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Analysis Of Critical Thinking, Collaboration, And Communication Skills In The Implementation Of Project-Based Learning For Science In Elementary Schools

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Abstract

Implementation of the Project-Based Learning (PjBL) Model Involving Elephant Grass Planting to Enhance Communication, Collaboration, and Critical Thinking Skills Among Grade VI Elementary School Students. This study aims to analyze improvements in the communication, collaboration, and critical thinking skills of Grade VI elementary school students through the implementation of an environmentally-oriented Project-Based Learning (PjBL) model centered on an elephant grass planting project. This qualitative study involved Grade VI students as research subjects. Data were collected using student activity observation sheets, teacher interviews, and activity documentation. The data collection techniques employed included documentation, interviews, and observation of student behavior and attitudes during the learning process. Research validation was achieved through data source triangulation and data collection technique triangulation. The results indicate that integrating the elephant grass planting project significantly stimulated students to think critically when analyzing land conditions and solving plant maintenance issues. Furthermore, the division of roles during soil preparation and planting proved to strengthen collaboration skills among students. Students' communication skills also showed significant improvement, evidenced by their active participation in group discussions and the presentation of observation journals before the class.

Keywords: Project-Based Learning, Communication, Collaboration, Critical Thinking.

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INTRODUCTION

Schools are educational institutions that develop students with various skills upon graduation. Many competencies are essential for students to survive in society, including the 3Cs. Today, everything is closely linked to the 3Cs, including critical thinking, communication, and collaboration (Sari et al., 2021). The uncertain progress and development of technology and information, including social media, and the limited availability of natural resources (SDA), require critical and creative thinking skills from each individual.

To improve 3C competencies, schools need to equip them with life skills. Project-Based Learning (PJBL) is a key example. In one school, sixth-grade students must be familiar with learning that fosters active participation. This school has a unique practice of planting elephant grass to meet the needs of the surrounding community. Many of the parents are goat farmers who require a significant supply of goat feed. Due to the school's extensive grounds, teachers have planned a project to plant elephant grass (a topic on artificial vegetative propagation). In this elephant grass planting project, students are taught critical thinking, collaboration, and effective communication skills.

Students and their class teacher analyzed problems in their surrounding environment. After analyzing the situation, it turned out that many people in the school area work as livestock farmers, thus requiring elephant grass as animal feed. Furthermore, there was vacant land behind the school that could be utilized. Therefore, the students and teacher planned a project: planting elephant grass.

The grass planting process was not carried out by the students themselves, but was accompanied by the co-curricular advisor and collaborated with several parents who are goat farmers. The students' task was to assist the elephant grass farmers and record the grass growth. Students were also encouraged to observe the planting, care, and growth of elephant grass. This helped them understand how to properly plant and care for elephant grass. Through this process, students developed life skills outside of classroom instruction. Students learned to think critically, a skill everyone should possess. Critical thinking involves logical and systematic thinking when making decisions or solving problems. Students must begin to be trained in critical thinking, which is applied to the process of analyzing problems in the community, leading to the emergence of creative ideas for planting elephant grass. Furthermore, students also learn to cultivate creativity, collaborate with peers, and communicate effectively with others.

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Many factors contribute to the need to develop life skills from elementary school (Nurnaningsih et al., 2023). Education in the current era of globalization faces complex and dynamic challenges. In this era, education must develop the skills required in the 21st century. To face 21st-century learning, every student must possess critical thinking, collaboration, and communication skills. Critical thinking is essential for solving and understanding life's problems. The following are some characteristics of critical thinking in student learning. Critical thinking, on the other hand, is the ability to evaluate and analyze information to make informed and rational decisions. Critical thinking skills are essential and essential for all students, as they are crucial for facing the challenges of the 21st century (Widiawati et al., 2024).

Critical thinking encompasses the activity or ability to filter, analyze, and critique information received, and summarize it according to their expertise. This ability enables students to process information received from the environment or media in their brains and understand it later, allowing them to assess its accuracy and act on it to devise solutions. Teachers are required to generate a concept. Furthermore, students will be active and effective throughout their lives, developing understanding, evaluating different insights, developing empowering problem-solving skills, sharing perspectives, and possessing the appropriate analytical skills. Teachers need to develop critical thinking skills that help them develop their teacher structure (Inganah et al., 2023).

