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Exploring Teachers Challenges in Implementing Literacy and STEAM in Early-Childhood Classrooms

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Abstract. The Independent Learning Curriculum, known as the *Kurikulum Merdeka Belajar* (KMB), was introduced in Indonesia in 2021 to replace the 2013 Curriculum, marking a significant shift in early-childhood education in Indonesia. This transition emphasizes a project-based approach in which teachers act as facilitators, promote pupil-centered learning, and are responsible for creating their own learning modules. The KMB prioritizes three key areas, namely (i) religious values and character, (ii) self-identity, and (iii) literacy and Science, Technology, Engineering, Arts, and Mathematics (STEAM). However, teachers have experienced challenges in implementing literacy and STEAM activities, as these areas cover a broad range of interdisciplinary knowledge. This study explores the difficulties that teachers encounter when integrating literacy and STEAM in their classrooms. Fifteen participants were selected using purposive sampling to ensure relevant insights into the research objectives. One-on-one and online interviews were conducted, recorded, transcribed, and analyzed thematically. Five key challenges emerged: limited knowledge, time constraints, pupil characteristics, technological limitations, and teachers' attitudes. The findings highlight that despite the positive intentions behind the KMB, early-childhood teachers face significant barriers in successfully integrating literacy and STEAM. To address these challenges, more comprehensive support is needed, including targeted professional development and better access to resources. Overcoming these obstacles is crucial for the effective implementation of the KMB and its goal of fostering independent learning and creativity in young children.

Keywords: literacy; *Kurikulum Merdeka Belajar*; early childhood; challenges

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1. Introduction

Concerns about the quality of education in Indonesia have prompted significant reforms aimed at strengthening learning outcomes and better equipping young children for the challenges of the 21st century. A major catalyst for these changes was Indonesia's poor performance in the 2018 Programme for International Student Assessment (PISA) in which the country ranked 70th out of 78 participating countries (Organisation for Economic Co-operation and Development, 2023; Wicaksono & Korom, 2023; Ozer, 2023).

This result underscored persistent issues in literacy and overall educational effectiveness, compelling the Ministry of Education, Culture, Research and Technology to implement transformative policies to address these shortcomings, particularly in early-childhood education. Building on these concerns, research conducted within the Indonesian context has identified six key challenges that hinder the development of proficiency in literacy and Science, Technology, Engineering, Arts and Mathematics (STEAM) in young children (Jannah & Prodjosantoso, 2024; Twiningsih & Elisanti, 2021).

These challenges include (i) a lack of teacher knowledge and understanding of core concepts, (ii) insufficient skills in integrating technology into classroom practices, (iii) limited creativity and innovation in developing teaching resources, (iv) difficulties in adapting instruction to local or district-specific contexts, (v) inadequate professional guidance and support, and (vi) limited parental involvement in the learning process.

In response to the challenges faced in the educational system, the Ministry of Education, Culture, Research and Technology introduced the *Kurikulum Merdeka Belajar* (KMB) in 2021, effectively replacing the previous 2013 Curriculum. The KMB places significant emphasis on three core domains that are aimed at developing well-rounded pupils, namely (i) religious values and character, (ii) self-identity, and (iii) literacy and STEAM (Andriani et al., 2024; Istianah, 2023).

The domain of religious values and character is central to character education, promoting values such as diligence, obedience, patience, sincerity, and religious commitment (Hazyimara, 2024; Cinantya et al., 2018; Masjid et al., 2023). These values are considered essential for fostering pupils' moral and ethical development (Amalia et al., 2024). The second domain, self-identity, emphasizes autonomy and multicultural engagement by allowing pupils to explore their personal interests and talents (Suharno et al., 2023). The third domain, literacy and STEAM, reflects the commitment to the 21st century by cultivating problem-solving skills and scientific literacy (Susanto & Susanta, 2024).

The KMB adopts a project-based learning approach that encourages headmasters and teachers to assess the existing educational framework critically and respond to contemporary challenges in teaching. Empirical research indicates that a project-based learning approach significantly enhances pupils' critical thinking skills, as demonstrated by measurable improvements in analytical reasoning and problem-solving competencies (Kokotsai et al., 2016; Yuliantina & Puspitaari,

2024). By fostering reflective teaching, the KMB promotes creativity, flexibility and pupil-centered learning strategies that prioritize individual needs and collaborative engagement. Ultimately, this reform aspires to nurture a generation equipped not only with academic proficiency but also with strong character, self-awareness, and essential 21st century skills.

In alignment with the government's directive to integrate literacy and STEAM across all educational levels, the Ministry of Education, Culture, Research and Technology introduced a flexible framework that offers teachers autonomy and responsibility to design their own learning modules (Puspitasari & Patonah, 2024). This framework is part of the KMB and empowers teachers by granting them full autonomy in creating educational content tailored to the unique needs of their pupils.

