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Toward global scientific literacy: Evaluating primary science education in Indonesia's Merdeka and Cambridge curricula

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Abstract. In response to global demands for 21st-century competencies, Indonesia has implemented the Merdeka Curriculum, while many internationalised schools adopt the Cambridge Curriculum. Both aim to foster scientific literacy but differ in philosophical foundations, curriculum structure, and pedagogical design. This study aims to compare the implementation of science education in these two curricula at SD Tunjung Sari, an SPK (Satuan Pendidikan Kerjasama) school in Bali, to identify their respective strengths and inform future curriculum integration. Employing a qualitative design, data were collected through document analysis, semi-structured interviews, and classroom observations. The study focused on four key components: learning objectives, content, instruction, and assessment, using Miles and Huberman's interactive model. Findings indicate that the Merdeka Curriculum emphasises holistic development and contextual learning through project-based and Science–Technology–Society (STS) approaches. At the same time, the Cambridge Curriculum promotes inquiry-based learning with a structured, internationally benchmarked sequence. Although both curricula align with PISA's scientific literacy domains, they differ in content scope and delivery. The study recommends a hybrid model that integrates global standards with local values to enhance science education in diverse contexts. This can support policymakers and educators in designing future-ready curricula that are both globally competitive and culturally rooted.

Introduction

In an era characterised by rapid technological advancement and growing global interconnectivity, science education has become pivotal in equipping learners with the competencies required for critical thinking, problem-solving, and responsible citizenship (Yasa et al., 2022). In response to these demands, educational systems worldwide have undergone substantial curriculum reform, shifting from content-heavy paradigms to competency-based, inquiry-driven models aligned with international benchmarks such as the Programme for International Student Assessment (PISA) (OECD, 2023). Indonesia's national response to this global trend is encapsulated in the Merdeka Curriculum, which aims to cultivate the *Profil Pelajar Pancasila,* a holistic student profile encompassing noble character, critical reasoning, independence, cooperation, creativity, and global diversity (Rachman et al., 2024; Widana et al., 2023). Simultaneously, many internationalised schools in Indonesia, particularly those under the Satuan Pendidikan Kerjasama (SPK) framework, adopt the Cambridge International Curriculum. This globally recognised framework emphasises inquiry-based learning, scientific reasoning, and reflective engagement (Wijayanti et al., 2024; Purnadewi & Widana, 2023).

While both curricula purport to prepare students for 21st-century challenges, their conceptual orientations and pedagogical strategies diverge significantly. The Merdeka Curriculum integrates Science (IPA) within a broader interdisciplinary framework (IPAS), emphasising real-world relevance, character development, and cultural responsiveness through project-based learning and the Science, Technology, and Society (STS) approach (Rohsulina et al., 2024). In contrast, the Cambridge Curriculum introduces Science as a discrete subject from early primary years, structured around three interrelated strands: *thinking and working scientifically*, *scientific content*, and *science in context,* fostering early mastery and international academic alignment (Shoufika et al., 2024; Citrawan et al., 2024). These differences raise critical questions regarding how curricular objectives, content, pedagogy, and assessment strategies are conceptualised and implemented in practice, particularly in dual-framework settings such as SPK schools.

The imperative for a future-oriented science curriculum is increasingly driven by the profound transformations brought about by digital advancement and ecological instability. In the face of challenges such as climate change, global health crises, and technological disruption, science education must evolve from mere knowledge transmission to a dynamic process of cultivating transferable skills, ethical reasoning, and adaptive expertise (Syofyan et al., 2025; Suhardita, 2024). In alignment with this shift, global frameworks such as PISA have expanded the definition of scientific literacy to encompass the application of knowledge in socially and environmentally relevant contexts (OECD, 2023). Consequently, curricular design must integrate cognitive, metacognitive, and ethical competencies to prepare learners for complex, interdisciplinary realities (Amaruddin et al., 2024; Widiana et al., 2024). Within the Indonesian context, this evolution is exemplified by the implementation of the Merdeka Curriculum and the adoption of the Cambridge International Curriculum in SPK schools, an educational intersection that embodies both global benchmarking and local cultural relevance (Supriyanto et al., 2025; Wijayanti et al., 2024). These dual frameworks operate simultaneously, offering a unique site for examining how international standards are reconciled with national identity in classroom practices. This pedagogical negotiation reflects broader discourses on educational equity, localisation of global learning goals, and the decolonisation of knowledge (Limiansi et al., 2023; Minsih et al., 2025). By scrutinising the enactment of these curricular models in situ, this study contributes to the scholarly dialogue on curriculum internationalisation, offering insights into how science education can be reimagined as both globally competent and contextually grounded.

