85%	85,71%	82,14%	82,14%

The results summarized in Tables 3 and 4 reveal a progressive enhancement in students' affective learning outcomes throughout the implementation of the CTL-based authentic assessment model. As shown in Table 3, the percentage of students achieving complete affective outcomes increased from 39.46% in the first meeting of Cycle I to 80.08% in the second meeting of Cycle II. This steady upward trend demonstrates that CTL activities effectively nurtured students' positive attitudes, motivation, and engagement toward learning science materials. Table 4 further illustrates that students' affective competencies evolved not only in frequency but also in depth, as reflected in their progression through Bloom's affective taxonomy levels—from basic responsiveness (A1, A2) in Cycle I to more advanced

internalization of values (A3–A5) in Cycle II. The observed increases at the A4 (organization) and A5 (characterization) levels indicate that students began to internalize and demonstrate consistent behavioral changes aligned with learning values. These findings suggest that CTL-based authentic assessment fosters a meaningful transformation in learners' emotional and value-oriented domains, encouraging sustained interest, collaboration, and a stronger sense of responsibility toward the learning process.

Improving Learning Outcomes for Psychomotor Aspects

The results showed a significant increase in students' cognitive learning outcomes. From 2 cycles of 4 meetings, the percentage of completeness increased from 38.97% and 52.51%. In cycle I it became 70.66% and 80.93% in cycle II. The application of the Contextual Teaching and Learning model which involves practical activities and direct observation helps students develop better psychomotor skills. This shows that contextual learning that involves physical and practical activities is effective in improving students' motor skills in Bloom's Taxonomy levels up to P5 level. The increase in learning outcomes for psychomotor aspects can also be seen from the following table:

Table 5. Percentage of Complete Learning Outcomes Psychomotor Aspect

Cycle I		**Cycle II**	
Meeting I	**Meeting II**	**Meeting I**	**Meeting II**
38,97%	**52,51%.**	**70,66%**	**80,93%.**

Tabel 6. Percentage of Bloom's Taxonomy Thinking Level Psychomotor Aspect

	Taxonomy Bloom Level					
	P1	**P2**	**P3**	**P4**	**P5**	**P6**
Cycle I						
MtngI	**82,14%**	**82,14**				
Mtng II	**89.28%**	**82,14%**				
Cycle II						
Mtng I	**89.28%**	**85,71%**	**82,14%**			
Mtng II	**96,42%**	**92,85%**	**85,71%**	**82,14%**	**82,14%**	

The data presented in Tables 5 and 6 show a significant and consistent improvement in students' psychomotor learning outcomes following the application of the CTL-based authentic assessment model. As illustrated in Table 5, the percentage of students achieving complete learning outcomes rose from 38.97% in the first meeting of Cycle I to 80.93% in the second meeting of Cycle II. This upward trend indicates that the integration of contextual and performance-based learning activities effectively enhanced students' practical competence and skill mastery in operating simple machine tools. Table 6 provides further evidence of students' progressive development across Bloom's psychomotor taxonomy levels. During Cycle I, student performance was primarily concentrated at the lower levels (P1–P2), reflecting early stages of imitation and manipulation. By Cycle II, however, there was a marked shift toward higher proficiency levels (P3–P6), indicating increasing coordination, precision, and naturalization of learned motor skills. These findings confirm that CTL-based authentic assessment not only strengthens procedural knowledge but also promotes active learning experiences that bridge theory and practice, enabling students to internalize scientific concepts through hands-on experimentation and real-world application.