However, with this autonomy comes the significant responsibility for teachers to ensure that the learning modules they develop are not only appropriate for the specific age group and developmental stages of their pupils but also culturally sensitive and reflective of the local context. Additionally, teachers must ensure that the modules are aligned with the diverse abilities of the pupils in their classrooms, promoting inclusive and accessible learning experiences for all. This approach aims to foster creativity and innovation in teaching practices while maintaining educational standards that support pupil success.

The transition from the 2013 Curriculum to the KMB has resulted in significant changes to the roles of both teachers and pupils and to the overall teaching approach. As a result, many teachers are struggling to implement the KMB effectively (Harefa, 2024). Given that the KMB is still in its early stages, teachers face substantial challenges in designing creative projects that align with the curriculum's focus on fostering independent learning through play. Furthermore, teachers have reported a lack of information and guidelines from the Ministry, which makes it even more difficult for them to implement the KMB successfully (Maulidia & Shobahiya, 2024).

Many teachers also lack clarity on how to develop literacy and STEAM modules that meet the specific objectives of the KMB (Yulianti et al., 2024). In view of these challenges, this study aims to investigate the difficulties teachers face in integrating literacy and STEAM into early-childhood classrooms with the goal of offering insights that can support and improve the implementation of the KMB in preschools.

2. Review of the Literature

A curriculum plays a pivotal role in early-childhood education, acting as a framework that guides the achievement of future educational goals and ensuring that learning is more effective and efficient. It serves as a structured plan that provides teachers with clear direction on objectives, content, learning materials, and methods to reach specific educational outcomes (Aliyyah et al., 2023). The curriculum encompasses four key components, namely (i) goals and objectives, (ii) course content or materials, (iii) methods or procedures, and (iv) assessment

and evaluation. These components are present in every teaching and learning arrangement from early-childhood education to higher education. Moreover, the curriculum acts as a benchmark for measuring educational success (Mimin, 2021).

In Indonesia, the significance of the curriculum is emphasized in one of the regulations issued by the Minister of Education, Culture, Research, and Technology, which focuses on preparing pupils to be responsible members of society who are guided by faith in God and noble character while promoting values aligned with *Pancasila* (Rachman et al., 2024; Syahidan & Rahmat, 2023). Indonesia has continually reviewed and refined its curriculum to improve the quality of education, with the National Curriculum undergoing the following 11 revisions: (i) 1947 Curriculum, (ii) 1964 Curriculum, (iii) 1968 Curriculum, (iv) 1973 Curriculum, (v) 1975 Curriculum, (vi) 1984 Curriculum, (vii) 1994 Curriculum, (viii) 2004 Curriculum – Competency-Based Curriculum, (ix) 2006 Curriculum, (x) 2013 Curriculum, and (xi) the KMB.

The KMB was introduced in Indonesia in 2021 to replace the 2013 Curriculum and represents a significant change. While the 2013 Curriculum relied on a teacher-centered approach, focusing on the teacher's role as the primary instructor, the KMB shifts the focus and encourages teachers to act as facilitators (Halil et al., 2024; Rais & Xuezhi, 2024). This change allows pupils to engage freely with learning resources (Setiawan & Syifa'ul Fuadiyah Ahla, 2022). Independence is the central theme of the KMB, fundamentally altering the roles of both teachers and pupils.

The curriculum offers diverse pathways for pupils to learn, empowering them to choose their own learning activities based on their interests, talents, needs, and abilities (Ngaisah et al., 2023; Sari et al., 2024). Rooted in the philosophy of progressivism, the KMB aims to cultivate independent and creative learners with an emphasis on learning through play (Nurwahidah, 2022; Faiz & Kurniawaty, 2020; Rosmiati et al., 2025; Sihombing et al., 2021). The KMB has several learning outcomes but primarily, it aims to build 21st-century skills through learning that is centered on exploration, problem-solving, and creativity.

Literacy and STEAM represent two distinct sets of subjects. Literacy traditionally refers to the ability to read and write, while STEAM stands for Science, Technology, Engineering, Art, and Mathematics. However, literacy extends beyond the basic skills of reading and writing. It is also about the ability to communicate, count, solve everyday problems, understand challenges, and use one's potential to address them (Aini et al., 2024). Some scholars interpret literacy as the capacity to understand and use information across various media or the ability to communicate effectively (Livingstone, 2004; Rasi et al., 2019).

In early childhood, literacy development is closely linked to children's abilities to comprehend language (receptive literacy) and to express themselves (expressive literacy) (Stojanovik & Riddell, 2008; Wise et al., 2007). For children aged five to six years, receptive literacy skills include the ability to follow simultaneous instructions, to adhere to rules, to repeat more complex sentences, and to

recognize values (Almelhi, 2021; Vehkavuori et al., 2021). Conversely, expressive literacy skills encompass responding with expressions and body language, answering more complex questions, communicating orally, speaking in simple but complete sentence structures (subject-predicate-object in Indonesian), expressing thoughts and feelings verbally, continuing a story, showing comprehension of story concepts, and recognizing signs, symbols, and images in preparation for reading, writing, and counting (Berninger & Abbott, 2010; Neumann et al., 2019).