Field observations and preliminary interviews at SD Tunjung Sari, an SPK primary school in Bali, revealed varying implementation practices between the two curricula, particularly in how teachers interpret and deliver science content. Teachers reported challenges in integrating local context within the Cambridge framework and, conversely, noted gaps in scientific rigour and resource support under the Merdeka Curriculum. These disparities highlight a gap between curriculum ideals and classroom realities, warranting empirical investigation.

Theoretically, the Merdeka Curriculum adopts a holistic and interdisciplinary approach through IPAS (Ilmu Pengetahuan Alam dan Sosial), integrating Science with Social Studies to promote contextual relevance and character building using project-based and STS (Science–Technology–Society) approaches (Rohsulina et al., 2024). In contrast, the Cambridge Curriculum treats Science as a discrete subject from Year 1, structured around three interrelated strands: thinking and working scientifically, scientific content, and science in context (Shoufika et al., 2024). These divergent logics raise questions about how learning objectives, content, pedagogy, and assessment are translated into practice, especially within dual-curriculum institutions.

Despite the coexistence of these curricular models in Indonesia, empirical research that systematically compares their implementation at the primary level remains scarce. Such comparative inquiry is essential to illuminate how each framework translates abstract policy goals into tangible classroom realities and how they support students' development of scientific literacy as defined by the PISA domains: context, knowledge, competencies, and attitudes (Rahmah et al., 2024; Syofyan et al., 2025). The primary aim of this study is to conduct a comprehensive comparative analysis of science education at the primary level by examining the Merdeka Curriculum and the Cambridge Curriculum across seven key dimensions. First, it seeks to analyse the learning objectives articulated in both curricula, with particular attention to their underlying epistemological orientations, competency focus, and expected student outcomes. Second, the study investigates the roles and pedagogical autonomy of teachers, exploring the extent to which educators are empowered to adapt and implement curriculum content and methods in response to local classroom contexts. Third, the research examines classroom culture and student engagement, focusing on how each curriculum promotes participatory learning environments and fosters student motivation and involvement. Fourth, the study compares the structure and scope of science content, including the thematic organisation, progression of scientific concepts, and the depth and breadth of material presented from Year I to Year VI. Fifth, it analyses the instructional processes and pedagogical strategies endorsed and enacted within each curricular framework, such as project-based learning, inquiry-based approaches, and contextual integration. Sixth, the study evaluates the assessment systems and standards, encompassing both formative and summative practices, performance-based assessments, and alignment with national or international benchmarks. Finally, it synthesises triangulated insights from document analysis, classroom observations, and teacher interviews to assess the curriculum adaptability in diverse educational settings, highlighting the strengths, challenges, and transformative potential of each curricular model. By situating this inquiry within a real-world SPK setting, the study contributes to ongoing debates on curriculum internationalisation, educational equity, and the hybridisation of global and local values in science education.

Method

This study adopted a qualitative research design to analyse the differences in science learning at the primary education level between the Merdeka Curriculum and the Cambridge Curriculum. The research compared both curricula in terms of learning objectives, content, instructional processes, and assessment practices. The research was conducted at SD Tunjung Sari, situated in Mas Village, Ubud District, Gianyar Regency, Bali Province. The institution operates as a *Satuan Pendidikan Kerjasama* (SPK), authorised to implement both the Indonesian National Curriculum and the Cambridge International Curriculum. Data collection was carried out over two months, from March to May 2025, during the 2024/2025 academic year.

