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STRENGTHENING 21ST CENTURY SKILLS THROUGH AN INDEPENDENT CURRICULUM IN MATHEMATICS EDUCATION IN INDONESIA: CHALLENGES, POTENTIAL, AND STRATEGIES

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ABSTRACT

Several research results show that 21st century skills such as critical, creative, collaborative and communicative thinking in Indonesian students are not as expected. Then the Ministry of Education and Culture launched the Independent Curriculum as an effort to improve the quality of education and adapt it to the needs of the times. The aim of this research is to identify the challenges, potential and strategies for implementing the Independent Curriculum in strengthening 21st century skills in mathematics education in Indonesia. This research is a Systematic Literature Review (SLR) which examines various literature sources. The research results show that the Merdeka Curriculum has great potential in supporting the development of 21st century skills. The Merdeka Curriculum provides flexibility in learning, encourages creativity and critical thinking through a student-centred approach, and strengthens collaboration and communication skills. However, implementation faces challenges such as lack of resources, teacher preparedness, resistance to change, and the need for more flexible evaluation. The Merdeka Curriculum requires an implementation strategy that includes teacher training, development of innovative materials, technology integration, and ongoing evaluation.

Keyword: 21st Century Skills, Independent Curriculum, Mathematics, Challenges, Potential, Strategies

INTRODUCTION

21st century skills are a crucial component in preparing students to face increasingly complex and dynamic future challenges. Given the important role of mathematics in various aspects of life and industry, strengthening these skills through mathematics education is very important. Especially in the era of globalization and industrial revolution 4.0, 21st century skills have become very vital in education. These skills include the ability to think critically, collaborate, communicate, and innovate. Therefore, preparing students to have 21st century skills requires serious attention from various parties.

However, the 21st century skills of students in Indonesia are not yet as expected. Several studies show that the low critical thinking, creative, collaboration and communication skills of students in Indonesia can be seen from various sources. Research from the Organization for Economic Co-operation and Development (OECD) through the Program for International Student Assessment (PISA) revealed that Indonesia is ranked at the bottom (71st out of 78 countries) in reading,

mathematics and science literacy (OECD, 2019). Further research by the Indonesian Ministry of Education and Culture (2020) also found that many students in Indonesia do not reach the minimum standards for literacy and numeracy, with only around 30% of students achieving the minimum proficiency level in literacy. This shows the low literacy and numeracy skills of students. These two research results reflect the low critical and creative thinking abilities of students. Furthermore, research by the Asia Society (2017) examined the readiness of students in Asia, including Indonesia, to face the challenges of the 21st century. This report found that many students in Asia, including Indonesia, still lack collaboration and communication skills. For example, only about 40% of students feel they have enough opportunities to work in teams at school. Overall, these studies show that the critical thinking, creative, collaboration and communication skills of students in Indonesia still need to be improved, one of which is through improving the curriculum.

In Indonesia, through the Minister of Education, Culture, Research and Technology (Mendikbudristek), launched the Merdeka Curriculum on February 11 2022. The Merdeka Curriculum will begin to be implemented in stages in Indonesia in 2021. The implementation of this curriculum is part of the efforts of the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) to improve the quality of education and adapt to the needs of increasingly dynamic times. The Merdeka Curriculum is intended to respond to these needs by emphasizing student-centred learning and the development of these essential skills in every subject, including mathematics. The Merdeka Curriculum is in line with the Partnership for 21st Century Skills (P21), with an emphasis on developing learning and innovation skills, information, media and technology skills, as well as life and career skills (Farisi, 2016). Additionally, the Merdeka Curriculum emphasizes the importance of creativity, which is another key skill sought by employers. Integrating a design mindset into education can increase students' competitiveness and readiness to respond to the demands of Industry 4.0 (Noh & Karim, 2021). Creativity, along with critical thinking, is elevated as essential for success in the workplace and for meeting the needs of a rapidly changing economy (Sola et al., 2017).

Previous studies have examined the implementation of the educational curriculum in Indonesia, most of the previous research focused more on the implementation of the Merdeka Curriculum in general without specifically examining how this curriculum is applied in mathematics subjects. Many studies do not specifically measure the development of 21st century skills (critical thinking, creative, collaborative, and communicative) in the context of mathematics learning. In addition, there is a lack of research that identifies specific strategies to overcome the challenges faced in implementing the Merdeka Curriculum in mathematics education.

However, it is very important to identify potentials that can be optimized in implementing the Independent Curriculum to strengthen 21st century skills in mathematics education. This includes research that analyzes specific challenges in implementing the Independent Curriculum in mathematics learning, such as teacher readiness, availability of learning resources, and institutional support. As well as

effective and widely applicable strategies to overcome the challenges faced, as well as maximize the potential that exists in mathematics education with the Independent Curriculum.By providing an in-depth analysis of the implementation of the Merdeka Curriculum in the context of 21st century skills, this research is expected to provide valuable recommendations for policy makers, educators and educational practitioners to optimize mathematics learning strategies in Indonesia.