Critical thinking skills are essential for analyzing and understanding problems to find appropriate solutions. In the 21st century, critical thinking is highly beneficial for students. Given the rapid development of technology and globalization, students need not only to understand theory in learning but also to integrate information processing and problem-solving into their learning process, both in the classroom, school environment, and community. Developing students' critical thinking skills is the responsibility of teachers at every level of education.

Creativity is a cognitive concept related to creative thinking and innovation in decision-making. It is a product, process, or interaction that creates new perspectives, thoughts, and objects. It also involves recognizing problems, determining possible solutions and alternatives, forming hypotheses, testing, and evaluating results. All students are creative in their use of language, and their language subsequently enables new associations, exciting combinations, and new understandings. These skills foster uniqueness in students and equip them with extraordinary imagination and intelligence. Creative activities encourage students to express what they have learned in new ways (Kariadi, 2021).

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Creative thinking skills are the next stage of critical thinking. Creative thinking requires strong analytical skills to generate new thoughts or ideas. Creative thinking skills are characterized by openness in thinking, connecting various concepts to generate solutions, and originality. Critical-creative thinking skills will support the development of computational thinking skills because they guide users to think systematically to generate solutions. Based on this, it is understood that computational thinking is the way researchers think, starting from analyzing problems, formulating solutions, and implementing them so that reliable results can be known (Dvorakova et al., 2019).

Critical thinking skills have long been considered crucial for everyone, especially students and academics. Critical thinking encompasses not only analytical skills but also the ability to make reasoned decisions. This skill is increasingly important today because much information is created and disseminated easily and without reliable information (S. Mahanal, 2019). Many community members are easily deceived by information that is unclear, based on issues, and lacks robust data. Critical thinking skills are extremely useful for understanding explicit or implicit information. Critical thinking involves analyzing information or problems, connecting them with relevant data, evaluating them, and drawing conclusions or decisions. Therefore, critical thinking skills are considered a high-level thinking skill (A.C. McLaughlin & A.E. McGill, 2017). People accustomed to critical thinking are difficult to deceive, have stable thinking, and make wise decisions. This ability can be acquired through problem-based learning and engaging in learning activities.

However, the development of critical thinking skills should begin when students are in elementary formal education. Critical thinking and problem-solving skills encompass several aspects. First, students are able to use reasoning effectively according to their needs. Next, they are able to use systems thinking, meaning students must be able to analyze the interactions or relationships between existing components. Furthermore, students are able to make judgments and decisions based on the best analysis. Another expected skill is problem-solving. Regarding communication and collaboration skills, students must be able to communicate clearly. They must be able to effectively express various ideas in various situations. Furthermore, regarding collaboration skills, students must be able to work flexibly in teams to reach shared decisions (Dwi Rahma Putri, et al., 2022).

Collaboration is the activity of sharing responsibility and accountability in completing tasks based on goals. In the 21st century, collaboration means students participating in authentic and purposeful collaborative learning opportunities to create new knowledge together

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(Beckmann, 2016). Collaboration is also a process that involves cooperation by several individuals in a group or team to achieve desired results while simultaneously fostering trust among the experts involved. Teamwork is necessary to address or solve complex problems in everyday life.

Collaborating to complete a task or assignment is now a requirement. In fact, the current academic culture in Indonesia requires multidisciplinary collaboration in learning and research. This means that learning is required to bring out differences in disciplines as additional perspectives, as well as in research (Nemiro, 2021). Group learning is often used to train collaboration skills. Collaboration is not simply bringing several people together into one group; it also requires creating a harmonious environment to achieve goals. A harmonious environment within a group can be defined as an ideal environment in which heterogeneous groups respect each other's opinions, take responsibility, contribute, support joint decisions, and provide good communication. These aspects support successful collaboration. The ability to collaborate can be practiced through problem-based activities such as conducting field research. Therefore, the ability to collaborate is crucial for students, as they must be able to adapt to diverse social backgrounds and suppress personal egotism for the sake of a common goal.

