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Exploring Mathematics' Teacher Knowledge and Challenges in Curriculum Change Implementation: Case Study in Indonesia

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Abstract:
The *Merdeka* Curriculum, Indonesia's national curriculum, has been in place for 2 years. A qualitative phenomenological study was conducted to investigate teachers' understanding of the *Merdeka* Curriculum, its implementation, challenges faced, and strategies to overcome them. The study involved 9 participants, with 3 teachers each from Independently Sharing (IS), Independently Changing (IC), and Independently Learning (IL) schools, selected through purposive sampling. Data was collected through interviews, observations, and documentation. Interviews were conducted with open-ended questions regarding teachers' knowledge, implementation, challenges, and strategies related to the *Merdeka* Curriculum. Observations were made during learning sessions, and documentation included Teaching Modules and assessment tools. The research revealed that teachers were cognizant of the differences between the *Merdeka* Curriculum and its predecessor. Teachers from IS schools demonstrated the ability to create independent learning resources, implement project-based learning, differentiate instruction, integrate the *Pancasila* Student Profile Project (P5), and utilize various forms of assessment. However, teachers from IC and IL schools were still reliant on government-provided Teaching Modules. Additionally, teachers from IL schools had not yet implemented diagnostic assessments. Challenges in implementing the *Merdeka* Curriculum included organizing materials, addressing the diverse initial abilities of students, managing additional teacher responsibilities, and dealing with limited facilities and infrastructure. Strategies to address these challenges included utilizing online resources, offering remedial support for students with lower abilities, structuring assignments, and better scheduling facility and infrastructure usage.

Keywords: challenge in curriculum change, curriculum implementation, *Merdeka* curriculum, teaching module, teacher knowledge

1. Introduction

Mathematics is a field of study focused abstraction, exploration, and relationships built through reasoning (Golding, 2018). It is essential for technological advancements as it requires logical thinking skills (Keputusan Kepala (Decree of The Head) BSKAP, 2024). In the era of globalization, technological advancements, such as Artificial Intelligence (AI), have significantly impacted human life by making it easier. To keep pace with these advancements, mathematics education in schools must align with curriculum development (NCTM, 2010). Fey (2014) emphasized the importance of transforming the curriculum to enhance learning strategy in schools.

A curriculum is a set of plans outlining objectives, content, learning materials, and methods used to guide educational activities towards achieving goals (UU No. 20, 2003). Li and Lappan (2014) noted that the curriculum plays a crucial role in structuring the educational experience for students. Gouëdard et al., (2020) stated that countries view curriculum reform as essential for schools to adapt to the fast-changing world of the 21st century.

Indonesia has undergone several curriculum changes in 1950, 1960, 1970, 1975, 1984, 1991, 1994, 2006, and 2013 (Kristiawan, 2019). Changes, developments, and improvements related to the curriculum continue

to be carried out by the Indonesian government reflecting the evolving demand of globalization (Cheung & Man Wong, 2012; Machali, 2014; Rumahlatu et al., 2016). The Covid-19 pandemic highlighted the urgency of implementing the *Merdeka* (Emancipated Learning) Curriculum at the elementary and secondary levels to address learning loss (Mendikbudristek (Minister of Education, Culture, Research, and Technology), 2022a). This curriculum involves three stages: Independently Sharing (IS) where schools develop learning tools independently, Independently Changing (IC) where schools implement the *Merdeka* Curriculum with tools from the government, and Independently Learning (IL) where schools are still allowed to combine the *Merdeka* Curriculum with the previous curriculum (Kepala (Head of) BSKAP, 2022). The *Merdeka* Curriculum aims to enhance the quality of education process. The quality of education can be achieved through assessment and continuous quality development including student quality, learning environment, content, process, and learning outcomes (Adams, 1993).

Compared to the previous curricula, the *Merdeka* Curriculum introduces significant changes, such as completing learning achievement within specific phases rather than at fixed class (Mendikbudristek, 2022b). This flexibility allows schools to determine their learning approach to students' characteristic and learning environments. Additionally, the *Merdeka* Curriculum also emphasized soft skills and character development through the Pancasila Student Profile Strengthening Project (P5), and assessments align to the Program for International Student Assessment/PISA framework (Pusat Kurikulum dan Pembelajaran (Curriculum and Learning Center), 2023).