This research tries to focus on the potential, challenges, and adaptation strategies that might be used to maximize the implementation of the Merdeka Curriculum in mathematics education. Therefore, the aim of this research is to identify challenges, potential and strategies in strengthening 21st century skills through the Merdeka Curriculum in mathematics education in Indonesia

METHOD

This research method is the Systematic Literature Review (SLR) Methodology. The SLR method is used to identify, review, evaluate, and interpret all available research on a topic area of interest, with specific relevant research questions. SLR plays an important role in conducting a comprehensive literature review regarding the effectiveness of Critical Pedagogy in mathematics education in Indonesia. SLR helps in identifying key findings from existing research, enabling the synthesis of current knowledge and pinpointing research gaps that require further exploration (Fitriyana et al., 2023). This research was conducted through a comprehensive literature review from a variety of sources including journal articles, government reports, and policy documents. These sources were analyzed to collect data regarding the influence of the Merdeka Curriculum on mathematics education and how it can support the achievement of 21st century skills.

RESULTS AND DISCUSSION

Independent Curriculum

The Merdeka Curriculum is an education reform initiative launched in Indonesia to provide greater flexibility in learning and develop students' 21st century skills. This initiative is designed to overcome the challenges of a dynamic era and global competition with a more modern and inclusive educational approach. The Merdeka Curriculum aims to empower students with the skills and knowledge necessary to thrive in a fast-changing world, with an emphasis on critical thinking, creativity, collaboration and communication. In addition, the flexibility of the Merdeka Curriculum allows teachers to adapt their teaching methods to meet students' unique learning needs and interests (Huriyah et al., 2022). The initiative seeks to move away from traditional rigid educational structures and adopt a more flexible and learner-centered approach, enabling students to pursue their interests and develop skills relevant to the demands of the modern workforce and society. By promoting inclusivity, the Merdeka Curriculum aims to meet the diverse needs and abilities of students, ensuring that education is accessible and meaningful for all learners. The Merdeka Curriculum gives teachers the freedom to choose a variety of teaching tools and strategies, thereby increasing the overall effectiveness of instruction (Huriyah et al., 2022).

The implementation of the Merdeka Curriculum reflects Indonesia's commitment

to preparing its youth to face the challenges and opportunities of the 21st century, in line with global trends in education reform that prioritize the development of adaptable, innovative and globally competent individuals. The reliability of the Independent Curriculum in Indonesia provides several advantages that suit the various needs and interests of students. One of its main benefits is the opportunity for students to customize a curriculum that aligns with their individual goals and aspirations, often across interdisciplinary fields. This personalized approach allows students to explore their areas of interest more deeply while still maintaining a solid educational foundation (Collins et al., 2005.). Additionally, the flexibility of the Merdeka Curriculum fosters independence among students, empowering them to take control of their learning journey. This independence cultivates a sense of responsibility for their education, which leads to higher engagement and motivation (Atkinson, 2023).

Another advantage of the flexibility of the Merdeka Curriculum is its emphasis on project-based learning and the development of important 21st century skills such as critical thinking, creativity, and problem solving. By empowering students to choose their learning paths and methods based on their interests and talents, this curriculum facilitates the development of these important skills that are indispensable for success in the contemporary world (Sutaris, 2022).

The Merdeka Curriculum in Indonesia marks a significant educational paradigm shift, with the aim of empowering students to take control of their learning process. This curriculum model places students at the center of the educational experience, encouraging them to engage in independent learning based on their interests, skills, and needs (Usman et al., 2023). It is designed to cultivate a generation of independent learners who can actively participate in their education (Muliaman et al., 2023). This approach is in line with broader education reforms in Indonesia which emphasize the importance of students developing into independent learners (Utami & Suswanto, 2022).

In addition, the Merdeka Curriculum gives students the freedom to choose their learning paths, interests and talents, fostering a more personalized and student-oriented educational experience (Sakdiah et al., 2023). This curriculum also emphasizes the importance of students taking the initiative to learn independently without heavy dependence on external guidance (Usman et al., 2023).