In today's world, the advancement of technology makes it essential for individuals to master literacy, especially in specific areas such as digital literacy (Long et al., 2023; Suwana, 2017) and mental health literacy (Praharso et al., 2020; Rachmani et al., 2019). The learning outcome of the KMB in literacy is articulated as pupils' ability to understand and analyze various types of texts, to develop critical-thinking skills, to write effectively, and to use digital literacy to process and filter information wisely (Alfaruki, 2022).

In contrast, STEAM represents an integrated approach to education, combining the five disciplines to address global challenges. Given that children are naturally curious and enjoy experimenting and exploring, STEAM offers a practical educational approach that enables them to understand the world holistically through these experiences (Manowaluilou, 2024; Monkeviciene et al., 2020). By integrating STEAM-focused play, children's scientific inquiry, design thinking, creativity, and vocabulary related to interdisciplinary STEAM concepts are fostered (Sikder, 2023; Suharni et al., 2024). Indeed, STEAM evolved from Science, Technology, Engineering, and Mathematics (STEM) with the addition of an 'Art' element (Land, 2013).

Scholars state that the 'Art' element nurtures (i) thinking skills such as reasoning, intuition, perception, imagination, creativity, and problem-solving; (ii) social skills including self-confidence, self-control, conflict resolution, co-operation, empathy, and tolerance; and (iii) motivation to learn demonstrated by active involvement, increased attention, perseverance, and the courage to take risks (Maulidiyah et al., 2023). With project-based learning applications and the use of digital technology, pupils are expected to be able to develop real solutions to real-world problems and become individuals who are ready to face global challenges with a scientific and creative approach.

In summary, Science focuses on concepts related to the environment; Technology involves the skills, tools, and methods used to address human needs in various tasks; Engineering applies strategies to solve problems; Art is concerned with aesthetic values and beauty; and Mathematics explores the relationships between numbers, quantities, and logical reasoning. As such, STEAM is highly relevant to early-childhood education and may have lasting benefits throughout a child's development (Park, 2021). This perspective underscores the growing support for introducing STEAM at the earliest stages of education, promoting purposeful STEAM learning experiences for infants, toddlers, and preschoolers, and

recognizing its crucial role in shaping young children's cognitive development (Butera et al., 2016; Johnston et al., 2022; Agustina et al., 2022; Sikder et al., 2023).

The integration of literacy and STEAM in early-childhood education is increasingly endorsed by experts and policymakers worldwide as a holistic approach to fostering foundational competencies (Monkeviciene et al., 2020; Ng, 2024; Putri et al., 2025). Studies have shown that early-childhood experts perceive STEAM-based instruction as highly effective in promoting language development, critical thinking, and engagement through hands-on, inquiry-based learning (Haryanto et. al., 2024; Harris & de Bruin, 2018; Larkin & Lowrie, 2020).

In addition, the integration of arts and science within STEAM frameworks significantly enhances children's expressive language, collaboration skills, real-world problem-solving, and creativity (Harris & de Bruin, 2018; Ng, 2024; Ismiati, 2024). On a global scale, the Organisation for Economic Co-operation and Development (2020) has advocated cross-disciplinary curricula in early education, highlighting the importance of literacy and STEAM integration to prepare learners for future academic and professional demands (Manowaluilou, 2024). These perspectives reinforce the relevance of literacy-and STEAM synergy as not only pedagogically sound but also aligned with broader educational policy objectives.

The KMB replaces the traditional National School Standardization Exam with a Minimum Competency Assessment designed to capture pupils' core understanding and essential skills (Taridala, 2023). For children aged five to six years, the assessment of literacy and STEAM competencies is guided by authentic assessment and developmentally appropriate practices. Early-childhood educators are encouraged to apply formative assessment methods such as observational checklists, anecdotal records, and performance-based evaluations to monitor emerging abilities in language, numeracy, and problem-solving rather than relying on standardized tests (Pratami et al., 2024).

Literacy is evaluated through children's ability to understand and use language meaningfully, to recognize letter-sound correspondences, and to communicate ideas through speech, drawings, or early writing. In parallel, STEAM-related competencies are assessed through integrated project-based tasks that allow children to demonstrate scientific reasoning, creativity, and foundational mathematical skills through hands-on experiences and collaborative play (Faiz & Faridah, 2022; Putri et al., 2025). These practices embody the commitment of the KMB to a pupil-centered approach and holistic development.