The changes in a curriculum is related to how it is implemented at the educational unit level. Previous studies have examined teachers' abilities in implementing new curriculum. The research of Dessi Kristiyani (2015) and Nurwijayanti (2018) analyzed the implementation of the 2013 Curriculum in junior high school mathematics learning in Lombok focusing on aspects such as learning planning, learning implementation, assessment of learning outcomes, teacher knowledge and attitudes, and supporting facilities and infrastructure for the implementation of the 2013 Curriculum. The study only provides an assessment of the level of implementation carried out by teachers.

Other studies mention challenges in implementing the new curriculum includes inadequate facilities (Syomwene, 2013), heavy teacher workloads, diversity of learning in the classroom, inappropriate understanding (Cheung & Wong, 2012), and depth of curriculum changes (Retnawati et al., 2016). Further, there is research on teacher competence and self-efficacy conducted by Radite and Retnawati (2023) to determine the readiness and enthusiasm of mathematics teachers in implementing the *Merdeka* Curriculum. However, these studies did not specifically discuss the updates to the new curriculum. Teacher knowledge/competence is more of a theoretical test. In addition, changes to the components of the previous curriculum are not more significant than changes to the *Merdeka* Curriculum which includes many aspects such as changes in phases and learning outcomes, forms of assessment, and character development.

The stages of the *Merdeka* Curriculum implementation are divided into 3 different stages which present unique challenge and steps, unlike previous curricula. Therefore, with the many novelties in the *Merdeka* Curriculum, a study related to the relationship and alignment of the curriculum (in the context of its development and implementation) at various levels throughout the school education process is very important (Li & Lappan, 2014). Teacher knowledge of the curriculum is essential for effective teaching and adapting to changing educational needs as a pedagogical competence (Barut & Wijaya, 2020; Indonesia, 2005; Walshaw, 2012). Based on previous studies, the author wants to explore mathematics teachers' knowledge of the new aspects of the *Merdeka* Curriculum, especially in mathematics learning. The author also analyses the stages of planning, implementation, and evaluation of mathematics learning according to the *Merdeka* Curriculum. In addition, the author will address the challenges and strategies for overcoming the challenges of implementing the *Merdeka* Curriculum in mathematics learning.

2. Method

This qualitative study utilize a phenomenological approach in which researchers delve into an individuals' experience of a phenomenon to uncover description that reflects universal individual experiences (Creswell, 2013). The issue in this study necessities a deeper comprehension of human experiences shared by a

specific group of individuals (Padilla-Díaz, 2015) in relation to the implementation of the *Merdeka* Curriculum in mathematics education in Klaten Regency. Klaten Regency was selected due to designation as one of the pilot project areas for the *Merdeka* Curriculum at the junior high school level.

The study involved 9 mathematics teachers from Junior High School in Klaten Regency, Central Java Province during the 2023/2024 academic year. Participants were chosen using a purposive sampling technique. These teachers were selected based on recommendation from the head of the Klaten Regency mathematics teacher council considering their credibility and experience in implementing the new curriculum across both public and private schools. The 9 teachers were divided into 3 teachers from IS schools, 3 teachers from IC schools, and 3 IL schools. This selection aimed to ensure that participants could offer reliable and comprehensive data regarding the *Merdeka* Curriculum implementation in mathematics education.

The research was conducted from December 2023 to May 2024 until a sufficient amount of data was gathered. The research procedure followed Moleong's (2004) guidelines, which includes:

1. Orientation to understand field conditions from various sources,
2. Focused exploration through review of relevant theories, preparation of data collection instruments, and data analysis,
3. Verification of the data validity to establish a level of confidence in the obtained information.

The data in this study were obtained through interviews, observations, and documentation. Interviews were conducted directly face-to-face or via online video calls. The questions in the interview covered 5 main areas, teacher knowledge of changes in the *Merdeka* Curriculum, lesson planning of learning activities, implementation of learning activities, assessment of learning outcomes, and challenges faced along with strategies employed by teachers. Documentation involved collecting Teaching Modules prepared by teachers. The aspects of data collected through interviews, observations, and documentation are detailed in Table 1.