21st Century Skills

21st century skills refer to the set of competencies needed to succeed in this fast-changing global and digital era. These skills emphasize the ability to handle complex information, think critically, work collaboratively, and adapt to changing work and social environments. 21st century skills encompass a diverse set of competencies that are critical for individuals to thrive in the contemporary world. These skills are characterized by various perspectives, but generally revolve around critical aspects such as ways of thinking, working, and living in a connected and media-rich environment Anagün (2018). The Partnership for 21st Century Skills and other trusted organizations have identified key components of these skills, including critical thinking, problem solving, creativity, communication, collaboration, innovation,

teamwork, decision making, leadership, application of knowledge, independence, and learning how to learn (Rizaldi et al., 2020). These skills are further categorized into ways of thinking (creativity, critical thinking, problem solving, decision making), ways of working (communication, collaboration, teamwork), tools for working (information literacy, information communication technology), and life in the world. (life and career, personal and social responsibility) (Motallebzadeh et al., 2018).

Additionally, 21st century skills are essential for individuals to navigate the educational, professional, and social landscape effectively. They include learning and innovation skills, information, media, and technology skills, as well as life and career skills (Yoo, 2020). These skills are fundamental to success in today's world and the workplace of the future, emphasizing competencies such as creativity, communication, problem solving, collaboration, critical thinking, technological literacy, and cross-cultural skills (Illene et al., 2023). Additionally, they cover collaborative problem-solving skills, complex problem-solving skills, digital information literacy, and other important abilities.

At its core, 21st century skills are a set of knowledge, skills, work habits, and character traits that are considered critical for success in the modern era. These skills enable individuals to adapt to the ever-changing demands of society, education, and the world of work, emphasizing creativity, critical thinking, communication, collaboration, problem solving, and digital literacy as core competencies for thriving in the 21st century.

In mathematics education there are four main abilities of 21st century skills that are often considered important:

(1) Critical Thinking Ability

Critical thinking skills in mathematics involve engagement in analytical reasoning, logical evaluation, and problem solving in the context of mathematical concepts and their applications. These skills require the ability to analyze mathematical problems, evaluate different approaches, make informed decisions, and justify solutions based on mathematical reasoning and evidence Firdaus et al. (2015). In the realm of mathematics education, critical thinking skills are essential for students to effectively navigate complex mathematical challenges and develop a deeper understanding of mathematical concepts (Basri et al., 2019).

Developing critical thinking skills in mathematics includes various components, including analysis, evaluation, inference, explanation, and self-regulation (Basri et al., 2019). Students are encouraged to question assumptions, explore various solution paths, assess the validity of mathematical arguments, and reflect on their problem-solving strategies (Mulyanto et al., 2018). By involving themselves in this cognitive process, students improve their ability to think critically about mathematical problems, producing more robust problem solving results (Palinussa, 2013).

In addition, critical thinking skills in mathematics are closely related to the ability to apply mathematical concepts in real-world contexts, forming a deeper connection between theoretical knowledge and practical problem solving (Aizikovitsh-Udi & Cheng, 2015). Students with strong critical thinking skills in mathematics demonstrate a high

level of mathematical proficiency, as they can effectively analyze mathematical situations, conclude logically, and convey their reasoning clearly (Ariawan et al., 2022).

Educators play an important role in cultivating students' critical thinking skills in mathematics by designing learning experiences that encourage inquiry, exploration, and reflection (Mujib et al., 2022). Through problem-based learning, collaborative activities, and opportunities to discuss mathematics, teachers can improve students' ability to think critically about mathematical concepts and problems (Tajudin & Chinnappan, 2016). In addition, integrating technology and innovative teaching strategies can further improve students' critical thinking skills in mathematics (As'ari et al., 2017).

In conclusion, critical thinking skills in mathematics are essential for students to become skilled problem solvers, effective communicators, and analytical thinkers in the field of mathematics. By cultivating these skills through engaging learning experiences and thoughtful teaching practices, educators can empower students to approach mathematical challenges with confidence, creativity, and logical reasoning.

(2) Creative Thinking Ability;

The ability to think creatively in mathematics involves the capacity to approach mathematical problems innovatively, generate new solutions, and think flexibly and critically in the realm of mathematical concepts and applications. This ability includes authenticity, fluency, flexibility, elaboration, and authenticity in the problem solving process Hidayat & Evendi (2022). In the context of mathematics education, fostering creative thinking skills is very important for students to develop a deeper understanding of mathematical concepts and excel in problem solving tasks (Yuliani et al., 2018).

Indicators of creative thinking ability in mathematics include fluency, which refers to the ability to generate multiple solutions to a given problem; flexibility, which involves considering different approaches and points of view in problem solving; authenticity, which involves producing unique and innovative solutions; and elaboration, which requires expanding ideas and solutions in detail (Muhammad & Nikmah, 2021). These indicators reflect the cognitive processes involved in creative mathematical thinking and can be used to evaluate students' proficiency in this domain.