Data were collected through document analysis, semi-structured interviews, and classroom observations, under qualitative research methodology (Hairudin et al., 2023; Mareza, 2021). The instruments used encompassed several components. Document analysis sheets were employed to examine key curricular materials. For the Merdeka Curriculum, this included the curriculum framework, IPAS teaching modules, student textbooks, and assessment rubrics. For the Cambridge Curriculum, documents analysed comprised the science syllabi, teacher guides, workbooks, lesson plans, and standardised assessments. Semi-structured interview guidelines consisted of open-ended questions organised around the four primary curriculum components: objectives, content, instructional practices, and assessment strategies. Each theme was systematically aligned with analytical indicators derived from the corresponding curriculum documents. In addition, observation checklists were used to capture instructional strategies, teacher–student interactions, and the use of curricular resources during IPAS and Cambridge Science classes. To ensure coherence and analytical rigour, a detailed blueprint of the interview and observation instruments was developed in tabular format, outlining each dimension, such as instructional strategies and assessment techniques, along with their corresponding indicators and question items.

Interview participants included (1) homeroom teachers of Years III, IV, V, and VI; (2) the school principal; and (3) Science subject teachers. Classroom observations were carried out during both IPAS and Science sessions to triangulate findings from different methods and sources (Nadhirah & Puspitasari, 2024; Wijayanti et al., 2024).

To ensure data validity, triangulation was applied through both methodological triangulation and data source triangulation. This approach is widely endorsed in qualitative educational research as a means of reducing bias and increasing data reliability (Hairudin et al., 2023; Mareza, 2021; Nadhirah & Puspitasari, 2024). Methodological triangulation was achieved by integrating document analysis, interviews, and observations to provide a multi-faceted understanding of the instructional phenomena under investigation (Hairudin et al., 2023). Meanwhile, data source triangulation involved the collection of information from a range of informants and institutional records to ensure internal consistency and confirmability of findings (Nadhirah & Puspitasari, 2024; Wijayanti et al., 2024).

The data analysis followed the interactive model proposed by Miles and Huberman, consisting of three iterative stages: data reduction, data display, and conclusion drawing (Miles & Huberman, 1994). In the data reduction phase, researchers selected and condensed data relevant to the study's aims and research questions, filtering out non-essential information to enhance analytical focus (Cohen, L., Manion, L. & Morrison, 2018). The reduced data were then organised into thematic displays, including narrative summaries and conceptual categories, allowing for clearer identification of emerging patterns (Creswell & Clark, 2018).

Finally, conclusions were drawn by synthesizing the displayed data with theoretical concepts and prior research findings. This stage involved iterative cross-validation to ensure that all interpretations were empirically grounded and aligned with the research objectives (Cohen, L., Manion, L. & Morrison, 2018). Triangulation served as a critical validation mechanism across all stages, enhancing the credibility and rigour of the entire research process (Sandelowski & Barroso, 2007).

Results and Discussion

The findings and discussion section presents a comparative analysis of Science education (Ilmu Pengetahuan Alam – IPA) as implemented under the Merdeka Curriculum and the Cambridge Curriculum at Tunjung Sari Primary School, which operates as an International Partnership School (Satuan Pendidikan Kerjasama/SPK). The comparison is structured around four key components of the curriculum: learning objectives, content, learning processes, and assessment (Rachman et al., 2024; Syofyan et al., 2025; Wijayanti et al., 2024).

Learning Objectives

Regarding learning objectives, the Merdeka Curriculum prioritises the development of the Pancasila Student Profile (Profil Pelajar Pancasila), which consists of six dimensions: noble character, critical reasoning, global diversity, mutual cooperation, independence, and creativity (Wijayanti et al., 2024). These dimensions are translated into learning outcomes categorised under scientific understanding and scientific process skills. Each phase, Years 1–2 (Phase A), Years 3–4 (Phase B), and Years 5–6 (Phase C) progressively builds these outcomes. Scientific understanding encompasses competencies such as identifying, analyzing, simulating, and explaining scientific phenomena, whereas scientific process skills involve observing, predicting, designing experiments, analyzing data, and communicating results (Limiansi et al., 2023; Syofyan et al., 2025). This structure reflects a stage-wise approach to curriculum implementation, aligning with developmental readiness and future competency demands (Rachman et al., 2024; Ray et al., 2014).