Given that the combination of literacy and STEAM is a relatively new endeavor in Indonesia, preschool teachers must be innovative in integrating the two when designing learning media under the KMB framework. However, the culture of reading, from childhood through to adulthood, or even the awareness of its importance, is not universally present in Indonesian society. Kusuma (2022) states that "The reality shows that the Indonesian nation is not a nation of readers" (p.18), a sentiment supported by UNESCO's 2012 report, which highlighted that

reading interest in Indonesia was just 0.001%. Among other similar findings from national and international organizations, a 2014 UNESCO report found that Indonesian children read only 27 pages of books annually. Such statistics are disheartening, as they suggest that despite the abundance of children's novels that are published and distributed in Indonesia, these books are not fully read by Indonesian children each year.

Furthermore, the implementation of STEAM in education (or its predecessor STEM) has been a longstanding issue, with challenges such as limited curriculum development, teacher preparation, and standardization in early-childhood settings. Therefore, this study is crucial in emphasizing the need to nurture children's literacy skills from preschool and in encouraging preschool stakeholders to take the initiative in developing STEAM-based curricula for young learners. This study aimed to investigate the challenges that teachers face in implementing literacy and STEAM learning in early-childhood classrooms.

3. Methodology

The research employed a case study research design with a qualitative approach. This research design was deemed appropriate to achieve the research objective – to explore in-depth the challenges that teachers face in implementing literacy and STEAM learning in early-childhood classrooms.

3.1 Sampling

The research was conducted in Riau Province, Indonesia. Riau Province was purposefully selected as the research location because of its status as a pilot province in implementing literacy and STEAM learning. This early adoption provided a unique opportunity to explore the practical challenges and responses to KMB implementation within a real-world early-childhood education context. Furthermore, Riau presents a diverse educational landscape, encompassing both urban and rural settings, and this allowed for a richer understanding of the systemic and instructional barriers that teachers face. The province's varied socioeconomic and infrastructural conditions also offer valuable insights into how contextual factors influence the integration of literacy and STEAM approaches in early-childhood classrooms.

A total of 15 participants from the following three categories took part in this research: (i) principals, (ii) curriculum coordinators, and (iii) early-childhood teachers. These categories were chosen due to their critical roles in the implementation of literacy and STEAM in the early-childhood curriculum. Principals, as school leaders, are the first persons to receive information about literacy and STEAM learning. As such, the government provides training and workshops for principals to make sure that they have a clear understanding of literacy and STEAM learning. The training and workshops enable them to convey information to teachers and to develop implementation plans of literacy and STEAM learning for their schools. Given their pivotal role in the implementation of literacy and STEAM learning, principals were included in the study.

The second category was curriculum coordinators. Curriculum coordinators were involved because of their responsibility for developing daily educational plans and providing training to teachers in the implementation of the daily educational plans in early-childhood classrooms. The third category was early-childhood teachers. These teachers are directly responsible for carrying out teaching and learning activities related to literacy and STEAM. Therefore, early-childhood teachers are the implementers of the literacy and STEAM learning. Based on the justifications given above, these three groups of participants were essential in gaining a comprehensive understanding of the challenges in implementing literacy and STEAM learning.

A purposive sampling technique was used in the participant selection process and was guided by specific criteria: (i) participants who teach literacy and STEAM in early-childhood classrooms; (ii) participants who have attended courses on developing or implementing literacy and STEAM; and (iii) participants with more than 10 years of experience teaching in preschools. Table 1 provides detailed information about the participants. The study participants consisted of female preschool teachers only, as the proportion of male teachers in early-childhood education in Indonesia is significantly lower than female teachers. A 2023 report indicated that only 1.77% of teachers across Indonesia were male, with the remaining 98.23% of teachers being female (Ulfah & Karolina, 2023).

Table 1: Participants information

No.	Category of Participant	Code	Sex	Age (years)	Teaching Experience (years)
1.	Principal	P1	Female	45	20
2.	Principal	P2	Female	50	25
3.	Principal	P3	Female	48	22
4.	Principal	P4	Female	47	23
5.	Principal	P5	Female	46	21
6.	Curriculum Coordinator	C1	Female	40	12
7.	Curriculum Coordinator	C2	Female	38	15
8.	Curriculum Coordinator	C3	Female	42	12
9.	Curriculum Coordinator	C4	Female	39	15
10.	Curriculum Coordinator	C5	Female	41	13
11.	Preschool Teacher	T1	Female	35	21
12.	Preschool Teacher	T2	Female	30	12
13.	Preschool Teacher	T3	Female	33	15
14.	Preschool Teacher	T4	Female	36	12
15.	Preschool Teacher	T5	Female	34	15

3.2 Research Instrument

The data were collected using a semi-structured interview protocol. This method was selected because it facilitates a casual yet in-depth conversation with participants, helping the researcher to gain a deeper understanding of the study's context. The interview protocol was developed based on previous research and aimed to explore the challenges that teachers face in implementing literacy and STEAM in early-childhood classrooms. The interview constructs were informed

by literature identifying systemic and instructional barriers to effective literacy and STEAM integration (Nurdiyanti et al., 2024; Rosanawati, 2025). Two experts in early-childhood education, each with over 20 years of experience and holding a Doctor of Philosophy in Early Childhood Education, were consulted to review the protocol and ensure that the questions effectively addressed the research objectives. A total of 10 interview questions derived from four constructs were developed, namely (i) pedagogical challenges, (ii) professional development and training, (iii) support and resource constraint, and (iv) infrastructure challenges. The interview protocol was developed and administered in Bahasa Indonesia, the participants' native language, to ensure clarity and cultural relevance during data collection.