Measuring creative thinking abilities in mathematics can be done through various methods, such as problem solving tasks, mathematics tasks that require open solutions, and performance assessments that assess students' fluency, flexibility, originality, and elaboration in the problem solving process (Rahayuningsih et al., 2022). Additionally, tools such as model disclosure activities (MEAs) can be used to provide opportunities for students to engage in creative and applied mathematical thinking, enabling educators to analyze students' mathematical thinking and identify those with exceptional domain-specific mathematical creativity (Chamberlin & Moon, 2005).

Additionally, self-assessment instruments, guided discovery worksheets, and mixed-method studies can be used to evaluate students' creative mathematical thinking abilities and their self-efficacy, providing insight into their problem-solving and creative mathematical reasoning skills

(Yuliani et al., 2018; Rahayuningsih et al. ., 2022). By integrating innovative teaching approaches, such as guided discovery learning or problem-based learning, educators can improve students' creative thinking skills in mathematics and promote higher-order cognitive processes (Jatisunda et al., 2020; Ratnaningsih, 2017).

In conclusion, creative thinking skills in mathematics involve originality, fluency, flexibility, and elaboration in the problem solving process. Educators can assess and foster these abilities through problem-solving assignments, open-ended mathematics assignments, and innovative teaching strategies that encourage students to think creatively and critically in mathematical contexts.

(3) Communication Skills;

Communication skills in mathematics refer to students' ability to effectively convey mathematical ideas using symbols, diagrams, tables, or other media to solve mathematical problems and convey mathematical concepts clearly (Setiyani et al., 2020; Rohid et al., 2019). This skill is important for students to express their mathematical reasoning, share problem-solving strategies, and engage in mathematical discussions with peers and teachers (Susanti et al., 2020). Effective mathematical communication involves organizing and connecting mathematical thoughts, conveying mathematical ideas logically and clearly, analyzing strategies used by others, and using mathematical language accurately (Tong et al., 2021).

Indicators of communication skills in mathematics include the ability to convey mathematical ideas logically and clearly using spoken language, visuals and written forms such as pictures, graphs, calculations and algebraic representations (Awaludin, 2022; Anggraini et al., 2022). Students with strong communication skills can present mathematical ideas to different audiences, justify their solutions, and use mathematical conventions, vocabulary, and terms accurately (Mustafa, 2022). In addition, students who can connect real objects, pictures, and diagrams with mathematical ideas demonstrate skills in mathematical communication (Suri et al., 2022).

Measuring communication skills in mathematics can be achieved through various assessment methods, such as analyzing students' written explanations of mathematical concepts, evaluating their oral presentations of problem-solving strategies, and assessing their ability to use mathematical language and symbols accurately (Suryawati et al., 2022; Fay et al., 2022). Performance tasks, collaborative activities, and model discovery activities can also be used to measure students' skills in conveying mathematical ideas effectively (Amni, 2021; Nuary, 2022). Additionally, self-assessment tools, rubrics, and structured observation protocols can provide valuable insight into students' mathematical communication skills and help educators identify areas for improvement (Kaya & Aydin, 2016; Powell & Hebert, 2016).

Educators can improve students' communication skills in mathematics by combining strategies such as problem-based learning, collaborative learning, and the use of multimedia resources to promote mathematical discussions and encourage students to express their mathematical thinking (Bina et al., 2021; Paroqi et al., 2020). By providing opportunities for students to engage in mathematical discussions, present their solutions, and receive feedback on their communication,

educators can establish a classroom environment that develops effective mathematical communication skills (Jehadus et al., 2021; Sumargiyani & Nafi'ah, 2020) .

In conclusion, communication skills in mathematics are essential for students to convey mathematical ideas clearly, justify their reasoning, and engage in meaningful mathematical discussions. By assessing and developing these skills through a variety of learning approaches, educators can empower students to convey their mathematical thinking effectively and improve overall mathematical proficiency.

(4) Collaboration Capabilities.

Collaboration skills in mathematics refer to students' capacity to work together effectively, share ideas, engage in mathematical discussions, and jointly solve mathematical problems Sutama et al. (2022). In the context of mathematics education, collaboration skills are essential for students to communicate mathematical concepts, justify their reasoning, and participate in problem solving tasks cooperatively (Lilienthal, 2022). Effective collaboration in mathematics involves active participation, respectful communication, sharing ideas, and joint decision making to achieve common mathematical goals (Marwiang et al., 2014).

Indicators of collaborative abilities in mathematics include engaging in productive mathematical discussions with peers, listening actively to others' points of view, contributing ideas to group problem solving tasks, and working collaboratively to reach agreement on mathematical solutions (Grossman, 2011). Students who demonstrate strong collaboration skills in mathematics can effectively communicate their mathematical thinking, provide constructive feedback to peers, and engage in meaningful mathematical discussions (Tachie, 2022). In addition, students who work together to explore mathematical concepts, analyze problem-solving strategies, and collectively present solutions demonstrate expertise in collaboration abilities (djunaidi, 2021).