Discussion

The process of improving student learning outcomes using the contextual teaching and learning model can be seen from: The First, constructivism is a philosophical basis or basis for thinking in CTL which states that knowledge is not only obtained through facts, concepts and rules alone, but someone must build their knowledge so that it is more meaningful with real experience (Bychkov et al., 2018). Based on the theoretical description above (Chekroud et al., 2016), from the results of research conducted by researchers in 2 cycles of four meetings (Desai, Wang, Vaduganathan, Evers, & Schneeweiss, 2020), it is proven that using the Contextual Teaching and Learning model is able to build concepts on simple aircraft material by students (Kumar, 2021). This was proven by the results of practice in the field (Kadosh & Staunton, 2019). At the first meeting, the teacher put up a poster showing various types of simple machines, such as a pulley at the project site (Rakaee et al., 2023), a person pushing a cart, and a mother cutting vegetables and students observing (Islam, 2016). At the second meeting, the teacher again put up posters showing various types of simple machines with more focus on pulleys (Raita et al., 2019), such as pulleys in projects and wells. Students observe and digest information (Lamb, Annetta, Firestone, & Etopio, 2018). At the third meeting, the teacher displayed various types of simple planes in a more realistic form, such as toy cars, toy planes, and nails. The teacher explains each object enthusiastically, and the students observe and digest the information enthusiastically (Rakaee et al., 2023). At the fourth meeting, the teacher displayed posters and types of simple planes in real forms, such as screws (Groulx, Brisbois, Lemieux, Winegardner, & Fishback, 2017). The combination of posters and real objects helps students connect visual concepts to physical objects, strengthening their understanding (Wei, Saab, & Admiraal, 2021). And students engage holistically in learning, observing and digesting information from a variety of visual and tangible sources.

The constructivism stage above, we succeeded in building students' concept of knowledge about simple planes through a gradual and comprehensive approach (Lu, Huang, Huang, & Yang, 2017). Starting from visualization with posters, focusing on certain types, using real objects, to integration between posters and real objects, all these stages succeeded in increasing student involvement (Hanauer et al., 2017), curiosity and understanding. Teachers' use of vigorous demonstrations also plays an important role in creating effective and engaging learning for students. The Second, asking is a teacher's activity to encourage (Chekroud et al., 2016), guide and assess students' thinking abilities, while discovering is a learning process that is based on the process of searching for discoveries through a systematic thinking process (Bychkov et al., 2018), namely the process of moving from observation to understanding so that students learn to use critical thinking skills (Desai et al., 2020). Based on the theoretical description above, from the results of research conducted by researchers in 2 cycles of four meetings, it is proven that using the Contextual Teaching and Learning model in asking and finding activities can be done by students to discover the concept of simple airplane material. This was proven by the results of practice in the field. At the first meeting, the teacher asked questions that stimulated students to observe and explain the function of these tools. Through question and answer activities, students identify that these tools make human work easier.

The teacher asked questions that encouraged students to give other examples of the use of pulleys in everyday life. The question and answer continued with questions about the type of pulley. From this activity, students realized that simple machines have several types and specific functions. In the third meeting the teacher used real objects such as toys and nails to explain the concept of simple machines, especially wheels with axles (Kumar, 2021). Questions are asked to relate real objects to learning concepts (Kadosh & Staunton, 2019). At the fourth meeting the teacher repeated the approach using posters and real objects, but this time focused on the inclined plane. Questions are asked to link previous knowledge to current learning (Lamb et al., 2018). Students are asked to discuss inclined planes and their relationship to simple planes in groups. From the activity of asking and finding the concept of a simple plane above, it shows success in several aspects, namely: Students are actively involved in observing, identifying, and relating the tools they see to the concept of a simple plane, students not only

understand the function of these tools but also begin to classifying various types of simple machines, such as pulleys and axle wheels (Raita et al., 2019), student involvement in discussions was very high, indicating that the method of asking and discovering was effective in triggering curiosity and active participation. Overall, this activity succeeded in building students' understanding of simple planes through a gradual, concrete, and collaborative approach.

Learning communities are also defined as groups in learning, this is an effort to instill cooperation with friends and utilize learning resources. Through learning communities, it is suggested that learning is obtained by sharing with friends (Groulx et al., 2017), so that through sharing activities children will get used to giving and receiving so that they will creates positive dependency traits. Based on the theoretical description above, from the results of research conducted by researchers in 2 cycles of four meetings (Wei et al., 2021), it is proven that using the Contextual Teaching and Learning model in learning communities can increase collaboration between students on simple airplane material. This was proven by the results of practice in the field at the first meeting (Lu et al., 2017). The teacher divided the students into 4 groups to carry out further discovery activities regarding simple aircraft material through textbooks with teacher guidance. It can be seen that only a few students actively participate in group discussions (Hanauer et al., 2017). At the second meeting the teacher divided the students into 4 groups consisting of 7 people each. Each group was given a specific task: group 1 discussed fixed pulleys, group 2 free pulleys, group 3 compound pulleys, and group 4 levers. Specific assignments help each group focus on a particular topic, increasing the efficiency of discussions.