3.3 Data Collection and Analysis

One-on-one interview sessions were conducted with each participant online via the Google Meet platform. Online platforms were chosen due to the geographical distribution of the participants across Indonesia, making virtual interviews the most effective method to reach them. Each session lasted from 40 minutes to 60 minutes and was recorded for transcription purposes. NVivo software was employed to organize, code, and retrieve data segments systematically, supporting a rigorous and transparent thematic analysis process. Thematic analysis, as outlined by Braun and Clarke (2006), was employed to analyze the interview findings. This method involves six stages: (i) data familiarization, (ii) coding, (iii) theme development, (iv) theme review, (v) theme definition and naming, and (vi) report writing.

3.4 Credibility and Consistency

Credibility and consistency are essential elements in qualitative research, as they are key determinants of the validity and applicability of the research. Credibility refers to the extent to which the evidence supports the interpretations drawn from the data. In contrast, consistency pertains to the degree to which the findings of a qualitative study can be replicated, assuming similar conditions and yielding comparable results. This concept also involves detailed reporting of the context within which the interviews were conducted. In this study, credibility and consistency were ensured through member checks and peer review.

Member checks involve returning the data and interpretations to the participants for confirmation of their accuracy and validity. This process not only validates the data but also enhances the credibility and consistency of the findings. For this study, participants were provided with the interview transcripts and given a week to review them. All participants agreed with the content of the transcripts, confirming their accuracy.

Peer review involves obtaining feedback from experts in the field to enhance the quality and validity of the research. This method ensures the accuracy, consistency, and credibility of qualitative findings. For this study, two experts with over 20 years of experience in early-childhood education were engaged to review the themes, sub-themes, and interview findings. The experts provided constructive feedback and suggested reorganizing certain findings under different themes or sub-themes. The improvements were made in accordance

with their recommendations, further strengthening the quality and reliability of the research.

In addition, to enhance qualitative rigor and minimize potential bias, the researcher maintained a reflexive journal throughout the research process. This journal was used to document personal assumptions, decisions, and reflections, enabling critical self-awareness and transparency. Regular entries supported the researcher in distinguishing personal perspectives from participants' voices, thus strengthening the credibility of the findings.

4. Findings

Based on the conducted interviews, five key themes emerged regarding the challenges that teachers face in implementing literacy and STEAM learning. These challenges were (i) limited knowledge and understanding; (ii) time constraints; (iii) pupil characteristics; (iv) technological limitations; and (v) teachers' attitudes.

4.1 Limited Knowledge and Understanding

Participants in this research shared that they have limited pedagogical content knowledge and understanding of literacy and STEAM learning. Their responses revealed a lack of proficiency in the fundamental concepts underpinning each component of literacy and STEAM. The participants admitted to having minimal pedagogical content knowledge of science, technology, engineering, mathematics, and the arts. This lack of pedagogical content knowledge makes it particularly challenging for them to integrate these components into a cohesive learning activity in early-childhood classrooms:

> *More about understanding language-rich literacy, recognizing letters; maybe not all teachers, including myself, fully understand what literacy is. From my perspective, literacy involves recognizing letters, answering questions, speaking well, and reading. However, a comprehensive understanding of literacy is still lacking. The challenge is perhaps understanding literacy itself—what it really means and its purpose. Maybe not all teachers truly grasp this. In STEAM, particularly the technology aspect, it's still quite challenging. I don't yet understand what kinds of technological activities should be introduced to children, so I'm still unsure.* (T4)

Participants noted in their responses that differences in teachers' understanding and comprehension levels contribute to the challenges in implementing literacy and STEAM learning. This issue is exacerbated by limited reading habits and insufficient efforts by teachers to improve their knowledge and skills in teaching literacy and STEAM. However, limited understanding among participants was not solely an individual shortcoming but also reflected broader systemic issues, including insufficient teacher training programs and a lack of ongoing professional development opportunities. Hence, participants suggested that this issue could be solved by providing comprehensive information and in-service training to support effective implementation in practice:

> *The main obstacle we face is, first, differing mindsets. Not all teachers have the same understanding of what is meant by implementing and strengthening literacy. We face the challenge of limited reading culture among teachers. To strengthen literacy and numeracy, teachers must employ various methods and media, particularly focusing on how children listen, mimic vocal sounds, and associate learning with books. This understanding is still not fully developed. Here, the frontline is the teachers, but they need clear information about how to implement it in practice.* (C2)

4.2 Time Constraint

The second challenge identified by the participants was time constraints. They explained that the new literacy and STEAM approach demands extensive preparation of learning materials. The curriculum's focus on using recycled items adds to their workload, as they must dedicate time to sourcing and collecting suitable materials. Additionally, some materials are difficult to find and thus, even more time and effort is required in creating engaging and effective learning experiences:

> *The materials required are quite extensive, and sometimes we need to use recycled items, which are not always easy to find. For instance, things like shells, seeds, or bottle caps take considerable time to collect.* (T3)

The participants noted that they need to allocate additional time to plan creative activities for literacy and STEAM. They must ensure that the learning materials are appropriate, aligned with the activities, and meet the curriculum requirements. However, their limited knowledge of literacy and STEAM makes it challenging to plan and prepare suitable materials for these activities:

> *In literacy and STEAM, creativity takes time. If we want to be creative, we must allocate a lot of time.* (T2)
>
> *At the very least, we need to think about what activity we'll do tomorrow and ensure the materials are ready. If we want to be creative, it requires effort and time.* (T4)

Participants also highlighted the challenge of juggling multiple responsibilities at once. They noted that they must allocate time for managing student resources and preparing teaching materials while also dedicating time to improving their knowledge and understanding of literacy and STEAM. This creates a dilemma, as teachers must often choose between prioritizing pupil-related activities and their own professional growth. They expressed concerns that their workload is not proportionate to the salary they receive. These challenges can diminish teachers' motivation and adversely affect their performance:

> *Teachers learn independently to deepen their understanding of Kurikulum Merdeka Belajar, but this requires sacrificing time to prepare materials for the next day.* (P5)

> *The school program is excellent. We start from the basics with online training. However, the limited time allocated for online training is regrettable, as we cannot fully reach all teachers, and we remain uncertain about whether each teacher has understood the material.* (P3)

4.3 Pupil Characteristics

Literacy and STEAM education require teachers to have a deep understanding of their pupils' individual characteristics when designing and planning learning activities. These activities must be tailored to meet the specific needs of each pupil in the classroom. As such, teachers must be adaptable, creative, innovative, and well-informed in order to develop lessons that address the various needs of all pupils. However, all the participants emphasized that the wide range of pupil characteristics poses a considerable challenge for them in creating effective teaching and learning experiences. In relation to pupil diversity, teachers face difficulties arising from differences in developmental stage, learning style, and level of engagement in addition to the necessity to manage pupils effectively throughout the learning process. The findings highlight that this diversity requires teachers to remain proactive and ensure that all pupils stay engaged and focused during lessons:

> *The challenge in this Independent Learning Curriculum [KMB] is that we must pay attention to the specific characteristics of the children.* (T5)

> *The issue is that [pupils] demonstrate short attention spans or disengage when content is not sufficiently stimulating.* (T3)

Similarly, effective pupil management requires teachers to support learners with slower processing speeds without disrupting the attention of pupils with faster processing speeds. This challenge calls for teachers continually to develop new and creative strategies to guide both fast and slow learners throughout the lesson. Teachers must, therefore, be sufficiently skilled to ensure that every pupil stays engaged in the learning process. This is particularly important when fast learners attempt to engage with the lesson but lose focus when the teacher needs to repeat explanations for those who are slower in grasping the material. Such situations can lead to fast learners becoming bored and disengaged:

> *In the Independent Learning Curriculum [KMB], we need to explore and guide the children, allowing them to think and respond. However, when active learners become distracted, it becomes challenging. If there are active learners in the class, the teacher faces difficulties because the focus shifts to managing these students, interrupting the attention given to those we are trying to guide.* (C2)

Similar to the classroom teachers, the school leaders highlighted the urgent need for professional development focused on differentiation and pupil-centered instructional strategies. Administrators such as P1 and P4 advocated equipping educators with the necessary skills to accommodate diverse learning profiles effectively. Similarly, participants in leadership roles, including P2 and C3, emphasized that fostering equitable participation across the learning spectrum

requires not only pedagogical innovation but also responsive classroom management strategies.

4.4 Technological Limitations

Technological limitations emerged as a significant finding in this study. Participant C5 emphasized that teachers often struggle to incorporate media into the learning process effectively. They are required to develop diverse forms of media to meet the varying needs of pupils. These findings highlight the technological constraints within STEAM education, with teachers facing challenges in delivering effective lessons due to limited access to appropriate technologies. The lack of resources also restricts the teacher's ability to generate innovative ideas for teaching and learning activities. Additionally, C3 noted that this issue is particularly prominent in rural schools.