Communication skills are not limited to direct verbal activities but also include written activities. Communication skills are also supported by language fluency and data-driven learning. Collaborative skills encompass several indicators: students must contribute positively to their group, respect differences of opinion, and value shared decisions based on mutual agreement. These indicators demonstrate the ideals of group activities. Critical thinking skills are considered special because not everyone can achieve this high-level thinking skill. Critical thinking is characterized by reviewing the information obtained and connecting it with real data to form an assessment of its accuracy. Therefore, critical thinking skills require a person to think based on analysis and data to understand the information contained therein.

Communication skills are undeniably crucial in various aspects of life, such as social and professional life. Someone with good communication skills will more easily convey their ideas and build strong networks. Good communication skills become ingrained in a person, enabling them to represent themselves. Communication is not limited to conveying ideas verbally; it can also use written or even visual media. The better a person's communication skills, the better the information transfer will be received. This is a crucial element for students, as they must be able to express a variety of opinions to ensure they are accepted and understood as they desire. Sometimes, many good ideas go unnoticed due to the inability to convey them effectively (C. van

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der Vleuten, 2019). Verbal and nonverbal communication can be taught to students through research activities, reporting research results, and communicating research findings. Therefore, communication skills are supported by several aspects: 1) communication ethics; 2) effective word choice; 3) systematic; and 4) data-driven. Communication skills can be simultaneously trained through problem-based learning that requires discussion, for example, in research activities and scientific presentations.

To ensure the learning process is engaging, relevant, and beneficial for students, teachers need to be wise in selecting learning models and designing effective strategies and programs. Learning models and strategies play a crucial role in determining how students learn while simultaneously practicing desired skills. Therefore, educators are expected to encourage students to think critically, work in teams, use technology effectively, learn independently, and appreciate cultural diversity, so that students are prepared to face the demands and changes of the ever-evolving modern world.

The results of the Auto Desk Foundation's research on the characteristics of Project Based Learning. The results of the study state that Project Based Learning is a learning approach that has the following characteristics: 1) students make decisions about a framework, 2) there are problems or challenges presented to students, 3) students design a process to determine solutions to the problems or challenges presented, 4) students are collaboratively responsible for accessing and managing information to solve problems, 5) the evaluation process is carried out continuously, 6) students periodically reflect on the activities that have been carried out, 7) the final product of learning activities will be evaluated qualitatively, h) the learning situation is very tolerant of errors and changes. Project based learning is a learning approach that gives students the freedom to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others.

Critical Thinking Skills in Elementary Science Learning

Critical thinking is recognized as one of the most essential competencies required for learners in the twenty-first century because it enables students to analyze information, evaluate evidence, solve problems systematically, and make reasoned decisions based on logical arguments. In elementary science education, critical thinking plays a fundamental role because science learning is not merely focused on memorizing concepts but also on understanding scientific phenomena through inquiry, experimentation, observation, and reflection. Students

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are expected to identify problems, formulate hypotheses, collect and interpret data, analyze relationships among variables, evaluate evidence, and communicate scientific conclusions. These cognitive processes encourage learners to construct meaningful knowledge rather than simply receiving information from teachers. According to Facione (2020), critical thinking consists of interpretation, analysis, evaluation, inference, explanation, and self-regulation, all of which are interconnected cognitive skills that support effective reasoning and problem-solving. Similarly, Ennis (2018) defines critical thinking as reasonable and reflective thinking focused on deciding what to believe or do, emphasizing the importance of evidence-based judgment. In the context of elementary science, these skills help students investigate natural phenomena systematically while developing scientific literacy necessary for lifelong learning.

The development of critical thinking in science classrooms requires learning environments that actively engage students in authentic problem-solving situations rather than teacher-centered instruction. Contemporary educational theories suggest that students develop higher-order thinking through inquiry, collaborative discussions, and real-world investigations where they are encouraged to question assumptions and evaluate alternative explanations. Science education based on constructivist learning theory positions students as active constructors of knowledge through interaction with their environment and peers. During this process, teachers function as facilitators who guide learners in developing conceptual understanding through questioning, experimentation, and reflective dialogue. The Organisation for Economic Co-operation and Development (OECD, 2023) emphasizes that critical thinking is closely associated with students' ability to analyze complex information, evaluate multiple perspectives, and solve unfamiliar problems using evidence-based reasoning. Consequently, science instruction should provide opportunities for learners to investigate authentic scientific issues, analyze data critically, and justify conclusions using scientific evidence.