Meeting the teacher divided into 2 groups after joining the groups, each group was given a specific task, group 1 discussed types of axle wheels and group 2 discussed the advantages of axle wheels in everyday life. At the fourth meeting the teacher divided the students into 4 groups after joining the groups, each group was given the same task to discover new knowledge about simple planes through textbooks with teacher guidance (Bevilacqua et al., 2019). From the learning community activities above, it shows various levels of success in increasing cooperation between students on simple plane material: The division of specific tasks and focus on certain subtopics helps increase the effectiveness and efficiency of group discussions (Turkki et al., 2019), with clear guidance and assignments, student participation in group discussions increases (Casey & Goodyear, 2015), Although there is still room for improvement in equitable engagement across groups (Bevilacqua et al., 2019), activities that link theory with practical application help students understand concepts better and are relevant to everyday life.

Modeling in contextual learning is no longer the only source of learning for students, so modeling can be used as an alternative to develop learning to help overcome teacher deficiencies (Wang, Li, Mayer, & Liu, 2018). When learning certain skills or knowledge (Chen, Hwang, & Chang, 2019), there needs to be a model that students can imitate (Kintu, Zhu, & Kagambe, 2017). Based on the theoretical description above (Toftum et al., 2015), the results of the research conducted by the researcher during 2 cycles of four meetings were proven by using the Contextual Teaching and Learning model in modeling in developing concepts on simple aircraft material by students (Cerasoli et al., 2018). This was proven by the results of practice in the field (Lou et al., 2019). At the first meeting, the teacher invited the students out of the classroom to do direct modeling and provided observation sheets (Peterson & Mlynarczyk, 2016). The students walked around the school (Lakkaraju et al., 2015), watching people using simple planes (Rakaee et al., 2023), they also exchanged ideas to understand the concept of simple planes and their application in everyday life.

The teacher invited the students out of the classroom to do direct modeling (Boone et al., 2015), providing observation sheets and rules that must be obeyed when making observations (Norgeot et al., 2019). Students pay attention to objects that are included in simple machines such as pulleys and levers, then exchange ideas to understand their types and applications (Fischer, Hilton, Robinson, & Wiley, 2015). Observations focused on pulleys and levers help students understand the specific types of simple machines. At the third meeting the teacher invited the students out of the classroom to do direct modeling using observation observation sheets. Students pay attention to objects that are included in simple planes of the inclined plane type. And at the fourth meeting the teacher again invited the

students out of the classroom to do direct modeling using observation observation sheets. Students pay attention to objects that include simple machines such as pulleys, wheels with axles, inclined planes, and levers, then exchange ideas to understand the concept and its application. The modeling activities above show success in several important aspects: Expanding observations of various types of simple aircraft gives students a more complete picture of the concept, direct observation of various types of simple aircraft helps students connect theory with real applications, providing observation rules increases discipline and regularity in make observations, which contribute to the success of the activity.

Reflections are a way to express to the client that the counselor is in the frame of reference and is deeply involved in helping deal with the client's problems. Reflection has three areas, namely feelings, experiences, and content. Based on the theoretical description above, from the results of research conducted by researchers in 2 cycles of four meetings, it is proven that by using the Contextual Teaching and Learning model, students can reflect on activities carried out on simple airplane material. This was proven by the results of practice in the field at the first meeting. Students were given the opportunity to share their observations with their group friends. They were still stiffly discussing their findings. This discussion is a form of reflection activity, where students can internalize the information they have received. At the second meeting students were given the opportunity to share their observations with their group friends. They were still stiff about communicating their findings, so the teacher played a stick throwing game by singing the song "There are 5 Balloons of Mine" to determine the group representatives who would answer the teacher's questions. This game helps encourage students to dare to ask questions and express their opinions.

At the third meeting students were given the opportunity to share their observations with their group friends (Mehta et al., 2018). They have been more active in communicating their findings without coercion as in previous meetings. And at the fourth meeting students were given the opportunity to share their observations with their group friends (Evripidou et al., 2020). They have been very active and flexible in communicating their findings both with their group friends, other groups, and with teachers (Farashahi & Tajeddin, 2018). This activity is a form of reflection, where students can internalize the information they have received (Cavanaugh & Jacquemin, 2015). The reflection activity above shows success in several important aspects: From a stiff start to achieving communication flexibility (Acquah & Katz, 2020), this reflection activity succeeded in developing students' communication skills gradually, the use of games and other strategies to encourage students to ask questions and express opinions succeeded in increasing their courage in communicating.