Measuring collaboration abilities in mathematics can be achieved through various assessment methods, such as observing student interactions during group problem solving tasks, evaluating the quality of mathematical discussions in collaborative settings, and assessing students' ability to work together to solve complex mathematical problems (Brunson et al., 2013) . Performance assessments, peer evaluations, and self-assessment tools can also be used to measure students' ability to collaborate with peers to achieve mathematics goals (Lu'luilmaknun et al., 2021). Additionally, rubrics, structured observation protocols, and reflective journals can provide valuable insight into students' collaboration skills and their ability to work effectively in mathematics teams (Gadanidis et al., 2011).

Educators can improve students' collaboration abilities in mathematics by combining strategies such as cooperative learning, group problem solving assignments, and peer feedback mechanisms to promote collaborative mathematical interactions (Lubinski & Benbow, 2006). By providing opportunities for students to work together, engage in mathematical discussions, and jointly explore mathematical concepts, educators can establish a classroom environment that helps

develop effective collaboration skills in mathematics (Cai et al., 2005).

In conclusion, collaboration skills in mathematics are essential for students to work effectively in groups, communicate mathematical ideas, and engage in cooperative problem-solving tasks. By assessing and developing these skills through a variety of learning approaches, educators can empower students to collaborate successfully with peers, communicate their mathematical thinking, and improve their overall mathematical abilities.

The Potential of the Independent Curriculum in Providing Strengthening 21st Century Skills Through the Independent Curriculum in Mathematics Education in Indonesia

The Merdeka Curriculum in Indonesia offers great opportunities to improve 21st century skills, especially in mathematics education. This curriculum reform prioritizes the development of independent learning skills among students, empowering them to direct their educational journey (Utami & Suswanto, 2022). By promoting independent learning, students are motivated to actively seek knowledge that matches their interests and abilities, reducing dependence on external sources (Usman et al., 2023). This shift towards independent learning is important to prepare students for the demands of the 21st century, where independent learning and adaptability are highly valued.

In addition, the Merdeka Curriculum places a strong focus on character education, aiming to form well-rounded individuals who embody values such as integrity, responsibility and resilience (Suryantari, 2022). Integrating character education into the curriculum not only provides academic knowledge but also instills important qualities necessary for success in the contemporary world (Huriyah et al., 2022). This comprehensive approach to education is in line with the overarching goal of nurturing Indonesia's future generations to face the challenges of the future.

In addition, the Merdeka Curriculum advocates a student-based approach to learning, where teachers act as facilitators of knowledge and students play an active role in their educational journey (Fauzi et al., 2022). This transition to student-based learning fosters a culture of autonomy and creativity, allowing students to explore multiple perspectives and develop a deeper understanding of mathematical concepts. By empowering students to direct their learning process, the Merdeka Curriculum sets the foundation for more engaging and effective mathematics education (Sakdiah et al., 2023).

The Potential of the Independent Curriculum to Strengthen Critical Thinking Abilities

The Merdeka Curriculum in Indonesia aims to improve critical thinking skills among students by emphasizing innovation, creativity, project-based learning, and a student-centered approach (Zainuri et al., 2023). This curriculum reform gives teachers the freedom to explore innovative teaching methods and approaches, empowering them to foster students' critical thinking abilities (Zainuri et al., 2023). Critical thinking is essential to equip students with the skills necessary to face challenges and make informed decisions in the 21st century (Simpson & Courtney, 2008).

In the realm of mathematics education, the Merdeka Curriculum provides a platform for introducing innovative teaching methods that improve students' problem-solving skills and critical thinking abilities (Szabó et al., 2020). By integrating real-world problem-solving experiences into the curriculum, educators can effectively foster students' 21st century skills in mathematics (Szabó et al., 2020). This approach not only improves students' math proficiency but also equips them with transferable skills that are important for success in a variety of fields (Gravemeijer et al., 2017).

In addition, the Merdeka Curriculum integrates project-based learning and problem-solving approaches to develop students' critical thinking skills. By involving students in real-world projects and activities that require analytical thinking and problem solving, this curriculum offers a practical platform for honing critical thinking skills (Setiyani et al., 2022).

Furthermore, the Merdeka Curriculum promotes a student-centered learning environment, encouraging students to question, analyze and evaluate information critically, fostering a culture of inquiry and intellectual curiosity. By placing students at the center of the learning process, the Merdeka Curriculum fosters their critical thinking skills and encourages them to engage deeply with the subject matter (Mu'arifin, 2022).

