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Application of STAD Approach in Differentiated Learning Assisted by Chromebooks to Improve Science Learning Outcomes in Class VI

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Abstract

This study is motivated by the need to improve the quality of teaching and student learning outcomes in elementary schools in the context of rapid technological development. The research aims to analyze the impact of implementing the Student Teams Achievement Divisions (STAD) approach in differentiated learning assisted by Chromebooks on the science learning outcomes of sixth-grade students at SD Negeri 2 Harian, Samosir. The STAD approach emphasizes cooperative learning and shared achievement, while differentiated learning accommodates students' diverse needs in terms of content, process, and assessment. Chromebooks were utilized to support learning flexibility and access to digital resources. This study employed a descriptive qualitative method with a case study design. Data were collected through participatory observation, in-depth interviews, and analysis of students' learning outcome documents. The research involved seven sixth-grade students with diverse learning characteristics. The results indicate that the integration of the STAD approach with Chromebook-assisted differentiated learning increased student engagement, collaboration, and interaction during learning. Quantitative data showed that 85.7% of students achieved scores above the Minimum Completeness Criteria. In addition, qualitative findings revealed improvements in students' critical thinking, problem-solving abilities, and digital literacy. In conclusion, integrating the STAD approach with Chromebooks creates a collaborative, adaptive, and effective learning environment that enhances science learning outcomes while fostering essential social and technological skills in elementary education.

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INTRODUCTION

The quality of teaching and student learning outcomes at the elementary school level is a fundamental concern in Indonesian education, particularly in the context of rapid technological development. The increasing diversity of students' abilities, learning styles, and readiness levels requires learning approaches that are more adaptive, inclusive, and responsive to individual needs. Conventional teaching methods that apply uniform instruction to all students are often unable to optimally accommodate these differences, resulting in less effective learning outcomes.

One approach that addresses this challenge is differentiated learning, which adjusts content, learning processes, and assessment based on students' characteristics and needs (Amini, 2023). Differentiated learning aims to ensure that all students, regardless of their abilities or backgrounds, are able to achieve learning objectives. Previous studies have shown that differentiated learning can create a more inclusive learning environment and significantly improve student learning outcomes (Fairus, 2024).

Alongside pedagogical innovation, the integration of technology has become increasingly important in elementary education. Data from the Ministry of Education and Culture of the Republic of Indonesia (2020) indicate that tens of thousands of elementary schools have begun integrating technology into learning. One technology that has been widely adopted is the Chromebook, which provides flexible access to digital learning resources and supports independent as well as collaborative learning. Chromebooks enable students to explore learning materials according to their needs and pace, making them highly suitable for supporting differentiated learning.

The Student Teams Achievement Divisions (STAD) approach, developed by Slavin, is a cooperative learning model that emphasizes teamwork, individual accountability, and shared achievement. Through structured group work followed by individual assessment, STAD encourages active participation, collaboration, and responsibility for learning outcomes. Research has shown that the STAD approach can increase student motivation, engagement, and academic achievement, particularly in conceptual subjects such as science (Matona, 2024).

Despite the growing use of technology and cooperative learning models, research that integrates the STAD approach with Chromebook-assisted differentiated learning at the elementary school level remains limited. In practice, many teachers have not yet maximized the potential of technology to support differentiated and cooperative learning, which affects the effectiveness of learning outcomes. Therefore, there is a need to examine how the integration of the STAD approach and Chromebooks within a differentiated learning framework can improve student learning outcomes.

Elementary school is a critical stage for developing students' cognitive, social, and emotional competencies (Fitriana, 2021). Learning approaches at this level should not only support academic mastery but also foster collaboration, critical thinking, and digital literacy. The integration of STAD and Chromebook-assisted differentiated

learning is expected to create a collaborative, adaptive, and effective learning environment that aligns with students' developmental needs.

Based on this rationale, this study aims to analyze the planning, implementation, and effectiveness of the STAD approach in differentiated learning assisted by Chromebooks in improving science learning outcomes of sixth-grade students at SD Negeri 2 Harian, Samosir. The findings of this research are expected to provide practical recommendations for teachers and schools in optimizing technology-supported, inclusive learning practices in elementary education.

METHOD

This study employed a qualitative approach with a case study design. This design was chosen to enable an in-depth analysis of the implementation of the Student Teams–Achievement Divisions (STAD) approach in differentiated learning assisted by Chromebooks, particularly in understanding student interactions, learning behaviors, and learning experiences during science instruction on the solar system. The focus of the research was not merely on learning outcomes, but also on the learning process itself, including how collaboration within STAD groups and the use of digital technology influenced students' engagement and understanding. The study was conducted at SD Negeri 2 Harian, located in Onanrunggu District, Samosir Regency, North Sumatra Province, involving sixth-grade students who participated directly in the implementation of this learning approach.

The research participants consisted of seven sixth-grade students, comprising five female students and two male students. The selection of participants was based on the characteristics of the class in which the STAD approach and Chromebook-assisted differentiated learning were implemented. Given the limited number of participants, this study acknowledges that the generalizability of the findings is limited. Therefore, the research is positioned as an exploratory or pilot study aimed at gaining an in-depth and preliminary understanding of the impact of integrating the STAD approach with differentiated learning supported by Chromebooks. The findings of this study are expected to provide initial insights and serve as a foundation for future research involving a larger number of participants and broader contexts.