> *For STEAM, we face challenges with IT ... But the issue is that we only have one projector whereas there are eight classes, so we have to take turns.* (T2)

Regional disparities in digital infrastructure remain a significant barrier to equitable education in Indonesia, particularly in rural and remote areas where internet access is limited. These technological constraints not only impede the delivery of instruction but also place additional demands on teachers who must navigate these challenges with minimal support. Compounding this issue is the limited capacity of teachers to integrate technology meaningfully into literacy and STEAM instruction. A lack of pedagogical and technical proficiency results in the underuse of available resources, thereby reducing the effectiveness of KMB educational initiatives:

> *In terms of digital resources, they are quite limited. One issue is the lack of devices, and rural areas find it harder to adapt to digital learning due to insufficient media. It's more about being pupil-centered, so teachers must also be more creative. We look things up on Google, check TikTok, and from there, we can imitate.* (T3)

4.5 Teacher Attitude

Teachers' attitude plays a significant role in the successful implementation of literacy and STEAM education. Beyond access to technology and teaching materials, many teachers exhibit limited motivation and lack of initiative in expanding their own knowledge and pedagogical approaches. As highlighted by the participants, while some teachers have resources such as Wi-Fi, the lack of personal interest in reading and professional development limits their ability to innovate in the classroom. This mindset often leads teachers to focus narrowly on basic literacy skills such as helping pupils learn to read rather than exploring more creative or integrated teaching methods that could enrich learning experiences. The findings suggest that fostering positive attitudes such as openness to continual learning, creativity, and proactive engagement is essential for teachers in facilitating diverse and dynamic literacy and STEAM activities effectively:

> *The challenge is that some teachers, even though they have Wi-Fi and facilities, don't read much. So, when it comes to literacy, they only focus on getting students to read books, whereas there are many other things they could explore.* (P3)

5. Discussion

The findings from this study reveal significant challenges in implementing literacy and STEAM learning within the KMB. Through interviews with key stakeholders, five major themes emerged: (i) limited knowledge and understanding, (ii) time constraints, (iii) pupil characteristics, (iv) technological limitations, and (v) teachers' attitudes.

Teachers face difficulties due to a lack of foundational knowledge in both literacy and STEAM. The curriculum heads of the schools particularly emphasized the importance of aligning the learning purpose of literacy and STEAM with the developmental needs and abilities of the preschool children and that when designing the learning activities, teachers should be conscious of the varied interpretations of learning achievements within literacy and STEAM. The participants revealed the need for various daily engaging activities that align with the project-based learning approach of KMB, and how this variety also makes the children's assessments highly challenging.

However, the participants admitted to having only a basic understanding of literacy, often equating it solely with letter recognition, reading, and answering questions without fully grasping its broader implications (Choi & Behm-Morawitz, 2017). Moreover, the teachers claimed that their knowledge of technology and engineering was limited, so integrating these into classroom activities had been difficult. Moreover, the differences in comprehension among teachers further exacerbated the issue, resulting in a struggle to transform the diverse components of literacy and STEAM into cohesive learning experiences. Insufficient reading habits and the lack of training further contribute to these challenges (Firda & Suharni, 2022), highlighting the need for structured guidance and professional development opportunities.

Another critical challenge was the significant time commitment required for preparing learning materials. Teachers could barely find the time to find recycled items to cater to the emphasis of the KMB on hands-on learning, let alone the freedom to tailor their subjects further to their respective local culture as encouraged by the curriculum (Asmayawati et al., 2024; Toyibah et al., 2024). The results of this study confirmed that teachers constantly struggle to balance planning time with their other responsibilities such as managing students and improving their own professional knowledge. Limited time for professional development often forces them to choose between lesson preparation and their own learning (Sadeghi & Richards, 2021). Online training opportunities, while beneficial, are often too brief to ensure that all teachers fully grasp the content, further affecting their ability to implement literacy and STEAM effectively.

The interviews also revealed how teachers are expected to create multiple learning mediums, each of which must be tailored to the diverse needs of the

students. This expectation is rooted in KMB's concept of freedom, which promises students that they will have the freedom to choose the learning medium that is most suitable for them. For this to be true, the burden is on the teachers for their alternative learning mediums to be accommodating and flexible. The curriculum encourages student autonomy and exploration, but children's varying learning paces, attention spans, and engagement levels pose difficulties in maintaining an inclusive and effective learning environment (Yulianti et al., 2024). Some students struggle to focus, while others require additional guidance, thus creating challenges in balancing the support for different learning speeds.

Managing these differences is particularly challenging when fast learners disengage while waiting for their peers to catch up. Unfortunately, teachers are barely trained in navigating diverse pupil characteristics when designing their lesson activities. As noted by Thoma et al. (2023), the combination of teachers' limited knowledge of all the components of literacy and STEAM and their lack of time and training to prepare is a long-term critical challenge for teachers. The results underscore the teachers' frustration with overcoming their difficulties in adapting to the project-focused curriculum and the changing demands on children.

