Literature Review: Development of Science Capital-Based Student Worksheets to Enhance Critical Thinking Skills of Elementary School Students

Winarsih[1], Firmanul Catur Wibowo[2], Otib Satibi Hidayat[3]
Universitas Negeri Jakarta[1,2,3]
Jl. Jl. Rawamangun Muka Raya No.11, Jakarta Timur,
Daerah Khusus Ibukota Jakarta 13220[1,2,3]
Telp. (021)4898468
E-mail: winarsih@unj.mhs.ac.id[1],
fcwibowo@unj.ac.id[2], otibsatibi@unj.ac.id[3]

ABSTRACT

Critical thinking skills of elementary school students remain relatively low, particularly in the evaluation indicator. One contributing factor is the lack of innovation in the development of Student Worksheets (LKPD). This article aims to systematically review the development of science capital-based worksheets as an alternative approach to enhance critical thinking skills in elementary schools. The method used is a literature review, with literature searches conducted across academic databases such as Google Scholar, JSTOR, ScienceDirect, Garuda, as well as policy documents from the Indonesian Ministry of Education and Culture (Kemendikbudristek). The findings indicate that various LKPD development approaches (STEM, PBL, SETS, Discovery Learning, Multiple Intelligences) have proven effective in improving critical thinking skills, with high levels of validity and practicality. However, no study has explicitly integrated science capital into LKPD. The science capital approach offers integrative advantages by valuing students' experiences, knowledge, attitudes, and social networks as a starting point for learning, while simultaneously building scientific identity and addressing participation gaps. The Kurikulum Merdeka (Merdeka Curriculum) policy provides a conducive foundation for implementing this approach. In conclusion, the development of science capital-based LKPD represents an urgent theoretical leap to address the challenges of low critical thinking skills and the need for learner-centered education. Further empirical research is needed to test the effectiveness of science capital-based LKPD.

Keywords: Student worksheets, LKPD, science capital, critical thinking, elementary school, literature review, Merdeka Curriculum

INTRODUCTION

The 21st century demands that every individual possesses adequate skills to adapt to rapid changes. Critical thinking skills are one of the essential competencies greatly needed (Fadila, 2024). Science education is expected to serve as a primary vehicle for students to develop reasoning, analyzing, evaluating, and decision-making abilities based on scientific evidence. At the elementary school level, science learning (referred to as Natural and Social Sciences/IPAS in the Merdeka Curriculum) plays a strategic role in fostering the foundations of scientific thinking from an early age (Kemendikbudristek, 2024). The latest curriculum policies, through Permendikbudristek No. 12 of 2024 and SK BSKAP No. 32 of 2024, have established the Merdeka Curriculum as the national curriculum framework, within which the IPAS Learning Outcomes emphasize the development of students' critical and analytical thinking skills (Kemendikbudristek, 2024).

However, the reality on the ground indicates that elementary school student's critical thinking skills remain in the moderate to low category. A study analyzing critical thinking skills at SD Negeri 1 Sidoharum revealed that the average critical thinking skills of students were in the moderate/fairly critical category. Furthermore, among the four indicators measured (interpretation, analysis, inference, and evaluation), the evaluation indicator was found to be in the low category (Wahyono et al., 2025). These findings indicate a significant gap between the ideal curriculum objectives and actual achievement in the field.

One of the root causes of low critical thinking skills is the suboptimal use of innovative and contextual teaching materials. Observations conducted at SD Negeri Ungaran 01, for example, found that the Student Worksheets (LKPD) used had not been developed innovatively and did not adequately support students' various types of intelligence (Budiman et al., 2024). Teachers also still face obstacles in developing LKPD that align with curriculum demands, often resorting to using commercially available LKPD that do not fully meet student's needs (Rajagukguk et al., 2024).

This is where the urgency to develop LKPD based on a new approach emerges. The Science Capital approach, championed by Louise Archer and her research team, offers a fresh perspective on science learning ((Docking, 2021; Godec et al, 2017). Science capital is understood as a set of science-related resources and dispositions that a person possesses, encompassing scientific knowledge, attitudes towards science, science-related behaviors, and social networks connected to science (Docking, 2021). The science capital approach is highly relevant to addressing the challenge of low critical thinking skills because it emphasizes linking abstract scientific knowledge with children's concrete, everyday experiences.