Data collection was carried out using participatory observation, in-depth interviews, and analysis of learning outcome documents. Participatory observation was conducted using a structured observation guide that focused on student interactions within STAD groups, levels of active participation, collaborative behavior, and the utilization of Chromebooks during learning activities. In addition to structured indicators, narrative field notes were used to capture unexpected events or significant behaviors that emerged throughout the learning process. In-depth interviews were conducted in a semi-structured manner using an interview guide designed to explore students' learning experiences, understanding of the material, challenges encountered,

and perceptions of the STAD approach and the use of Chromebooks in learning. The interviews provided rich qualitative data that complemented the observational findings.

Documentation analysis included the examination of student worksheets, individual and group quiz results, and learning progress records provided by the teacher. These documents were analyzed using an assessment rubric developed to measure students' conceptual understanding, problem-solving abilities, and creativity in learning, in accordance with the established indicators of learning success. The use of multiple data sources allowed the researcher to obtain comprehensive and triangulated data related to the research focus.

To ensure the validity of the research instruments, expert judgment was employed. Observation sheets, interview guides, and assessment rubrics were reviewed by two experts in the fields of education and science to evaluate their relevance, clarity, and alignment with the research objectives. Suggestions and feedback from these experts were used to revise and refine the instruments prior to data collection. Data triangulation was also applied to enhance the credibility of the findings by comparing and confirming data obtained from observations, interviews, and document analysis. For instance, observational data indicating active group discussions were cross-validated with students' interview responses and supported by evidence from learning outcome documents.

Data analysis was conducted qualitatively through the process of identifying patterns, themes, and meanings related to student interactions, learning experiences, and the impact of the learning approach on student outcomes. The analysis was guided by indicators derived from humanistic learning theory, including students' willingness to express opinions, ask questions when encountering difficulties, engage in problem-solving activities, and produce creative outputs during learning (Putri, 2024). Finally, this study was conducted in accordance with ethical research principles. Permission was obtained from the school and students' parents or guardians, participant confidentiality was ensured, student participation was voluntary, and all research findings were reported objectively and responsibly.

RESULT AND DISCUSSION

RESULT

The findings of this study indicate that the implementation of the Student Teams Achievement Divisions (STAD) approach within Chromebook-assisted differentiated learning has a meaningful impact on both the learning process and learning outcomes of sixth-grade students in science learning, particularly on solar system material. The increased student participation observed during the learning process suggests that structured cooperative learning creates a learning environment in which students feel more confident and motivated to engage actively. Students who initially experienced difficulties in understanding abstract concepts became more involved in discussions

and were more willing to express their ideas, indicating a shift from passive to active learning behavior. This change reflects how collaborative group settings encourage students to construct understanding through interaction and shared problem-solving.

The increased interaction among students during STAD group activities highlights the effectiveness of cooperative learning in fostering peer support and shared responsibility for learning. Students were not only focused on completing tasks individually but also showed awareness of group success, which encouraged them to assist peers who encountered difficulties. The structured nature of STAD groups appeared to provide clear roles and learning expectations, enabling students to collaborate more effectively and maintain focus throughout the learning activities. This collaborative atmosphere contributed to deeper engagement with the learning material and sustained participation during discussions and group work.

The integration of Chromebooks further strengthened the learning process by supporting differentiated learning practices. Access to visual, interactive, and multimedia learning resources allowed students to explore solar system concepts in ways that suited their individual learning preferences. Students were able to visualize abstract content more clearly through images, videos, and simulations, which supported comprehension and maintained learning interest. The flexibility offered by Chromebooks enabled students to engage with learning materials at their own pace while still participating in group-based activities, creating a balance between individual exploration and collaborative learning.

Students' perceptions of the learning experience, as revealed through interviews, reinforce the observational findings. Students described the learning activities as more interesting, enjoyable, and easier to understand compared to previous lessons. Group discussions became more meaningful because students felt they had opportunities to contribute ideas and ask questions without hesitation. This sense of involvement and ownership over learning activities appeared to enhance students' confidence and willingness to participate actively, which is essential in developing meaningful learning experiences at the elementary school level.

The improvement in learning outcomes further supports the effectiveness of the STAD approach assisted by Chromebooks. The majority of students achieved scores above the Minimum Completeness Criteria in the cognitive domain, indicating satisfactory conceptual understanding of the solar system. High performance in the psychomotor domain demonstrates that students were able to apply their knowledge through hands-on activities, group tasks, and presentations. These outcomes suggest that learning did not stop at conceptual understanding but extended to skill development and practical application, which aligns with the objectives of science learning in elementary education.

At the same time, the presence of individual variation in learning outcomes highlights the importance of considering student diversity within differentiated learning. Although most students benefited from the learning approach, one student did

not achieve the expected level of mastery, indicating that differentiated and cooperative learning strategies may require further adjustment to accommodate specific learning needs. This finding emphasizes that while STAD and Chromebook-assisted learning are effective for most students, continuous reflection and adaptation are necessary to ensure inclusive learning practices that support all learners.