Table 1. Data Collection Regarding Research Aspect

Research Aspect	Data Collection	Data Sources	Instrument
Teacher Knowledge of The *Merdeka* Curriculum	Interview	Teacher	Interview Guidance
Planning the Implementation of The *Merdeka* Curriculum	Documentation, Interview	Teaching module	Teaching module Review Form, Interview Guidance
Teaching Learning Activity	Observation, Interview	Teacher, Students	Observation Checklist, Interview Guidance
Assessment	Documentation, Interview	Assessment Document	Assessment Document Checklist, Interview Guidance
Challenge and Strategy	Interview	Teacher	Interview Guidance

To ensure data validity, triangulation of sources and techniques was employed. Data from each stage of the *Merdeka* Curriculum implementation were compared across the 3 teachers at each stage. In addition to interviews, teachers were requested to submit a Teaching Modules and allow observation of their instructional design practices. Subsequently, data analysis was conducted using the coding technique outlined by Bogdan and Biklen (2007) involving codes development from interview results, organization codes into sub-themes and themes, and drawing conclusions.

3. Results

The descriptive analysis was conducted to describe teachers knowledge of the *Merdeka* Curriculum and their experience in implementing the *Merdeka* Curriculum (planning, implementation, assessment, infrastructure, and challenges). Teachers' knowledge of changes in the *Merdeka* Curriculum is an important foundation in

effective planning, implemention, assessment, and strategies to address challenges in implementing the *Merdeka* Curriculum as a whole.

3.1 Teacher Knowledge

The *Merdeka* Curriculum introduces several significant changes compared to the previous curriculum. These changes must be well accommodated by teachers in each school. From the interview results, respondents have been able to mention several changes in the *Merdeka* Curriculum such as the following examples:

> *"...Learning in the Merdeka Curriculum is customized to the student's abilities, so there is a diagnostic test to determine which children are at level A, B or C. Level C cannot be equated with Level A." IS2*

> *"... It's like all the teachers are still feeling their way, like, eh, what's the name of it regarding learning tools like CP (Learning Achievement/LA), TP (Learning Objectives/LO), ATP (Flow of the Learning Objectives, and so on, it's like they're still feeling their way in their classes, it's still like in the 2013 Curriculum." IL2*

> *"...LO that I can relate to the P5 project that is currently happening."IS3*

The results of the analysis of open-ended questions regarding teachers' knowledge of the changes in the *Merdeka* Curriculum are summarized in Table 2.

Table 2. Teacher Knowledge of The *Merdeka* Curriculum

Codes	Sub-Theme	Theme
Partition of learning phases as stages that must be achieved at a certain level group.	Innovation in the *Merdeka* Curriculum as studied by teachers focused on administrative aspects of learning tools such as teaching modules which contain LA, LO, and FLO as well as curiosity questions as a reference for implementing learning strategies.	Teachers' knowledge about the *Merdeka* Curriculum encompasses administrative aspects, the preparation and implementation process of teaching and learning tasks that involves differentiated learning activities, curricular activities such as P5 projects, and assessments in various forms as per the national assessment framework.
The new components such as LA, LO, and FLO.		
Teaching modules as lesson plans have many interrelated components.		
There are curiosity questions before learning.		
The existence of the *Pancasila* Student Profile Strengthening Project (P5) as a curricular content.	Innovation in the *Merdeka* Curriculum are diagnostic assessments as an effort to carry out differentiated learning, the existence of P5, and the implementation of tests with different test forms.	
Implementation of diagnostic tests before learning.		
Implementation of differentiated learning.		
Formative and summative tests using various forms of assessment.		

Teachers' knowledge of changes in the *Merdeka* Curriculum, which includes guidelines for the planning the implementation of learning and assessment through information on the administration of learning devices, shows that the dissemination process of the *Merdeka* Curriculum underway, albeit gradually. The existence of teaching modules that are developed through a coherent process is also essential. This is due to Teaching Modules are a reference for teachers in carrying out intracurricular and extracurricular activities (P5) which must be carried out in a differentiated manner according to the results of the diagnostic assessment to be more effective for all students. Familiarity with important aspects of the *Merdeka* Curriculum can assist teachers prepare themselves and students to be able to carry out learning following the *Merdeka* Curriculum. From the results of the exploration of teachers' knowledge of changes in the *Merdeka* Curriculum, the realization in the form of administration of planning and implementation of learning and teaching activities including assessments and P5 will also be explored.

3.2 Planning and Developing Teaching modules

Planning is a part of one of the Education Process Standards mathematics teachers in Klaten Regency must meet when implementing the *Merdeka* Curriculum. Teachers independently plan mathematics lesson and collaborate with various parties, both learning communities, driving teachers, fellow members of the Mathematics Teacher Council (MTC), and the education office. Lesson planning is written into the Teaching Module, making the process of compiling the Teaching Module is important to be able to provide an overview. Based on the interview results, several teachers were able to clearly describe the process of compiling teaching modules.