In elementary education, critical thinking develops gradually according to children's cognitive development. Although younger learners may still be transitioning toward abstract reasoning, they are capable of developing analytical thinking when provided with appropriate scaffolding and contextual learning experiences. Vygotsky's social constructivist perspective highlights the importance of guided interaction within the Zone of Proximal Development, where teachers and peers support learners in accomplishing tasks beyond their current independent abilities. Inquiry-based science activities, observation of natural phenomena, experimental investigations, and reflective questioning provide effective opportunities to cultivate critical

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thinking among elementary students. Furthermore, research has demonstrated that integrating project-based and inquiry-oriented instructional approaches significantly improves students' analytical reasoning, problem-solving abilities, and scientific argumentation because learners actively participate in identifying problems, collecting evidence, interpreting findings, and presenting solutions. Students become more capable of distinguishing facts from opinions, evaluating the reliability of information, and constructing logical explanations based on empirical evidence.

Recent educational research indicates that developing critical thinking has become increasingly important in the era of digital transformation, where students are continuously exposed to large volumes of information from various sources. Elementary learners need the ability to evaluate the credibility of information, identify misconceptions, and synthesize knowledge from multiple perspectives. Teachers therefore need to design learning activities that encourage questioning, reasoning, reflection, and evidence-based discussion rather than emphasizing rote memorization. Effective science learning should incorporate authentic investigations, collaborative inquiry, experimentation, and reflective assessment to stimulate higher-order thinking. Assessment practices should also measure students' reasoning processes, argument quality, and problem-solving strategies instead of focusing solely on factual recall. By integrating critical thinking into elementary science education, schools can prepare learners to become scientifically literate citizens who are capable of addressing complex challenges, making informed decisions, and participating responsibly in society while fostering curiosity, creativity, and lifelong learning habits (Facione, 2020; OECD, 2023; OECD, 2024; UNESCO, 2021; Belland, Glazewski, & Richardson, 2021).

Collaboration and Communication Skills in Project-Based Science Learning

Collaboration and communication are among the core competencies required in twenty-first-century education because they enable students to work effectively with others, exchange ideas constructively, and solve problems collectively in diverse learning environments. These competencies are particularly important in elementary science education, where students are encouraged to engage in inquiry, experimentation, discussion, and collaborative problem-solving to understand scientific concepts. Collaboration refers to the ability of learners to work together toward shared goals by contributing ideas, respecting diverse perspectives, sharing responsibilities, and making collective decisions. Communication involves expressing ideas

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clearly, actively listening to others, presenting evidence, asking meaningful questions, and engaging in constructive dialogue. Both competencies are mutually reinforcing because successful collaboration depends on effective communication, while meaningful communication often emerges through collaborative learning experiences. According to the Partnership for 21st Century Learning (P21, 2019), collaboration and communication are fundamental competencies that prepare students to participate successfully in academic, professional, and social contexts characterized by teamwork and global interaction. Likewise, the OECD (2023) emphasizes that collaborative problem-solving integrates cognitive, interpersonal, and social skills required to address increasingly complex real-world challenges.

Science learning provides an ideal context for developing collaboration and communication because scientific inquiry naturally involves teamwork, discussion, observation, experimentation, and presentation of findings. Students working in groups learn to distribute tasks, negotiate different viewpoints, resolve disagreements, and build shared understanding through collective reasoning. Teachers play an important role in facilitating productive collaboration by organizing heterogeneous groups, establishing clear expectations, monitoring group interactions, and encouraging respectful communication among students. Social constructivist theory suggests that knowledge is constructed through interaction with others, making collaborative learning an essential strategy for promoting conceptual understanding. Through peer interaction, students are exposed to multiple perspectives that stimulate deeper thinking and improve conceptual comprehension. Communication activities such as presenting project results, explaining scientific observations, debating interpretations, and responding to peer questions further strengthen students' confidence, language development, and scientific reasoning. These experiences contribute not only to academic achievement but also to the development of interpersonal competencies needed for lifelong learning.