Based on this background, this article aims to conduct a systematic literature review on the development of science capital-based LKPD in an effort to enhance critical thinking skills among elementary school students.

1. The Concept of Science Capital and Its Relevance in Elementary Science Education

The concept of science capital was first introduced by Louise Archer and her research team through the ASPIRES project (2013) as an extension of the theories of cultural and social capital proposed by Pierre Bourdieu. DeWitt et al., (2016) explains that science capital can be understood as a "backpack" containing four main components: (1) what science you know, (2) how you think, (3) what you do, and (4) who you know. Known as the “science capital Holdall” metaphor.

Picture 1:
The “science capital Holdall” metaphor

Source: https://pendidikankimia.walisongo.ac.id/wp-content/uploads/2018/10/dewitt2016.pdf

In the context of elementary education, the application of the science capital approach has several strong justifications, including the fact that attitudes and aspirations related to science begin to form at an early age (Docking, 2021). The primary science capital teaching approach focuses on three main strategies: eliciting (exploring children's existing science experiences), valuing (appreciating those experiences), and linking (connecting everyday experiences with formal science knowledge).

2. Critical Thinking Skills: Definition and Indicators

Critical thinking skills refer to the ability to analyze facts, organize ideas, defend opinions, make comparisons, draw conclusions, evaluate arguments, and solve problems (Ningtiaz & Suswanto, 2025). Several indicators of critical thinking skills relevant to elementary school students include interpretation, analysis, inference, evaluation, explanation, and self-regulation. As previously mentioned in the introduction, empirical results show that elementary school students' critical thinking skills are still not optimal, with the most prominent gap occurring in the evaluation indicator (Wahyono, 2025).

3. Integration of Science Capital into LKPD

Integrating science capital into Student Worksheets (LKPD) represents a pedagogical innovation with great potential to address the existing gap (Docking, 2021). The science capital approach encourages teachers and LKPD developers to start from what is already known and familiar to children (everyday science), then gradually connect it to formal

science concepts. Research conducted by the CIEC at the University of York shows that the science capital approach, which links learning to industry and real-world applications of science, can effectively change the attitudes of elementary school-aged children toward science (Docking, 2021). Operationally, LKPD that integrates science capital should include activities such as eliciting initial experiences, connecting science knowledge to daily life, exploration and investigation, reflection, as well as collaboration and discussion.

4. Merdeka Curriculum Policy and Its Implications

The Merdeka Curriculum, which has been implemented nationally, provides a highly conducive policy foundation for the development of science capital-based LKPD (Kemendikbudristek, 2022). Several key relevant policies include the integration of science and social studies subjects into Natural and Social Sciences (IPAS) at the elementary level, an emphasis on project-based learning to strengthen the Pancasila Student Profile, and the IPAS Learning Outcomes that explicitly state the aim of developing critical and analytical thinking skills (Fadila, 2024; Kemendikbudristek, 2024).

METHOD

This study is a literature review (library research) using a qualitative approach with content analysis techniques. Literature collection was conducted through systematic searches across various academic databases, including Google Scholar, JSTOR, ScienceDirect, DOAJ, and national education journal portals such as Garuda (Kemendikbud) and other accredited journals. The keywords used included combinations of: "pengembangan LKPD", "science capital", "berpikir kritis", "sekolah dasar", "student worksheets", "critical thinking", "elementary school", and "IPAS". In addition to journal articles, official policy documents such as Permendikbudristek No. 12 of 2024 and SK BSKAP No. 32 of 2024 were also part of the reviewed sources (Kemendikbudristek, 2024).

The literature inclusion criteria were: (a) published between 2014 and 2026, (b) focused on science education or IPAS at the elementary school level, (c) discussed LKPD or the development of similar teaching materials, (d) discussed critical thinking skills, and (e) discussed the concept of science capital or related approaches. The analysis stages included literature collection and identification, screening based on inclusion criteria, extraction of key information, synthesis of findings, and drawing conclusions.

FINDINGS AND DISCUSSION

The literature search identified a number of relevant studies on LKPD development. Although no study explicitly developed science capital-based LKPD, various studies with different approaches demonstrated the effectiveness of LKPD in improving critical thinking skills.