> *"LO is discussed with the mathematics teacher group, usually at the beginning of the school year, in one school, called Kombel."* IS1

> *"The FLO is thought of after mapping the concepts that will be given to students. After mapping the concepts, the connections between the concepts will visible."* IS3

> *"...Identifying from the sentences contained in the LA, determine the verbs that are in accordance with the guidelines from the textbook."* IC1

> *"...Sometimes I just access google to see the Teaching Modules from other schools and from MTC we are given Teaching Modules to study, so I use FLO. I learn it first, so I haven't had time to edit it yet."* IL1

> *"...Derived from LA, we still use the template from the service. For the material there, we do not modify it, but we adjust it to the needs of the children, sometimes like that."* IL3

The results of the analysis of open-ended questions regarding the process of developing lesson planning tools in the form of Teaching Module are summarized in Table 3.

Table 3. Lesson Plan in The Form of Teaching Module Developing Process

Codes	Sub-Theme	Theme
Teachers derived LO from LA based on the character and needs of students.	The process of deriving LO from LA in Teaching Modules is carried out through discussions with fellow teachers and consulting with the driving teacher, taking into account the characteristics of students, content, context, and LA from the textbook.	The process of developing Teaching Modules begins with deriving LO from LA based on student characteristics, content, and context. Then FLO is created in one learning phase based on learning progression, connections between materials, and learning resources. After that, the Teaching Modules are developed by teachers either independently or in collaboration with learning communities or MGMPs and refer to government guidelines and considering
Teachers derived LO from LA based on content, context, and time.		
Teachers summarized LO by discussed with fellow teachers in MTC.		
Teachers derived LO from LA based on learning sources.		
Teachers adopted LO from the authorities.		
Teachers consulted with teacher consultant.		
FLO developed based on school condition.	The process of developing FLO in a learning phase is based on school conditions, learning progression, connections between materials, learning resources, and information from the MTC.	
FLO followed learning progression, material connection, and students with special needs.		
FLO developed based on learning sources.		
FLO adopted from the MTC.		
Teaching Module developed referring online guidance namely PMM.	The process of developing Teaching Modules from LO and FLO is carried out both independently and in collaboration with learning communities in schools and the MTC by referring to government guidelines and	
Teaching Module developed based on pre assessment and LO with learning method.		
Teaching Module designed by the MTC to be reflected and adjusted by the teachers.		
Teaching Module arranged by discussion		

with teacher community and MTC.	student abilities.	student abilities.
Teacher remains used lesson plan based on the previous curriculum.		

In general, there are differences between respondents from IS, IC, and IL schools in the process of preparing learning plans in the form of teaching modules. The gradation of these differences can be seen in Figure 1.

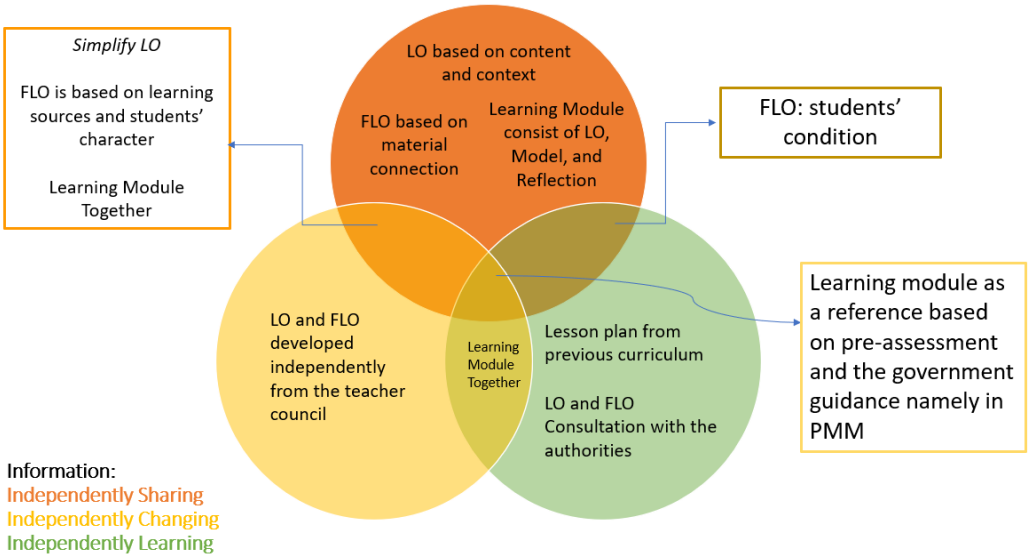

Figure 1. Description of Teachers' Experiences in Planning *Merdeka* Curriculum Implementation

Triangulation of teacher interview results related to lesson plan was carried out by observing the Teaching Modules made by each respondent. The results of observations of the Teaching Modules from each respondent are presented in Table 4.