The implementation of Project-Based Learning (PjBL) has been widely recognized as an effective instructional model for simultaneously fostering collaboration and communication skills in elementary science classrooms. During project implementation, students work collaboratively to identify problems, plan investigations, collect information, design solutions, create products, and present their findings to authentic audiences. This process requires continuous interaction among group members, encouraging learners to negotiate ideas, provide constructive feedback, solve conflicts, and assume shared responsibility for project outcomes. Bell (2020) explains that Project-Based Learning transforms classrooms into collaborative communities where students

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actively engage in inquiry while developing communication, leadership, and teamwork competencies. Similarly, Larmer, Mergendoller, and Boss (2021) argue that high-quality Project-Based Learning promotes sustained inquiry, authentic collaboration, reflection, critique, and public presentation, all of which strengthen students' communication competence alongside academic learning. In science education, projects grounded in real-life environmental or community issues enable students to connect scientific knowledge with practical applications while enhancing collaborative engagement.

Recent studies indicate that collaboration and communication significantly influence students' learning motivation, scientific achievement, and higher-order thinking. Collaborative learning environments increase student participation because learners feel more confident expressing ideas in small groups before communicating them to the whole class. Effective communication also enhances scientific literacy by enabling students to explain concepts using evidence, interpret experimental results, justify conclusions, and evaluate alternative explanations through academic discourse. In the context of twenty-first-century education, teachers should intentionally design learning experiences that integrate teamwork, discussion, peer feedback, presentation, and reflection into science instruction. Assessment should evaluate both the learning process and collaborative performance, including participation, responsibility, communication quality, conflict resolution, and collective problem-solving. By embedding collaboration and communication into Project-Based Learning, elementary science education can foster academically competent learners who are capable of working effectively with others, communicating scientific ideas clearly, and addressing authentic challenges through cooperative inquiry and evidence-based reasoning (OECD, 2023; UNESCO, 2021; Bell, 2020; Larmer, Mergendoller, & Boss, 2021; Hmelo-Silver, 2021).

DISCUSSION

At this school, particularly among sixth-grade students, the levels of collaboration, communication, and critical thinking skills remain very low. Based on preliminary observations conducted during science learning activities, several problems were identified: (1) students were still reluctant to ask questions or answer questions posed by the teacher, (2) there was a lack of communication among peers and between students and the teacher, (3) students tended to experience difficulties in communicating their ideas, (4) students demonstrated limited creativity in solving classroom problems, and (5) learning activities relied solely on textbooks, causing

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students to become bored more frequently. Inadequate critical thinking skills negatively affect students' creativity in solving problems effectively and efficiently. Consequently, students experience difficulties in communicating the results of their ideas due to decreased courage or self-confidence, as well as insufficient collaborative interaction among students.

As an alternative approach, teachers can implement instructional strategies that enhance students' communication, collaboration, and critical thinking skills. One effective approach is the use of the Project-Based Learning (PjBL) model. This is supported by research showing that the implementation of the TPACK-based Project-Based Learning model in science courses enabled university students to develop strong analytical and problem-solving abilities related to project completion. Furthermore, the final products produced by students were relevant to the projects assigned at the beginning of the learning process and were completed using appropriate and relevant sources. The findings concluded that the implementation of the TPACK-based Project-Based Learning model had a positive and significant impact on the creativity of prospective Madrasah Ibtidaiyah teachers in science courses, particularly in completing projects both individually and collaboratively (Fazilla et al., 2023).

The project was implemented through four stages of learning. Stage 1: Planning and Problem Analysis (Developing Critical Thinking). The teacher invited students to observe a barren area of the school garden. Students then participated in a discussion by answering questions such as, "Why is this area barren? Why is elephant grass suitable for this land?" Subsequently, students worked in groups to measure the area of land to be planted using measuring tapes and calculated the estimated number of elephant grass seedlings required. Each group also independently designed a daily schedule for watering and fertilizing the plants.