Conversely, the Cambridge Curriculum is designed to cultivate attributes such as responsibility, innovation, confidence, engagement in scientific problem-solving, and reflectiveness. These values are operationalised into three learning strands: thinking and working scientifically, content, and science in context. The contextual strand, in particular, enhances meaningful learning by bridging abstract concepts with real-world applications (Limiansi et al., 2023; Wijayanti et al., 2024). This competency-based design aligns with international trends in science education that emphasise inquiry, reflection, and active engagement (Syofyan et al., 2025).

Both curricula demonstrate alignment with the domains of scientific literacy as established by the Programme for International Student Assessment (PISA), which include context, knowledge, competencies, and attitudes (OECD, 2023; Nadifa & Zulvani, 2024). In the Merdeka Curriculum, these domains are addressed through integrated IPAS learning, which links science to students' social and environmental realities. Scientific knowledge and competencies are reinforced through experimental and analytical tasks, while character-based learning outcomes address the attitudes domain (Rachman et al., 2024; Syofyan et al., 2025). Similarly, the Cambridge Curriculum embeds these domains within its strands: 'thinking and working scientifically' aligns with competencies, 'content' with knowledge, and 'science in context' with real-world applications, while also fostering positive learner attitudes (Ray et al., 2014; Wijayanti et al., 2024).

Teacher Roles and Pedagogical Autonomy

Another noteworthy distinction lies in the role and agency of teachers within each curricular framework. In the Merdeka Curriculum, teachers are envisioned not merely as content deliverers but as facilitators of character and contextual learning who exercise pedagogical flexibility to adapt IPAS modules to local cultural and environmental themes. This autonomy enables the design of project-based learning that connects science education with students' lived realities, promoting ethical reflection and cooperation (Wijayanti et al., 2024). However, this flexibility also presents challenges, particularly in balancing interdisciplinary learning demands with the need for scientific rigour, especially in contexts where specialised science training is lacking (Rahmah et al., 2024).

In contrast, the Cambridge Curriculum offers a more prescriptive structure, standardising lesson plans, assessment rubrics, and instructional materials across contexts to support consistent content delivery. This standardisation provides teachers with clear instructional guidelines and sequenced content, enhancing reliability in teaching outcomes (Supriyanto et al., 2025). Nevertheless, such rigidity can constrain teacher innovation and limit the incorporation of culturally relevant examples or local environmental case studies (Winarto et al., 2024). Despite this, teachers trained under the Cambridge framework often benefit from extensive professional development that emphasises inquiry-based pedagogy and alignment with global best practices (Mutmainah et al., 2023; Supriyanto et al., 2025).

From a teaching perspective, the Cambridge Curriculum offers detailed lesson plans, textbook series, and assessments that support standardised instruction and facilitate accountability. However, it may limit teacher autonomy in localising content or innovating instruction beyond the set materials. In contrast, the Merdeka Curriculum grants teachers significant freedom to interpret modules, design projects, and adapt learning to local issues, which can increase relevance but may require more professional development and resource support. Educators must also navigate differing expectations around assessment. Cambridge relies heavily on performance-based and written testing, while Merdeka includes character assessment and performance tasks integrated into broader thematic units.

Classroom Culture and Student Engagement

Classroom culture and student engagement also diverge significantly across the two models. Observations at SD Tunjung Sari revealed that Merdeka-based Science lessons are marked by collaborative practices such as thematic discussions, group experiments, and community-based inquiry projects. These foster student-centred learning and align with the values of the Pancasila Student Profile, though at times they may lack the structured scaffolding necessary to ensure deep conceptual understanding for all students (Afida et al., 2024; Wijayanti et al., 2024). Conversely, Cambridge lessons tend to be more individualistic, focusing on scientific reasoning, structured laboratory work, and metacognitive tasks like hypothesis formulation and result interpretation approaches that foster analytical precision but may limit social learning opportunities, especially among younger students (Supriyanto et al., 2025; Winarto et al., 2024).