Table 4. Teaching Module Observation Result

Komponen	IS1	IS2	IS3	IC1	IC2	IC3	IL1	IL2	IL3
Learning Objective (LO)	V	V	V	V	V	V	V	V	V
Students' Prior Knowledge	V	V	V	V	V	V	-	-	V
P5	-	V	V	V	V	V	V	-	V
Learning Model and Method	V	V	V	V	V	V	V	-	V
Diagnostic Assessment	V	V	V	V	V	V	-	V	-
Aperception and Curiosity Question	V	V	V	V	V	V	V	-	V
Learning Activity	V	V	V	V	V	V	V	V	V
Reflection	V	-	V	V	V	V	V	-	V
Assessment	V	V	V	V	V	V	V	V	V
Enrichment and Remidial	V	-	V	V	V	V	V	-	V
Worksheet	V	V	V	V	V	V	V	-	V
Learning Sources	V	V	V	-	V	-	V	-	-

According to the observation results in Table 4, teachers from IS and IC schools have successfully developed complete Teaching Modules following government instructions. However, teachers from IL schools are still using lesson plans from the previous curriculum, resulting in several aspects of the *Merdeka* Curriculum are not yet available. The results of this observation are in accordance with the results of the interviews conducted. The Teaching Modules created by teachers will be used as a reference in the learning implementation process and assessment of learning outcomes carried out. In addition, there are guidelines for enrichment for students who have achieved the expected learning outcomes, while remedial support will be offered for students who have not achieved the expected learning outcomes. The availability of student worksheets and various relevant learning resources can enhance learning interactivity, interest, and effectiveness in achieving the planned goals.

3.3 Teaching and Learning Activity

The teaching and learning activity in the *Merdeka* Curriculum are part of the Process Standard that crucial to understand the depiction of the curriculum implementation. In addition to differentiated learning and the P5, the mathematics learning process within the *Merdeka* Curriculum framework has a unique characteristic, namely the existence of five process elements and several learning and assessment principles that can be chosen to be carried out by schools. The teaching and learning process also reflect the planning outlined in the Teaching Module created by the teacher. From the results of interviews with respondents, several teachers were able to clearly describe the learning implementation process, including:

> *"Oh, if there are five processes, it's often done because we always do, for example, proof of reasoning and evidence. Usually, my method is more like asking them to look first."* IS3

> *"The direct learning model is a favorite, interspersed with questions and answers. The cooperative group model, sometimes we give group assignments. Then for problem-based we use the problems in the textbook or module only."* IC1

> *"Well, for me, there are many solutions to the problem. Usually, for children who can't do it yet, I approach them, accompany them, and give them more material, but only within the scope of one table or in groups. For those who can, I usually tell them to continue. Continue with more material or more difficult questions."* IC2

> *"The differentiation is when I approach the students. Thus, what do they need, right? One student is different from another in terms of the lighting that is needed."* IC3

> *"The first is usually a question and answer session, the second is a survey, I share for example, have you ever studied this or not."* IL1

The results of the analysis of open-ended questions regarding the learning implementation process referring to the Teaching Module are summarized in Table 5.

Table 5. Teaching and Learning Process

Codes	Sub-Theme	Theme
Teacher guides students to make a spatial model project from various materials.	Teachers have used various learning models and methods such as PBL, PJBL, Discovery, Cooperative and question-and-answer methods, classical discussions, and fun direct learning.	The implementation of learning by teachers aligns with the standards in the *Merdeka* Curriculum, includes using diverse models and methods that invite students to be active and enjoyable, facilitating various differences among students through various means, implementing all standards of the mathematics learning process, and integrating into
Teacher used discovery learning		
Teacher employed classical discussion.		
Teacher implemented PjBL to learn about daily problems.		
Teacher used direct learning.		
Teacher used short question and answer, and quiz.		
Teacher used PBL model.		
Teacher conducted cooperative learning.		
Teacher carried out fun learning.		
Differentiated learning based on result/product.	Differentiated learning based on content, process, and product with various developments such as mentoring and peer teaching.	
Peer teaching by the high ability students.		
Differentiated on the assessment difficulties.		
Differentiated on process.		
Teacher carefully guided students with low abilities.		
Teacher did not conduct differentiated learning yet.		
The teacher has integrated 5 mathematics standard process in mathematics learning.	The implementation of learning applies the standards of the mathematics learning	
The students learnt representation.		
Teachers must get used to teaching the five process		