Stage 2: Project Implementation (Developing Collaboration). Students prepared the land by dividing responsibilities within small groups. Some students were responsible for digging and loosening the soil, others removed small stones, while the remaining members mixed compost fertilizer into the soil. The students then worked collaboratively to plant the elephant grass seedlings at appropriate distances to ensure orderly planting and optimal growth. During the maintenance phase, students took turns according to their group duty schedule to water the plants every morning or afternoon and ensure that the grass received sufficient sunlight.

Stage 3: Monitoring and Problem-Solving Discussion (Developing Critical Thinking and Communication). Each student maintained an observation journal by recording the growth of the elephant grass, including its height, leaf color, and density, in a project journal. Whenever

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problems occurred, such as wilted grass or pest infestations, each group gathered to discuss the possible causes and collaboratively determine appropriate solutions, such as increasing the watering intensity or providing additional nutrients.

Stage 4: Evaluation and Presentation of Results (Developing Communication Skills). Each group participated in a project exhibition through a Gallery Walk by creating a visual poster or a simple slideshow illustrating the transformation of the barren land into a green area. The groups then presented their work in front of the class, explaining the challenges they encountered, the strategies they used to overcome those challenges, and the distribution of responsibilities among group members. Finally, students engaged in self-reflection by providing responses and constructive positive feedback on the work produced by other groups.

Articles related to the keywords STEM-PjBL and 6C competencies were collected through the Scopus and Google Scholar databases with the help of the Publish or Perish application. The resulting pattern from 968 data points indicates that research on STEM-PjBL tends to increase between 2015 and 2025. Furthermore, network visualization patterns also indicate that STEM-PjBL is related to 6C competencies, but remains a rarely researched area. Furthermore, character and citizenship, as part of the 6C competencies, did not appear at all in the items mapped by VOSViewer. This represents a novelty in the research and a challenge for future research on how to holistically train 6C competencies in learning. Project-based learning with a STEM approach is recommended as a tool for training 6C competencies or 21st-century skills, as various studies have shown that STEM-PjBL has a multidimensional impact on learning (Winda Rachman Putri, et al., 2021). Researchers implemented the Project-Based Learning (PjBL) model to improve critical thinking, communication, and collaboration skills in sixth-grade students. This model was chosen because the stages of the PjBL model can facilitate aspects of higher-order thinking, communication, and collaboration skills in students through activities such as designing project plans, planning, and creating a work. Furthermore, PjBL engages students in learning, thus adding meaningfulness to learning.

Several studies have examined critical thinking, communication, and collaboration skills in elementary schools. The first by Ernita Pasaribu et al. (2024) found that implementing Higher Order Thinking Skills (HOTS)-based questions in elementary school learning aims to improve students' critical and creative thinking abilities. However, the biggest challenge in its implementation is how to measure and improve students' understanding of HOTS questions. This study aims to evaluate the understanding of grade 6-C students at SDN 101766 Bandar Setia

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regarding HOTS questions in Natural and Social Sciences (IPAS) learning, identify gaps in understanding, and provide recommendations for more effective learning strategies. The results showed that only 23.5% of students were able to answer the questions correctly, while the majority, 58.8%, did not understand the questions at all. Students with an average understanding numbered 17.7%. Based on these results, it is recommended that HOTS questions be introduced gradually, by improving teaching methods and creating a learning environment that supports the development of students' critical thinking skills.

Further research by Srirahmawati et al. (2024) found that 21st-century skills (6Cs), consisting of critical thinking, collaboration, communication, creativity, culture, and connectivity, are essential for facing the current era. However, students' 21st-century skills (6Cs) are still relatively low. This study aims to improve the 21st-century skills (6Cs) of fourth-grade elementary school students in the Merdeka Curriculum era. The research results show that the use of the Project-Based Learning model can improve students' 21st-Century Skills (6Cs), from a pre-cycle level of 55.4%, increasing by 17.35% in the first cycle to 72.75%. This figure then increased from 72.75% to 84.67% in the second cycle.