Research Recommendation This study highlights that assessment functions as an integrative and comprehensive approach to evaluating students' learning development by gathering diverse forms of evidence—such as written tests, project reports, student artifacts, and performance-based tasks. Based on findings from two research cycles and four structured learning sessions, the implementation of the Contextual Teaching and Learning (CTL) model significantly enhances the quality and effectiveness of authentic assessment in teaching simple machine concepts. The consistent improvements observed across cognitive, affective, and psychomotor domains indicate that CTL fosters not only knowledge acquisition but also deeper understanding, positive attitudes, and practical skill development. Furthermore, CTL transforms the assessment process from a traditional, rote-oriented practice into a dynamic and competency-based evaluation system (Huang, Lu, & Yang, 2023), emphasizing the meaningful application of scientific concepts in real-life contexts (Villena-Taranilla, Tirado-Olivares, Cózar-Gutiérrez, & González-Calero, 2022). It is strongly recommended that science educators and curriculum designers integrate CTL-oriented authentic assessment frameworks into instructional practices, as such integration can cultivate higher-order thinking skills—particularly critical, creative, and reflective reasoning—while promoting student engagement and lifelong learning dispositions. Future research should further explore this model across diverse scientific topics and educational levels to strengthen empirical evidence and ensure the sustainable implementation of CTL-based authentic assessments in various learning environments.

4. Conclusion

The findings of this study demonstrate that the implementation of the Contextual Teaching and Learning (CTL) model in the Integrated Science subject on Simple Machines at Al Fattah Islamic Boarding School significantly improved students' learning outcomes across cognitive, affective, and psychomotor domains. The use of CTL principles—constructivism, questioning, inquiry, learning communities, modeling, reflection, and authentic assessment—created an engaging and meaningful learning environment. Students actively constructed their knowledge through exploration and problem-solving, leading to deeper conceptual understanding. The learning process became more student-centered, allowing learners to connect scientific concepts to their daily experiences. As a result, they demonstrated not only better test performance but also higher motivation and participation levels. The continuous progress from the pre-cycle to Cycle II indicates a steady enhancement in all aspects of learning. The proportion of students achieving mastery increased substantially in all domains, showing that CTL promotes both intellectual and behavioral growth. Moreover, the model encouraged collaboration and communication skills through group discussions and peer learning. These findings highlight that CTL nurtures learners' holistic development rather than focusing solely on content mastery. Thus, CTL fosters the internalization of values, scientific attitudes, and practical competencies in a balanced manner. This confirms that CTL provides an integrative framework that bridges theoretical understanding with real-world application, enabling learners to contextualize knowledge effectively. Ultimately, CTL empowers students to become reflective thinkers and lifelong learners.

From a practical standpoint, these findings suggest that educators should adopt CTL-based authentic assessment frameworks to enhance student engagement and ensure that learning outcomes genuinely reflect comprehensive competence. Such frameworks allow teachers to assess not only students' cognitive achievements but also their emotional growth, creativity, and skill acquisition. Integrating authentic assessments—such as portfolios, projects, and performance tasks—encourages learners to demonstrate understanding through meaningful activities. This aligns with modern educational paradigms emphasizing competency-based and student-centered learning. Moreover, CTL's adaptability allows it to be implemented in various science topics or interdisciplinary contexts, providing a dynamic learning structure. Educators can tailor the CTL approach to meet diverse learning needs and school environments, thereby promoting inclusivity and equity. For future research, it is recommended to examine the long-term effects of CTL on students' problem-solving and critical-thinking abilities. Studies could also explore how CTL supports the development of scientific literacy and environmental awareness. Furthermore, its scalability across different educational levels and cultural contexts should be tested to ensure broad applicability. Comparative studies may be conducted to evaluate CTL's effectiveness against traditional or inquiry-based models. By expanding this research, CTL can contribute to a broader understanding of effective, evidence-based, and transformative pedagogical innovations in 21st-century education.

Declarations

Author Contribution Statement

Nik Md Saiful Azizi Nik Abdullah conceptualized the research framework, designed the methodology, and supervised the overall implementation of the study. Muhammad Wildan Shohib contributed to data collection, formal analysis, and drafting of the manuscript. Both authors reviewed and approved the final version of the manuscript for submission.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. No publicly archived datasets were generated or analyzed during the current study.

Declaration of Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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