standards through the chosen learning model.	process through integration in learning models using daily life problems and integration in assessment questions by referring to books that have implemented the five process standards.	P5 extracurricular projects to provide additional content such as creativity, independence, collaboration, and innovation.
Teachers integrated the five process elements into formative assessments/questions.		
Teachers did not understand the 5-standard process.		
Teachers integrated real contexts/everyday problems into learning.		
Teachers linked the five elements of the mathematics learning process with mathematical literacy.		
Teachers used module books that support the 5 elements of the process.		
Teachers linked certain materials if they are relevant to the project.	The integration of learning with P5 is still not optimal even though there are teachers who can integrate it through a project.	
The teacher asked students to draw the coordinates of the *Kethoprak* players on the P5 stage.		
Teachers did not know whether learning can be integrated in P5.		
Teachers have not integrated learning into P5.		

The differences between respondents from the IS, IC, and IL schools can be seen in Figure 2.

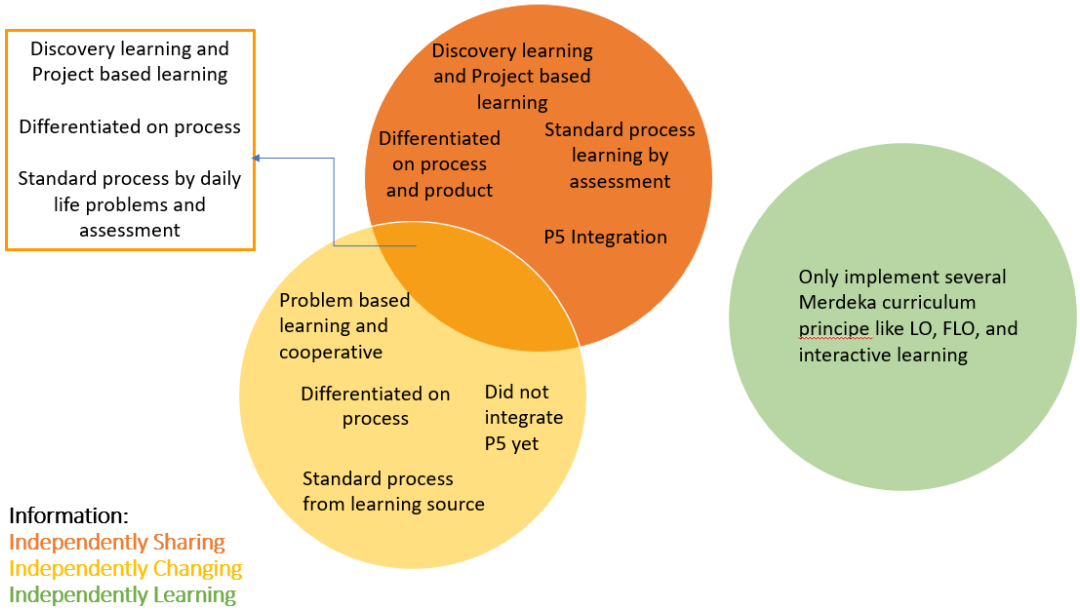

Figure 2. Description of Teachers' Experiences in Implementing *Merdeka* Curriculum

Triangulation of teacher interview results related to teaching and learning implementation was carried out by observing the teaching and activity by each respondent. The results of observations of teaching and learning activity from each respondent are presented in Table 6.