Another study on the 6Cs demonstrates that social studies (IPS) learning within the Merdeka Curriculum (Merdeka Curriculum) can provide the 6Cs necessary for 21st-century students to achieve the Pancasila learner profile. However, the reality is that IPS learning has not been integrated in accordance with the standard objectives of the Merdeka Curriculum. This research was motivated by the low learning outcomes of IPS due to teacher-centered learning activities, resulting in a lack of skill and student engagement. The solution to this problem is to implement a plan, do, see approach to problem-based learning. This study aims to improve learning outcomes through the PBL model in the subject of energy transformation in the IPS subject. The subjects of this research were fourth-grade students, including 6 boys and 16 girls at SDN 2 Girimoyo Malang. The results of this study were very comprehensive, exceeding the Minimum Competency (KKM) with an average classical completion score of 86.95 in the first cycle and 89.63 in the second cycle. This demonstrates that the implementation of problem-based learning can significantly improve student learning outcomes (Rani, Nisfia, 2023).

Lim Komalasari & Nurhalizah (2025) conducted research, specifically analyzing the implications of the Project-Based Learning (PJBL) model. They demonstrated that implementing the PJBL model can improve student learning outcomes, motivation, creativity, mastery of learning concepts, science process skills, academic achievement, and critical thinking.

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Implementing the Project-Based Learning (PJBL) model not only fosters independence, collaboration, and experimentation in students but also improves the quality of science education in schools.

Through the Elephant Grass Planting Project-Based Learning (PLAN), sixth-grade elementary school students actively participated in planting mini elephant grass in the school garden. This project was designed in an integrated manner to hone students' critical thinking skills as they analyzed soil conditions, calculated seed requirements, and sought solutions to challenges related to limited land and irrigation. Solid collaboration was evident throughout the process, with students working in small groups to share roles—from loosening the soil, planting seedlings, to regularly watering them. Furthermore, students' communication skills are naturally stimulated as they discuss care strategies, share ideas in groups, and periodically present observations of plant growth and development to the class. Through this hands-on learning experience, students not only gain a deeper understanding of biodiversity concepts but also hone 21st-century skills that are crucial for their growth and development.

The Project-Based Learning (PjBL) model was implemented to enhance critical thinking, communication, and collaboration skills in sixth-grade students. This model was chosen by the researchers because its stages facilitate higher-order thinking, communication, and collaboration skills through student activities such as designing, planning, and creating project plans. Furthermore, PjBL engages students in learning, adding meaningfulness to learning. The Project-Based Learning (PBL) model encourages students to actively express their opinions about the learning they experience and to develop projects that they discover can be solved. Project-Based Learning (PBL) offers several advantages in solving these problems. The Project-Based Learning (PBL) method is a 21st-century learning model that prioritizes or centers on students (student-centered). The Project Based Learning method emphasizes learning activities by doing something (Stix, 2007). By considering the age of students who are starting to mature and are eager to master new skills, Project Based Learning is expected to foster the 6C life skills of critical thinking, creativity, collaboration, communication, computational and compassion.

CONCLUSION

Project-Based Learning (PjBL) has proven effective in honing a variety of much-needed 21st-century skills, particularly communication, collaboration, and critical thinking. Through this project-based approach, students go beyond memorizing theory to encountering real-world

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challenges that require them to explore and solve problems in depth. This process fosters critical thinking as students analyze information, evaluate solutions, and make strategic decisions independently. At the same time, working on projects in groups fosters collaboration, as students learn to share roles, appreciate different perspectives, and manage team dynamics. This entire series of activities ultimately leads to improved communication skills, as students learn to clearly convey ideas during discussions, formulate arguments, and present their work to an audience..

FUTURE DIRECTIONS

Berdasarkan efektivitas Project-Based Learning dalam meningkatkan keterampilan abad ke-21, disarankan agar pihak sekolah mendukung penerapan metode ini melalui penyediaan fasilitas yang memadai dan pelatihan bagi pendidik. Selain itu, bagi peneliti selanjutnya, disarankan untuk mengkaji lebih dalam mengenai variasi bentuk proyek dan instrumen penilaian yang paling optimal, guna mengukur secara presisi sejauh mana PjBL dapat mengintegrasikan peningkatan kemampuan komunikasi, kolaborasi, dan berpikir kritis murid pada berbagai tingkatan umur dan mata pelajaran yang berbeda.

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