The integration of technology in literacy and STEAM education is hindered by limited resources and infrastructure. Many teachers lack access to the necessary digital tools such as projectors, computers, and reliable internet, particularly in rural schools. This disparity makes it difficult to implement digital aspects of STEAM learning effectively. Additionally, teachers often have limited proficiency in using the available technological tools for instructional purposes. Some attempt to supplement their knowledge by using online platforms such as Google and TikTok for lesson ideas, but these efforts remain constrained by the lack of formal training and institutional support. Literacy and STEAM, by definition, demand the use of technology.

In reality, however, there are many schools that lack access to any technology or to decent technology. Some schools lack computer laboratories, some only have projectors – and these are frequently broken or limited in number – and some have too many students who do not own devices or who are not allowed to bring their devices to school (Junaidi et al., 2020; Rasimin et al., 2024). The extent of this shortcoming can affect the level of reception of the learning activities and needs to be carefully explored in its implementation.

Furthermore, the hypocrisy between the teachers' encouragement of children's literacy and their own literacy practices is evident. This study found that teachers' personal reading habits and professional attitudes were inconsistent with their focus on the engagement of students in reading activities. Studies have shown that fostering a community of teachers who focus on continual learning is essential in overcoming these challenges (Durriyah & Zuhdi, 2018), but progress is hindered if the teachers themselves lack the motivation to explore new things. However, the reality is that many teachers in schools simply lack the time to address their personal development.

6. Research Implications

The findings of this study have several important implications for educational policy, teacher training, and curriculum development within the context of the KMB. First, the limited knowledge and understanding of literacy and STEAM among early-childhood teachers underscores the need for targeted professional development. Teacher training programs must place greater emphasis on content mastery and integrative pedagogical strategies that align with interdisciplinary approaches. This includes embedding STEAM and literacy components into preservice education and providing in-service training that enables teachers to implement these concepts effectively in early-childhood settings.

Second, time constraints were identified as a persistent barrier to planning and executing literacy and STEAM activities. This calls for a reassessment of teacher workload and scheduling at the institutional level. Policymakers and school leaders should consider revising curriculum pacing guides, allocating protected time for lesson preparation and reducing non-instructional duties that encroach on instructional planning. As such, flexible timetables and collaborative planning structures can support teachers in designing engaging integrated learning experiences that are consistent with the KMB framework.

Third, the diversity of pupil characteristics such as developmental differences, learning preferences, and attention spans requires a differentiated instructional approach. Teachers must be equipped with practical strategies to address this heterogeneity while maintaining classroom engagement. Therefore, curriculum developers should consider embedding flexibility within learning frameworks, while policymakers can support inclusive practices through teacher resources, classroom aides, and specialized training in differentiated instruction and learner-centered pedagogy.

Fourth, technological limitations continue to impede the equitable implementation of KMB, particularly in rural or underserved regions. Addressing this challenge requires not only improved infrastructure and equitable resource distribution but also capacity-building initiatives that enhance teachers' digital literacy. Investments in connectivity, access to devices, and ongoing ICT training are crucial to ensure that educators can integrate technology meaningfully into STEAM and literacy instruction.

Finally, the teachers' attitudes toward KMB and the integrated learning approaches play a pivotal role in successful implementation. Resistance or hesitation, often stemming from uncertainty or prior experiences, can hinder the adoption of new practices. Therefore, fostering a school culture that values professional growth, innovation, and reflective practice is essential. Leadership support, peer mentoring, and the celebration of successful classroom initiatives can motivate teachers to embrace change and adopt more proactive and learner-centered approaches in line with the goals of the KMB.

7. Conclusion

This study set out to explore the challenges faced by early-childhood teachers in implementing literacy and STEAM learning within the context of Indonesia's KMB. Focusing on Riau Province as a pilot region, the research provides in-depth insights drawn from the perspectives of principals, curriculum coordinators, and early-childhood teachers. Thematic analysis revealed five critical challenges, namely (i) limited pedagogical content knowledge in STEAM and literacy; (ii) insufficient training and professional development; (iii) inconsistent leadership and institutional support; (iv) technological and infrastructural disparities; and (v) time constraints related to curriculum implementation. These interconnected barriers highlight systemic and instructional issues that hinder effective integration of literacy and STEAM in early-childhood education settings.

Understanding these challenges is vital, as early-childhood education lays the foundation for lifelong learning. The findings underscore the need for policy initiatives that prioritize targeted teacher training, improved digital infrastructure, and sustained support from school leadership. In practice, the study suggests that professional development must be contextually relevant and focus on building teachers' competence and confidence in delivering integrated STEAM and literacy learning. Future research should broaden the geographical scope and adopt mixed methods to validate these findings further and to inform more inclusive and effective educational strategies across Indonesia.

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