Structure and Scope of Science Content

Regarding content, the Merdeka Curriculum formally introduces Science in Year 3, progressively building thematic units integrated within the IPAS framework, whereas the Cambridge Curriculum introduces Science from Year 1 with a more structured and compartmentalised approach (Limiansi et al., 2023). Weekly instructional time also varies. In the Cambridge Curriculum, Science is taught for 1.5 to 2.5 hours per week, depending on year level, with increasing duration per session from Year 1 to Year 6. In contrast, the Merdeka Curriculum dedicates five 35-minute sessions per week from Year 3 onwards. This differential allocation of content and time reflects diverse pedagogical philosophies: the Merdeka model favours thematic immersion and character integration, while the Cambridge model promotes early exposure and mastery of scientific concepts (Rachman et al., 2024; Syofyan et al., 2025; Wijayanti et al., 2024). The differences in Science content between the Merdeka and Cambridge curricula are summarised in Table 1 as follows:

Table 1. Comparison of Science Subject Content in the Merdeka Curriculum and the Cambridge Curriculum

Year Level	Merdeka Curriculum	Cambridge Curriculum
I	Not yet introduced	• Living things • Sound • Materials on Earth • The Earth • Humans as living beings • Force
II	Not yet introduced	• Environment and habitats of animals and plants • Motion and force • Properties of matter • Growth of living things • Light • Electricity
III	• Let us explore the animals around us • Understanding the life cycles of living things • Living in harmony with nature	• Plants as living things • Mixtures and their separation • Light • Human body organs • Animal classification • Force and magnetism

Year Level	Merdeka Curriculum	Cambridge Curriculum
	• Introduction to energy	• Earth and the Moon
IV	• Plants: The source of life on Earth • States of matter and their changes • Forces in our surroundings • Transformation of energy	• Skeletal system • Energy and its transformations • Matter and its changes • Earth structure • Light • Electricity
V	• Vision and hearing through light and sound • Harmony within ecosystems • Magnets, electricity, and life-supporting technologies • Exploring our planet	• Flowering plants, pollination, seeds, and fruits • Sound • States of matter • Digestive system • Force and magnetism • • Seasons and adaptation in animals and plants
VI	• How does our body move? • Exploring Earth and outer space • Emergency! Is Earth's energy running out? • Our planet is in danger	• Circulatory, respiratory, reproductive systems and related illnesses • Properties of materials, electrical conductors and insulators, reversible changes, and chemical reactions • Food chains, food webs, and energy flow • Mass, weight, and the effects of force • Light and the solar system

The comparison between the Merdeka Curriculum and the Cambridge Curriculum in primary-level science education reveals fundamental philosophical, structural, and pedagogical differences that reflect each curriculum's intended learning goals and global orientation (Table 1). By examining content coverage from Year I to Year VI, one can discern distinct trajectories in concept introduction, thematic focus, and developmental sequencing. These differences illuminate broader educational ideologies underpinning each framework namely, the character-and-context driven model of Merdeka, and the internationally benchmarked, skill-structured model of Cambridge.

One of the most notable differences between the Merdeka and Cambridge curricula emerges during the initial two years of primary education. In the Merdeka Curriculum, formal instruction in Science is intentionally postponed until Year III, with Years I and II instead dedicated to integrated, thematic learning experiences and character education grounded in the Pancasila Student Profile. This approach aligns with holistic child development theories that underscore the importance of cultivating emotional, moral, and interpersonal competencies in early childhood (Widiana et al., 2024). The emphasis on interdisciplinary and exploratory learning during these formative years supports the development of broad-based capabilities rather than premature disciplinary specialisation, allowing young learners to internalise values and develop socio-emotional maturity before engaging in abstract scientific concepts (Amaruddin et al., 2024). In contrast, the Cambridge Curriculum introduces Science from Year I, advocating a structured, inquiry-based model that familiarises pupils early with key scientific ideas such as living organisms, sound, materials, and physical forces. By Year II, this scope expands to include electricity, motion, light, and ecological habitats. This spiralled curriculum design reflects Cambridge's pedagogical philosophy, which seeks to progressively deepen conceptual understanding while promoting scientific language acquisition and investigative skills (Syofyan et al., 2025). While this early exposure may provide a strong cognitive foundation for scientific literacy, it may also pose developmental challenges for younger pupils who are still acquiring basic literacy and autonomy in learning. The contrast illustrates diverging educational philosophies: Merdeka's prioritisation of holistic, values-based learning versus Cambridge's emphasis on early academic structure and cognitive rigour.