Table 1:
Summary of Research Results on LKPD Development to Improve Critical Thinking

Study	Approach/Model	Main Findings
Islami (2025)	STEM-based LKPD	Material validity 75.84%, language 95%, media 78.18%; practicality 89.38%; effectiveness post-test 82.08%
Afriyani (2024)	Discovery Learning-based science LKPD	Attractiveness score 4.30, ease 4.55, usefulness 4.82; N-gain 0.12
Azzahro (2025)	Design Thinking-based ecosystem LKPD (ADDIE)	Expert validation: design 92.5%, material 94.9%, learning 92.5%; student response 81.25%; significant t-test (p=0.041)
Budiman et al., (2024)	Multiple Intelligences-based IPAS LKPD with Guided Inquiry (4D)	Media feasibility 97%, material 96%, language 98%; N-gain 0.504 (moderate)
Pramudiyanti et al., (2023)	PBL-based student worksheet (ADDIE)	Expert validity: material 0.8409, language 0.8036, media 0.7522; N-gain 0.7 (moderate)
Adhiyah & Pertiwi (2024)	SETS-based E-LKPD and ADDIE model	The SETS approach has been empirically proven to be superior to discovery learning in improving critical thinking.
Sherly (2024)	Canva application-based LKPD (ADDIE)	N-Gain improvement 0.56 (moderate)

1. Science Capital in Elementary Science Education

Literature on science capital in the context of elementary science education indicates that science capital plays an important role in shaping children's aspirations and participation in science (Docking, 2021). The Primary Science Capital Teaching Approach (PSCTA), with its strategies of eliciting, valuing, and linking, has been shown to improve children's engagement and aspirations toward science. Research by the CIEC at the University of York supports the idea that educators can change the attitudes

of elementary school-aged children who struggle to see the relevance of classroom science to their own lives (Docking, 2021).

From a policy perspective, the Merdeka Curriculum provides ample space for the development of innovative approaches such as science capital (Fadila, 2024; Kemendikbudristek, 2024). The policies of integrating science and social studies into IPAS, project-based learning, and the emphasis on the Pancasila Student Profile form a strong foundation (Kemendikbudristek, 2024).

2. Why Science Capital is Relevant as an Integrated Approach

The results summarized in Table 1 convincingly show that the development of LKPD using various approaches—STEM, Discovery Learning, Design Thinking, Multiple Intelligences, Guided Inquiry, PBL, SETS, and Canva digital media—has proven effective in improving the critical thinking skills of elementary school students (Islami, 2025; Afriyani et al., 2024; Azzahro, 2025; Budiman, 2024; Pramudiyanti & Rohman, 2023; SETS Study, 2022; Sherly, 2024). All studies reported high validity levels (ranging from 75-98%) as well as high practicality and positive responses from teachers and students. This indicates that the need for innovative and structured LKPD is strongly felt in the field (Rajagukguk et al., 2024).

Although the aforementioned approaches have proven effective, the science capital approach offers integrative and holistic added value (Docking, 2021). STEM, PBL, and Discovery Learning approaches have not explicitly valued the social and cultural capital possessed by each student. Science capital overcomes this limitation by making students' experiences, knowledge, attitudes, and social networks the starting point for learning, while also building students' science identity (Docking, 2021). This approach also addresses the equity gap because it values the diversity of economic and cultural backgrounds.

3. Synergy between Science Capital and Merdeka Curriculum Policy

The Merdeka Curriculum provides a highly suitable ecosystem for the implementation of science capital (Kemendikbudristek, 2022; Kemendikbudristek, 2024). The Merdeka Curriculum's focus on developing the Pancasila Student Profile, particularly the critical reasoning dimension, provides strong legitimacy for efforts to enhance critical thinking skills. Implementation barriers such as lack of teacher understanding can be overcome through structured training and mentoring (Rajagukguk et al., 2024).

The synergy between the science capital approach and the Merdeka Curriculum is further reinforced by international findings demonstrating that this approach effectively supports equitable, inclusive, and sustainable education. Fischer et al. (2024), in their study conducted in Finland, found that the science capital teaching approach (SCTA) is capable of integrating the 12 sustainability competences from the GreenComp framework, including critical thinking, systems thinking, and problem framing, which align with the critical reasoning dimension of the Pancasila Student Profile.

Furthermore, the study revealed that SCTA supports a balance among the three sustainability pillars (environment, society, and economy), although the economic pillar still requires more attention (Fischer et al., 2024). These findings are relevant to the context of the Merdeka Curriculum, which encourages cross-disciplinary and project-based learning to equip students to face 21st-century challenges.