In conclusion, the Independent Curriculum in Indonesia has great potential to improve 21st century skills, especially in mathematics education. Through the promotion of self-directed learning, character education, innovative teaching methods, and student-driven learning, this curriculum reform aims to equip students with the skills and competencies necessary to thrive in the dynamic landscape of the 21st century.

The Potential of the Independent Curriculum to Strengthen Creative Thinking Abilities

The Merdeka Curriculum in Indonesia aims to improve students' creative thinking abilities by encouraging innovation, creativity and a student-centred approach. This is in accordance with the opinion of Purnomo et al., (2022) that this curriculum reform emphasizes fostering independence and creativity in students, with the aim of developing their ability to think critically and creatively. By promoting the idea of "Merdeka" or independence, this curriculum encourages students to explore their creativity, think outside the box, and engage in collaborative projects that stimulate their creative thinking.

In addition, the Merdeka Curriculum integrates project-based learning and a problem-solving approach, giving students the opportunity to apply their creative thinking skills in real-world contexts. By involving students in practical projects that require innovative solutions, this curriculum develops their ability to think creatively and critically (Azhari, 2023). Additionally, the Merdeka Curriculum promotes a student-centered learning environment that values creativity, critical thinking, and problem-solving abilities. By emphasizing the importance of student-centered learning, this curriculum empowers students to develop their creative thinking abilities through interactive and collaborative learning experiences (Elfira et al., 2022).

In conclusion, the Merdeka Curriculum in Indonesia has the potential to strengthen students' creative thinking abilities by promoting independence,

innovation, project-based learning, and a student-centered approach. By fostering creativity and critical thinking, this curriculum reform equips students with the skills necessary to thrive amidst the dynamic and challenging landscape of the 21st century.

The Potential of the Independent Curriculum to Strengthen Communication Skills

The Merdeka Curriculum in Indonesia aims to improve communication skills among students through innovative teaching methods, project-based learning, and a student-centered approach. This curriculum reform focuses on fostering independence, creativity, and critical thinking, which are important components of effective communication (Ayn et al., 2017). By promoting the value of communication skills training and emphasizing the instructor's role in guiding students, the Merdeka Curriculum creates an environment that supports the development of strong communication skills. In addition, the integration of project-based learning and problem-solving approaches in the Merdeka Curriculum provides practical opportunities for students to apply and improve their communication skills in real-world contexts (Pfeiffer et al., 1998). Engaging students in hands-on projects that require effective communication helps them develop clarity, empathy, and active listening skills, which are essential for successful communication.

Furthermore, the student-centered learning environment promoted by the Merdeka Curriculum encourages students to actively participate in discussions, collaborate with peers, and engage in interactive learning experiences that improve their communication skills. By focusing on promoting a culture of open communication, this curriculum empowers students to convey their ideas effectively, listen carefully, and engage in constructive dialogue (Perron et al., 2015).

In conclusion, the Merdeka Curriculum in Indonesia shows potential in strengthening communication skills among students by fostering independence, creativity and critical thinking. Through innovative teaching methods, project-based learning, and a student-centered approach, this curriculum reform equips students with the communication skills necessary to succeed in the 21st century.

The Potential of the Independent Curriculum to Strengthen Collaboration Capabilities

The Merdeka Curriculum in Indonesia aims to improve collaboration skills among students through an innovative and student-centered approach. By promoting independence, creativity, and critical thinking, this curriculum reform creates an environment that encourages collaboration and cooperation (Purnomo et al., 2022). The emphasis on collaborative projects and a problem-solving approach provides students with practical experience that requires effective communication, cooperation, and teamwork. Involving students in group activities and projects helps them develop important collaboration skills, such as active listening, sharing ideas, and working together to achieve common goals (Azhari, 2023).

Additionally, the Merdeka Curriculum encourages a student-centered learning environment that values collaboration, communication, and teamwork. By promoting collaborative learning experiences, this curriculum empowers

students to engage in discussions, group work, and cooperative activities that enhance their collaboration abilities (Sari et al., 2023). This collaborative approach not only strengthens students' teamwork skills but also cultivates a sense of community and mutual respect among peers

Furthermore, the Merdeka Curriculum emphasizes the importance of interactive and participatory learning experiences that require students to collaborate, communicate effectively, and engage in collective problem solving (Nurzen, 2022). By including activities such as group discussions, independent projects, and collaborative learning assignments, this curriculum provides students with opportunities to develop and practice their collaboration skills.

In conclusion, the Merdeka Curriculum in Indonesia has the potential to significantly strengthen collaboration skills among students by promoting independence, creativity, and critical thinking, as well as fostering a collaborative and student-centered learning environment. Through an emphasis on teamwork, communication, and cooperative learning experiences, this curriculum reform equips students with the critical skills necessary for effective collaboration in the 21st century.