In Year III, the Merdeka Curriculum formally introduces science education through the IPAS (Ilmu Pengetahuan Alam dan Sosial) framework, with a strong orientation toward contextual learning grounded in students' immediate environments. Thematically, the curriculum includes exploration of animals, life cycles, harmonious coexistence with nature, and foundational energy concepts topics that are culturally and environmentally embedded (Amaruddin et al., 2024; Fadlillah et al., 2020). This approach reflects the Merdeka Curriculum's broader commitment to cultivating environmentally conscious and socially responsible citizens by linking science to ethical and ecological themes. The integration of moral ecology and local relevance is intended to help learners connect abstract scientific principles with real-life experiences, thereby fostering not only cognitive understanding but also emotional and civic engagement. In contrast, the Cambridge Curriculum in Year III adopts a more specialised and disciplinary orientation. Students are introduced to topics such as mixtures and their separation, properties of light, human body organs, animal classification, and physical forces such as magnetism, alongside an early look at astronomical bodies like Earth and the Moon (Supriyanto et al., 2025). This approach illustrates a forward-leaning curricular philosophy that emphasises breadth, content precision, and the acquisition of a universal scientific vocabulary. The Cambridge model's emphasis on early conceptual rigor contrasts sharply with Merdeka's contextualised and values-driven approach, highlighting broader pedagogical tensions between globally standardised education and locally grounded, ethical learning (Amaruddin et al., 2024; Fadlillah et al., 2024). While both curricula aim to prepare learners for contemporary global challenges, they differ significantly in how they sequence knowledge, frame scientific understanding, and develop learner agency in relation to culture and environment.

By Year IV, both the Merdeka and Cambridge Curricula introduce overlapping scientific themes; however, their pedagogical treatment and educational emphases diverge significantly. The Merdeka Curriculum incorporates states of matter, energy transformation, and environmental forces through daily life phenomena and project-based learning, situating scientific inquiry within students' lived realities. This contextualised approach is not merely academic but aims to cultivate ethical reflection and strengthen character formation, hallmarks of the curriculum's philosophical underpinnings (Amaruddin et al., 2024; Supriyoko et al., 2022). Project-based activities embedded within this framework are designed to engage learners in problem-solving tasks that are socially and environmentally relevant, thereby nurturing critical consciousness and moral engagement (Salmia et al., 2024). Moreover, this integrative design reflects a broader commitment to transdisciplinary learning, where science does not stand alone but intersects with social values, environmental stewardship, and personal development (Fatimah et al., 2023; Gunawan & Indrawan, 2025). In contrast, the Cambridge Curriculum advances a more segmented and content-focused trajectory. In Year IV, students study distinct biological and physical science topics, such as the skeletal system, states of matter, electricity, and earth structure. This diversification demonstrates the Cambridge model's vertical integration and its emphasis on mastering content knowledge through sequenced and compartmentalised instruction (Ray et al., 2014; Syofyan et al., 2022). Although both curricula strive to develop scientific literacy across domains of knowledge, competencies, and context (OECD, 2018), they differ in their curricular logic: Merdeka adopts an interdisciplinary integration across subjects, whereas Cambridge systematically builds disciplinary expertise within clearly defined scientific domains (Fatimah et al., 2023; Rahmah et al., 2024). These contrasts exemplify how national and international curricular frameworks respond differently to the dual imperatives of educational contextualisation and global scientific rigour.

In Year V, convergence between the Merdeka and Cambridge curricula becomes increasingly apparent, with both including core scientific themes such as sound, states of matter, ecosystems, and forces. However, a closer examination reveals distinct pedagogical orientations. The Merdeka Curriculum integrates these topics within a broader framework that prioritises real-world application, ethical reflection, and sustainability. For instance, topics such as vision and hearing, ecological harmony, and technologies like magnets and electricity are framed not merely as scientific content, but as elements of problem-solving and civic engagement activities. These are frequently explored through project-based learning that emphasises ethical decision-making and sustainable innovation (Amaruddin et al., 2024; Rahmah et al., 2024). Research has shown that Merdeka's contextualised science learning primarily through the inclusion of maritime and ecological themes, effectively strengthens learners' connection to their environment while enhancing critical thinking and moral development (Sarkity & Fernando, 2023).