In addition, Archer et al. (2024) asserted that the science capital approach is built upon the principles of justice-oriented pedagogy, which include recognizing and disrupting dominant power relations, using asset-based approaches, developing trust and care between teachers and students, and supporting student agency through science learning. These principles are highly aligned with the spirit of the Merdeka Curriculum, which emphasizes student-centered learning, differentiation, and the strengthening of the Pancasila Student Profile. Archer et al. (2024) also highlighted the importance of critical professional reflection for teachers, which aligns with efforts to overcome implementation barriers such as teachers' lack of understanding of innovative approaches (Rajagukguk et al., 2024).

In the context of a more inclusive curriculum, Cooper et al. (2024) proposed the concept of First Nations science capital as an extension of traditional science capital. They critiqued the Australian science curriculum for remaining Eurocentric and marginalizing the scientific knowledge of Indigenous communities. Through a science capital lens, Cooper et al. (2024) recommended a curriculum that is local and relevant, co-constructed with the community, and that recognizes diverse ways of knowing. Although the context differs (Australia vs. Indonesia), this recommendation is relevant to the Merdeka Curriculum's efforts to accommodate local wisdom and Indonesia's cultural diversity through contextual and meaningful teaching materials for students. Thus, the synergy between science capital and the Merdeka Curriculum lies not only in their shared goal of developing critical thinking but also in their mutual commitment to social justice, inclusivity, and cultural relevance in science education.

Based on the theoretical synthesis and empirical findings, several important implications can be formulated. First, science capital-based LKPD needs to be developed using systematic development models such as ADDIE or 4D (Budiman et al., 2024; Pramudiyanti et al., 2023). Second, the LKPD must include eliciting, valuing, and linking activities (Docking, 2021). Third, critical thinking skill indicators need to be adapted to students' cognitive development levels, with special attention to the evaluation indicator, which remains low (Wahyono et al., 2025). Fourth, development should involve various stakeholders: curriculum developers, teachers, and parents. Fifth, the form of LKPD can vary, both print and electronic (Adhiyah & Pertiwi, 2024; Sherly, 2024).

CONCLUSION

Future researchers are advised to conduct direct development and empirical testing of science capital-based LKPD, as no study has yet explicitly developed LKPD labeled "science capital" at the elementary school level. Development research can use the ADDIE, 4D, or Borg & Gall models (Pramudiyanti & Rohman, 2023; Budiman, 2024; SETS Study, 2022). The measured indicators of critical thinking skills need to be expanded, particularly the evaluation indicator (Wahyono et al., 2025).

Teachers are advised to begin integrating science capital principles into daily learning (Docking, 2021). Teachers can adapt approaches that have proven effective (STEM, PBL, SETS) by adding the elements of "who you know" and "what you do outside school". Schools are encouraged to conduct regular training on developing innovative LKPD (Rajagukguk et al., 2024). Existing Merdeka Curriculum policies need to be strengthened by providing more operational technical guidelines for developing science capital-based LKPD (Kemendikbudristek, 2024). A national training program for elementary school teachers on the science capital approach is required. The government should also encourage collaboration between schools and research institutions, industry, and the community.

This literature review concludes several important points. First, the critical thinking skills of elementary school students are still not optimal, with the evaluation indicator in the low category (Wahyono et al., 2025). Second, various studies on LKPD development using STEM, PBL, SETS, Discovery Learning, Design Thinking, Multiple Intelligences, and Guided Inquiry approaches have proven valid, practical, and effective in improving critical thinking skills (Islami, 2025; Afriyani et al., 2024; Azzahro, 2025; Budiman, 2024; Pramudiyanti & Rohman, 2023; SETS Study, 2022; Sherly, 2024). Third, the science capital approach offers integrative and holistic added value by utilizing, valuing, and connecting students' knowledge, attitudes, behaviors, and social networks related to science (Docking, 2021). Fourth, the Merdeka Curriculum policy provides a conducive foundation for the implementation of science capital (Kemendikbudristek, 2022; Kemendikbudristek, 2024). Fifth, no study has explicitly integrated science capital into LKPD; therefore, the development of science capital-based LKPD represents an important theoretical and practical leap forward.

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