Challenges of the Independent Curriculum in Providing Strengthening 21st Century Skills through the Independent Curriculum in Mathematics Education in Indonesia

Despite its many advantages, the Independent Curriculum in Indonesia faces challenges in integrating 21st century skills into mathematics education. The Merdeka Curriculum faces challenges in improving critical thinking, creative thinking, communication and collaboration skills in mathematics education. Some of the challenges faced are as follows.

1. Lack of Resources and Infrastructure

Implementing the Independent Curriculum which combines technology and new learning methods requires adequate infrastructure, such as digital devices and stable internet access. In many regions in Indonesia, especially in rural areas, there are still limited resources and infrastructure (Fahlevi, 2022).

2. Teacher Readiness and Adaptation

Incorporating 21st century skills into the curriculum requires substantial changes in the education sector, involving teachers, learning centers, and educational planning (Hernández-Fernández, 2022). Teachers have a key role in implementing the Independent Curriculum, but they face challenges in integrating programs such as the Life Values Education Program (Komalasari & Apriani, 2023). In addition, teacher readiness is critical for successful curriculum implementation, requiring the involvement of all stakeholders, including school principals, educators, students, parents, communities, and government (Nurzen, 2022).

Curriculum changes require teachers to adapt their teaching methods and often require additional training. Teachers in Indonesia may not be fully ready or have the necessary competencies to implement a more flexible approach focused on developing 21st century skills (Suryaman, 2020). Teacher readiness in preparing cross-disciplinary material and mastery of technology is also an obstacle. The learning approach in the independent curriculum demands competency-based learning strategies, innovative teaching techniques

that combine technology, inquiry-based learning, and high-level thinking skills (Farisi, 2016).

3. Resistance to Change

Changes in the education system often face resistance, both from teachers, parents and the education system itself. Newer, skills-oriented approaches may be seen as a diversion from traditional methods that focus more on factual knowledge, which are still valued in many educational contexts in Indonesia (Nasution, 2022).

4. Development of Relevant Learning Materials

Developing relevant and engaging materials that align with the Merdeka Curriculum, which supports skills such as critical thinking, creativity and collaboration is a challenge. These materials must be relevant to students' needs and at the same time promote 21st century skills, which requires resources, time, and expertise in curriculum development (Bahri, 2022).

5. Evaluation and Assessment

Skills-oriented curricula require evaluation methods that differ from standardized tests. Developing an evaluation system that assesses students' critical thinking, creativity and collaborative abilities is a challenge, because it requires a change from more traditional assessment systems which are generally more focused on exam results (Habibah, 2022).

6. Student Engagement

The Merdeka Curriculum emphasizes student-centered learning to improve the quality of the learning process (Mu'arifin, 2022). However, challenges remain in effectively integrating the four 21st century skills (Afandi et al., 2022). The curriculum also aims to include sustainable development goals through biotechnology projects, in line with the themes (Purnomo et al., 2022). Increasing student involvement in independent and project-based learning, in accordance with the principles of the Independent Curriculum, requires a different approach to teaching and also a change in students' learning attitudes. Changing students' mindsets from passive to active learning is a challenging process and requires time and consistency (Gusdwisari, 2020).

7. Policy and Financial Support

Successful implementation of the Merdeka Curriculum requires consistent policy support from the government and adequate resource allocation. The budget required for teacher training, developing learning materials, and improving infrastructure is often a major obstacle on a national scale (Wiranto, 2021). However, curriculum implementation faces obstacles such as limited funds, suboptimal academic information systems, lack of talent, and inadequate program information (Supriati et al., 2022).

In conclusion, the challenges faced by the Merdeka Curriculum in improving critical thinking, creative thinking, communication, and collaboration skills in mathematics education in Indonesia are related to the need for teacher readiness, innovative teaching methods, and effective integration of activities that promote these skills. Addressing these challenges requires concerted efforts to align teaching practices with curriculum goals and provide ongoing support for educators to facilitate the development of 21st century skills among

students. Addressing these challenges requires a comprehensive approach that involves all stakeholders in the Indonesian education system, including policy makers, educators, students and communities.