In contrast, the Cambridge Curriculum maintains a more analytical and content-driven structure, with an emphasis on systematic coverage of biological and physical sciences. The Year V curriculum introduces topics such as flowering plant reproduction, pollination, the digestive system, and seasonal adaptation, with a strong focus on descriptive accuracy and concept mastery. This approach is designed to cultivate learners' abilities in scientific reasoning, experimentation, and classification, aligning with international benchmarks in science education (Syamsy et al., 2023). The curriculum's emphasis on precise sequencing and structured assessment reflects its underlying educational philosophy, which values rigorous inquiry, standardisation, and evidence-based understanding.

Year VI marks the culmination of primary science education in both the Merdeka and Cambridge curricula, each presenting distinctive educational priorities. In the Merdeka Curriculum, science topics such as the human body in motion, environmental crises, planetary exploration, and sustainable energy are situated within a broader framework of values-based inquiry and civic responsibility. These themes are presented not simply as content for academic mastery but as pressing global concerns that necessitate ethical reflection and local action. The curriculum's holistic approach embeds scientific learning within environmental ethics and sociocultural relevance, reinforcing the objective of cultivating critically engaged and socially responsible citizens. Rahmah et al. (2024) assert that such integration of moral dimensions into the curriculum significantly enhances learner motivation and deepens conceptual engagement. The thematic design of Merdeka encourages students to see themselves as agents of change equipped not only with knowledge but with the ethical frameworks to address real-world challenges.

In contrast, the Cambridge Curriculum in Year VI consolidates scientific domains in a systematic and discipline-specific manner. The topics span biological systems (e.g., circulatory and respiratory functions), chemistry (e.g., chemical changes and material properties), physics (e.g., mass, weight, electricity), and astronomy (e.g., the solar system). This structured segmentation is aimed at establishing a solid foundation for secondary education, where scientific domains become even more formalised. Assessment at this level is anchored in standardised instruments such as the Cambridge Checkpoint, which evaluates both theoretical understanding and practical application of scientific knowledge. According to Syofyan et al. (2025), such assessments play a vital role in measuring science literacy against international benchmarks, although diverse instructional strategies also influence the overall impact of student learning.

Based on the data presented in Table 1, it is evident that there are content similarities between the Merdeka Curriculum and the Cambridge Curriculum. For instance, topics such as "States of Matter and Their Changes" and "Energy and Its Transformations" appear in both curricula, reflecting a common emphasis on core scientific knowledge (Rahmah et al., 2024; Syofyan et al., 2025). However, there are also differences in the year levels at which specific topics are introduced. For example, the topic of ecosystems is taught in Year V under the Merdeka Curriculum, but is covered in Year VI within the Cambridge Curriculum (Rahmah et al., 2024). Additionally, some scientific topics featured in the Cambridge Curriculum, such as animal classification and separation of mixtures, are not addressed in the Merdeka Curriculum, indicating a broader thematic scope in the former (Rahmah et al., 2024). Despite these differences, both curricula demonstrate alignment with the Science Knowledge component of the Science Framework developed by PISA and the OECD. This indicates that both the Merdeka and Cambridge frameworks are oriented towards preparing students for scientific literacy in accordance with international standards (Rahmah et al., 2024; Syofyan et al., 2025).

Instructional Processes and Pedagogical Strategies

Curriculum adaptability surfaced as a recurrent theme in interviews with educators and school leaders. While the Merdeka Curriculum was commended for its contextual responsiveness and national identity alignment, challenges remained in implementing interdisciplinary IPAS topics when science-specific resources or assessment guidance were insufficient (Afida et al., 2024; Rahmah et al., 2024). On the other hand, the Cambridge Curriculum was noted for its global consistency and high-quality materials. However, its relevance for Indonesian learners was sometimes questioned unless localised content was intentionally embedded (Supriyanto et al., 2025). These findings suggest that hybrid strategies combining inquiry-based rigour with cultural contextualisation may be the most effective pathway forward in SPK school contexts (Rahmah et al., 2024; Wijayanti et al., 2024).