Table 6. Observation Result of The Teaching and Learning Activity

Aspect	IS1	IS2	IS3	IC1	IC2	IC3	IL1	IL2	IL3
Curiosity Question	Short question and answer	Using daily problems	Short question and answer	Using daily problems	Online video context	Using daily problems	Using daily problems	Did not conduct	Short question and answer
Learning Model and Method	Discovery learning and cooperati-ve	PjBL and discussion	Discovery learning	Discovery learning and discussion	Discovery learning aided by Power Point	PBL using interactive video	Model 4C	PjBL	Exposito-ry
Differentiated Learning	Did not clear	Based on interest	Based on process, peer teaching	Did not conduct	Content and process	Different on the test	Did not conduct	Did not conduct	Did not conduct

Reflection	Short and general	According to the material	Did not conducted	Short reflection	Q&A about the material	Make a resume	Make a resume	Students' impression	Make a resume
Learning Achievement	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved

Based on the observation results in Table 6, teachers from IS and IC schools have successfully implemented the Teaching Modules into learning activities, despite some aspects that have not been fully successful. Teacher IS1 has not been able to apply differentiation properly because the grouping of students is random. Teacher IS2 has lacked time to reflect on learning. On the other hand, teachers from IL schools have not yet carried out several aspects such as curiosity questions, differentiation, and conducting active learning. The results of observation triangulation align with the interviews conducted with teachers in Table 5.

3.4 Assessment

To complement the planning and implementation of learning, the assessment process is an important aspect in the *Merdeka* Curriculum that needs to be explored. The learning assessment process according to the *Merdeka* Curriculum can be carried out at the beginning, during, or end of the learning process. From the results of interviews with respondents, several teachers were able to clearly describe the assessment implementation process carried out in various forms including:

> *"...For the initial assessment, I usually use a pretest of the material to be studied. Formative and summative. Here, there are already complete (students' worksheet) available, but sometimes I also make my own questions."* IC1

> *"...Usually, if I don't have time to make an interview, I usually use an interview, so later I'll call my child to come forward or I'll ask them questions, what did you do before I gave you this material? At the beginning, the interview was like that, just classical Q&A, interview, etc."* IC2

> *"Then, I also conducted a cognitive assessment at the beginning of semester 1."* IC3

> *"Self-assessment has not been done yet because this 7th grade is new, I mean when they are with me, they tend to be surprised."* IL1

> *"...Every three or five meetings I collect their notebooks and check them one by one. Oh, this one is writing. The other is not writing. Usually, I take my assessment from there too."* IL2

The results of the analysis of open-ended questions regarding the learning assessment process referring to the *Merdeka* Curriculum are summarized in Table 7.

Table 7. Assessment Conducted by The Teacher

Codes	Sub-Theme	Theme
Teachers assessed students' initial abilities using material from the previous level.	Initial assessment as a student diagnostic has been carried out to assess both cognitive and non-cognitive abilities through various techniques such as tests, survey questionnaires, interviews.	The assessments carried out by teachers have referred to the *Merdeka* Curriculum, namely the initial or diagnostic assessment, process assessment, and final
Non-cognitive assessment works in collaboration with Counseling Teacher.		
Teachers carried out an initial assessment in the non-cognitive and cognitive domains via Google Form.		
Teacher conducted an initial assessment to map learning styles using a questionnaire.		
Teachers do not conduct initial assessments, but rather conduct both class and individual interviews throughout the learning process.		
Teachers do but not every start of phase.		
Teacher conducted short Q&A and survey		

Teachers made assessments through student performance as they progress.	During the learning process, teachers also conduct cognitive, affective, and psychomotor assessments through tests, anecdotal notes, observations, and portfolios, as well as introducing question forms according to the national assessment framework.	assessment. Assessments have also been carried out for the affective, cognitive, and psychomotor domains using different forms like tests, questionnaires, observations, projects, portfolios. Furthermore, reporting has been standardized through applications provided by both schools and the government.
Teachers carried out formative assessments in various forms according to the AKM framework.		
Teachers made an anecdot about students.		
Teachers have personal notes regarding the learning process of students.		
Teachers have a record of achievement and discipline.		
Assessment of the process related to student activity and discipline.		
Teachers observed the skills of each student.		
The teacher provided exercises during learning.		
Teachers checked students' records every certain period.		
Mid-semester and final assessments from the authorities.	At the end of each semester, a final assessment is always held by the authorities, the foundation, and independently by teachers. For independent assessments in the form of projects, attitude assessments, and skills.	
The teacher made an assessment of the project.		
The final assessment of TP uses students' worksheet references or creates your own questions.		
Formative assessments are prepared by the teacher.		
Teachers carried out assessments of attitudes, skills and cognition.		
The final assessment was carried out by the foundation.		
Teachers carried out all assessments recommended by the curriculum.	Teachers have conducted various assessments recommended by the curriculum and made reports using both school and government applications (PMM).	
Teachers createed assessment reports with e-Rapor in PMM		
Teachers reported assessment results using an application provided by the school.		