Strategy for Implementing the Independent Curriculum in Strengthening 21st Century Skills through the Independent Curriculum in Mathematics Education in Indonesia

To effectively implement the Merdeka Curriculum in strengthening 21st century skills in Mathematics Education in Indonesia, a strategic approach is essential. The following are several implementation strategies for strengthening 21st century skills through the independent curriculum in mathematics education in Indonesia

1. Teacher Professional Training and Development

One key strategy is to provide adequate training for teachers so that they can implement the Merdeka Curriculum effectively. This training should include the use of new technologies, student-centered teaching methods, and techniques for integrating 21st century skills into mathematics lessons (Fahlevi, 2022). Teacher competency plays an important role in the implementation of the Independent Curriculum to improve 21st century skills among students (Banjarnahor et al., 2023). Teachers need to understand the importance of 21st century skills and integrate them into their teaching practices to create a conducive learning environment that effectively promotes these skills

2. Development of Innovative Learning Materials and models

Create innovative learning materials that cover not only mathematical theory but also practical applications that enhance skills such as problem solving, critical thinking, and data analysis. This material must be interesting and relevant to students' lives to increase their involvement (Nasution, 2022).

Apart from that, integrating problem-based, project-based, differentiated learning models is important. Such as STEAM integrated project-based learning, can be an effective approach to improve 21st century skills in Mathematics Education (Zayyinah et al., 2022). This model provides opportunities for students to apply mathematical concepts in real-world scenarios, which develops creativity, critical thinking, and collaboration.

3. Technology Integration in Learning

Using technology to support mathematics learning, such as mathematics software, educational applications, and online learning platforms. This technology can help students understand complex concepts through better visualization and increased interaction (Suryaman, 2020). Apart from that, it is also very important to prepare innovative learning media.

4. Skills-Focused Assessment Methods

Adopt more flexible, skills-focused assessment methods, which assess not only factual knowledge but also students' ability to apply that knowledge in real situations. This can include portfolio, project, and presentation-based assessments (Bahri, 2022).

5. Collaboration with Stakeholders

Involving various stakeholders, including parents, local communities, and industry, in the mathematics learning process. This collaboration can provide additional support for students and help

make learning more relevant and related to the real world (Gusdwisari, 2020).

6. Learning Programs that Adapt to Student Interests

Provide opportunities for students to choose topics or projects that interest them in a mathematical context. This will not only increase engagement but also allow students to develop skills in areas they see as relevant and interesting (Wiranto, 2021).

7. Continuous Evaluation and Feedback

Conduct ongoing evaluation and feedback on curriculum implementation to ensure that it meets its objectives in developing 21st century skills. This should involve regular analysis of student progress and adjustments to the curriculum based on those findings (Habibah, 2022).

Through these strategies, the implementation of the Merdeka Curriculum in mathematics education in Indonesia can be more effective in preparing students with the skills needed to succeed in the 21st century. This will create an education that is more adaptive, innovative, and responsive to students' needs and rapidly changing global demands. In conclusion, to strengthen 21st century skills through the Merdeka Curriculum in Mathematics Education in Indonesia, it is important to focus on developing customized learning tools, integrating project-based learning models, increasing teacher competency, and emphasizing mathematical modeling to engage students in the creative process of applying mathematical concepts to real world situations.

CONCLUSION

The Merdeka Curriculum has great potential in supporting the development of 21st century skills, especially in mathematics education in Indonesia. This curriculum provides flexibility in learning, encourages creativity, and critical thinking through a student-centered approach. The Merdeka Curriculum also strengthens collaboration and communication skills. However, the implementation of the Merdeka Curriculum faces several significant challenges, including limited resources, teacher readiness and adaptation, resistance to change, development of relevant learning materials, evaluation and assessment, and student involvement. To overcome this challenge, an implementation strategy is needed that includes teacher training, development of innovative materials, technology integration, and ongoing evaluation.

RECOMMENDATION

Based on the results of research regarding strengthening 21st century skills through the Independent Curriculum in mathematics education in Indonesia, the author provides the following recommendations.

1. The government and policy makers must ensure that all schools have adequate access to digital infrastructure and allocate sufficient budget for teacher training, development of learning materials, and improvement of school facilities, as well as regular evaluations of the implementation of the Merdeka Curriculum to identify areas that require improvement.
2. Teachers need to implement innovative and student-centered teaching methods, such as project and problem-based learning, utilizing technology in learning to make material more interactive and interesting, and using assessment

methods that assess students' critical thinking, creativity, collaboration and communication skills. Parents and families must support their children's learning process at home by providing a conducive environment, being actively involved in school activities, and establishing good communication with teachers and the school.

3. Communities and industry need to work together with schools to provide real projects that are relevant to the world of work, provide resource and expertise support, and provide internship or industrial excursion programs to give students hands-on experience. With support and collaboration from all stakeholders, it is hoped that the implementation of the Merdeka Curriculum will be successful in developing 21st century skills in students, especially in mathematics education, so that they are ready to face the challenges and opportunities in the future.
4. For future researchers, further studies can explore the long-term impact of the Merdeka Curriculum on student academic achievement and teacher professional development in a broader and more diverse context, especially in relation to 21st century skills.

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