In terms of the learning process, Science education under the Merdeka Curriculum employs project-based learning and the Science, Technology, and Society (STS) approach. These strategies aim to engage students in solving real-world problems and contextualising scientific concepts within social and environmental realities (Rahmah et al., 2024; Rohsulina et al., 2024). Project-based learning has been shown to enhance learning outcomes, foster creativity, and develop critical thinking among primary school students (Rohsulina et al., 2024). The integration of the STS approach through the IPAS subject encourages scientific attitudes, particularly environmental awareness, and ensures that science education remains relevant to local contexts (Rohsulina et al., 2024). Learning materials, such as teacher's guides and student textbooks, are provided by the government to support instructional delivery (Rohsulina et al., 2024).

By contrast, the Cambridge Curriculum places stronger emphasis on inquiry-based learning. This approach encourages students to conduct experiments to verify scientific concepts and apply them in global or real-life contexts (Shoufika et al., 2024). Teaching materials include teacher's books, student books, and structured student worksheets that guide experimentation and problem-solving procedures (Shoufika et al., 2024). This model promotes independent investigation and the development of analytical thinking skills, aligning well with the competencies domain of scientific literacy outlined by the OECD and PISA (Rahmah et al., 2024).

Assessment Systems and Standards
About assessment, both curricula adopt formative and summative evaluation strategies. Formative assessment in both models aims to provide feedback for improving the learning process, while summative assessment evaluates the extent to which learning objectives have been achieved (Rahmah et al., 2024; Shoufika et al., 2024). In the Merdeka Curriculum, project-based assessment, performance tasks, tests, and attitude assessment are commonly used, culminating in the *Ujian Sekolah* (School Examination) developed by individual institutions (Rahmah et al., 2024). In contrast, the Cambridge Curriculum emphasises testing and experimental competence, with students given the option to sit for the Cambridge Checkpoint examinations, which are standardised by the Cambridge Assessment body (Shoufika et al., 2024). Although not mandatory, these assessments serve as international benchmarks for evaluating student achievement in Science, Mathematics, and English.

Triangulated Insights and Curriculum Adaptability
Triangulation of interview, observation, and document data yielded convergent themes. For example, both teacher groups expressed challenges in balancing science content delivery with time constraints and student readiness. However, Merdeka teachers cited greater freedom to adapt content to local phenomena (e.g., rice farming, coral reefs), while Cambridge teachers focused more on academic vocabulary and procedural knowledge.

Curriculum adaptability emerged as a central issue. The Merdeka Curriculum's flexibility supports cultural alignment but risks inconsistency. Cambridge's clarity supports global recognition but can marginalise local identity. School leaders recommended greater integration of local content in Cambridge classes and more structured science training for Merdeka implementers, suggesting the need for a hybrid curricular pathway in SPK contexts.

Conclusion

This comparative study of Science education within the Merdeka and Cambridge curricula, as implemented in an SPK (International Partnership School) primary context, reveals both convergence and divergence across four fundamental curricular components: learning objectives, content, pedagogical processes, and assessment. The Merdeka Curriculum, grounded in the national vision of the *Profil Pelajar Pancasila*, offers a culturally embedded, values-oriented approach that integrates scientific understanding and process skills with character development. In contrast, the Cambridge Curriculum advances a competency-based, globally aligned model that emphasises inquiry, experimentation, and scientific reasoning from the early years of schooling.

Despite differences in topic sequencing and content breadth, both curricula demonstrate substantial alignment with the scientific literacy framework promoted by PISA and the OECD, encompassing the domains of context, knowledge, competencies, and attitudes. These shared foundations suggest that both models are strategically designed to develop not only cognitive mastery but also the attitudinal dispositions essential for 21st-century scientific citizenship.

Pedagogically, the Merdeka Curriculum employs project-based learning and the Science, Technology, and Society (STS) approach, fostering critical thinking, environmental consciousness, and contextual relevance. Conversely, the Cambridge Curriculum privileges inquiry-based learning underpinned by structured experimental engagement, promoting independent investigation and analytical rigour. Each model, therefore, reflects distinct epistemological and pedagogical orientations, contextual-humanistic in the former, and empirical-global in the latter, while ultimately converging on the goal of cultivating scientifically literate learners.

In terms of assessment, both systems incorporate formative and summative strategies; however, their implementation diverges in structure and emphasis. The Merdeka Curriculum places greater weight on performance-based and attitudinal evaluations culminating in locally administered school examinations, while the Cambridge model offers standardised, internationally benchmarked assessments through the optional Cambridge Checkpoint.

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