Overall, the discussion of these findings demonstrates that the integration of the STAD approach with Chromebook-assisted differentiated learning creates a learning environment that is active, collaborative, and supportive. This approach not only improves student engagement and understanding of science concepts but also supports the development of communication skills, collaboration, and digital literacy. The learning process becomes more meaningful as students actively construct knowledge through interaction, supported by technology that accommodates diverse learning needs, thereby contributing to improved learning outcomes in elementary science education.

DISCUSSION

The findings of this study confirm that the implementation of the Student Teams Achievement Divisions (STAD) approach within Chromebook-assisted differentiated learning positively influences both the learning process and learning outcomes of sixth-grade students in science learning, particularly on solar system material. The increased student participation, confidence, and collaboration observed during learning activities indicate that structured cooperative learning provides a supportive environment in which students are encouraged to actively construct understanding. This aligns with Slavin's cooperative learning theory, which emphasizes that STAD promotes learning through positive interdependence and individual accountability, allowing students to learn more effectively through peer interaction (Slavin, 2015).

The improvement in student engagement and interaction reflects the effectiveness of STAD in fostering meaningful collaboration. Recent studies have shown that cooperative learning models such as STAD significantly enhance student engagement and conceptual understanding in science subjects at the elementary level (Tran, 2019; Huda et al., 2021). Through group discussions and shared problem-solving, students are encouraged to articulate ideas, negotiate meaning, and support peers, which strengthens cognitive processing. These findings are consistent with research by Gillies (2016), who reported that cooperative learning environments improve both academic achievement and social interaction when students are guided to work collaboratively.

The integration of Chromebooks further strengthened the learning process by supporting differentiated learning practices. Access to multimedia resources, simulations, and visual representations enabled students to better understand abstract solar system concepts. Research within the last decade has demonstrated that technology-assisted learning enhances conceptual understanding and student motivation, particularly when digital tools are used to support active and collaborative

learning (Schindler et al., 2017; Sung et al., 2016). In the context of this study, Chromebooks allowed students to explore content according to their learning preferences while remaining engaged in group-based learning, which is a core principle of differentiated instruction (Tomlinson, 2017).

Students' positive perceptions of learning activities further support the effectiveness of combining STAD with technology-assisted differentiated learning. Students reported that learning became more interesting and easier to understand, which aligns with findings from recent studies indicating that student-centered and technology-supported learning environments increase motivation and learning satisfaction (Bond et al., 2020; Putri & Istiyono, 2022). Increased motivation is a crucial factor in elementary education, as it directly influences students' willingness to participate actively and persist in learning tasks.

The improvement in learning outcomes across cognitive and psychomotor domains reinforces the impact of this integrated approach. Most students achieved scores above the Minimum Completeness Criteria, indicating effective conceptual mastery, while high psychomotor scores demonstrate students' ability to apply knowledge through collaborative tasks and presentations. Similar results were reported by Rahmawati et al. (2021), who found that cooperative learning supported by digital media significantly improved both knowledge and skills in science learning. These outcomes suggest that learning activities were not limited to knowledge acquisition but also facilitated skill development and practical application.

At the same time, the variation in individual learning outcomes highlights the importance of inclusive practices within differentiated learning. Although the majority of students benefited from the approach, one student did not achieve the expected level of mastery, indicating that differentiated and cooperative learning strategies may require further adaptation for students with special educational needs. Recent inclusive education research emphasizes that cooperative and technology-based learning must be accompanied by individualized scaffolding to ensure equitable learning opportunities for all students (Florian & Black-Hawkins, 2017; Alnahdi, 2020).

Overall, this study strengthens empirical evidence that integrating the STAD approach with Chromebook-assisted differentiated learning creates an active, collaborative, and supportive learning environment. This approach not only improves student engagement and learning outcomes but also supports the development of essential 21st-century skills, including collaboration, communication, critical thinking, and digital literacy. These findings are relevant to current educational reforms that emphasize student-centered, inclusive, and technology-integrated learning in elementary education.

CONCLUSION

The findings of this study demonstrate that the implementation of the Student Teams Achievement Divisions (STAD) approach within Chromebook-assisted

differentiated learning has a significant and positive impact on the science learning process and outcomes of sixth-grade students, particularly on solar system material. Classroom observations indicate increased student engagement, interaction, and collaboration during group learning activities, supported by the effective use of interactive digital resources accessed through Chromebooks. Interview results further reveal that this learning approach enhances students' motivation, conceptual understanding, critical thinking, problem-solving abilities, and digital literacy. Quantitative analysis of learning outcomes shows that the majority of students (approximately 85.7%) achieved scores above the Minimum Completeness Criteria, confirming the effectiveness of this approach in improving learning achievement. Overall, the integration of the STAD cooperative learning model with Chromebook-assisted differentiated instruction creates a collaborative, inclusive, and student-centered learning environment that facilitates meaningful learning experiences and supports both academic mastery and the development of essential 21st-century skills.

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