According to the Table 3, the teachers can conduct various assessment technique in initial, activity, and after learning. However, there are differences among IS, IC, and IL school' respondents on the implementation of the assessments. These differences can be observed in Figure 3.

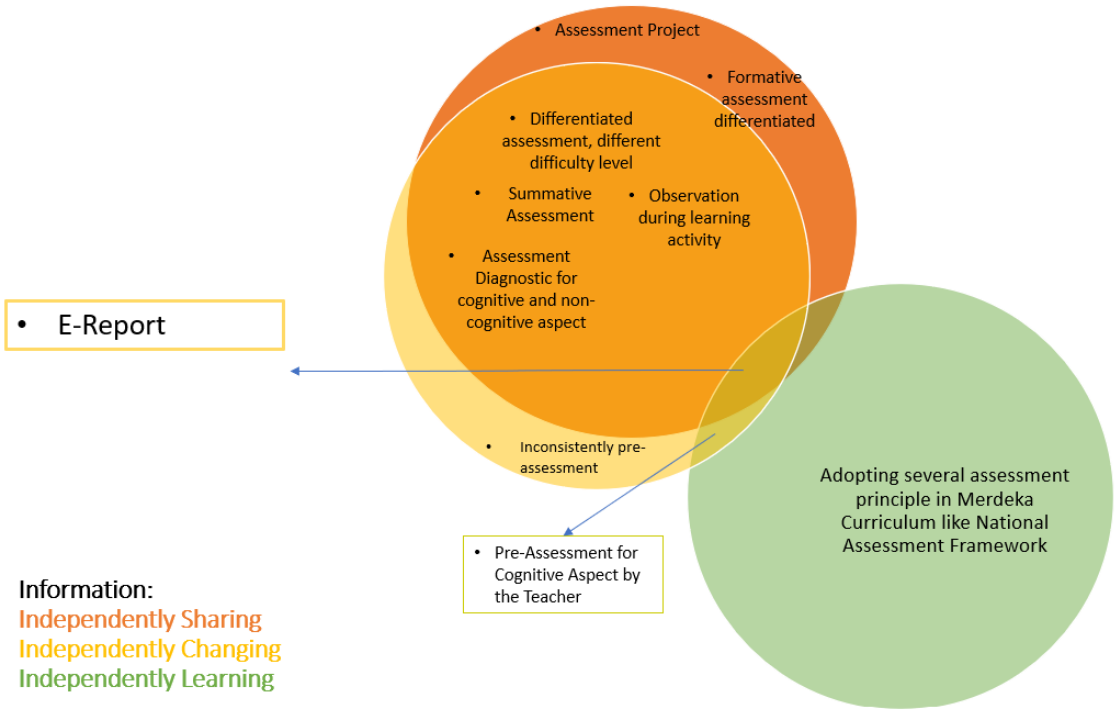

Figure 3. Description of Teachers' Experiences in Conducting Assessment Regarding *Merdeka* Curriculum

Triangulation of teacher interview results related to learning assessment was carried out by reviewing learning assessment documents by each respondent. The results of the review of learning assessments from each respondent are presented in Table 8.

Table 8. Review Results of The Assessment Instrument

Assessment	IS1	IS2	IS3	IC1	IC2	IC3	IL1	IL2	IL3
Diagnostic	Rubric and follow up complete	No follow up plan	Rubric and follow up complete	Rubric and follow up complete	Rubric and follow up complete	Rubric and follow up complete	Did not conduct	Did not conduct	Did not conduct
Process	Journal, test, self-reflection, observation	Test using AKM framework	Objective and essay test	Test and project	Test, anecdot, and observation	Test and project	Journal, test, and observation	Test and observation	Test
Sumative	From the authorities	From the authorities	From the authorities	From the authorities	From the authorities	From the authorities	From the authorities	From the authorities	From the authorities

Based on Table 8, it is evident that the results of the assessment review conducted by teachers are align with the interview results where respondents from IS and IC schools have successfully imolemented assessments according to the *Merdeka* Curriculum well. However, IL schools only partially implemented various assessments such as diagnostic assessments for differentiated learning.

3.5 Challenge and Strategy

The implementation of the *Merdeka* Curriculum, especially mathematics learning, both in the planning, implementation, and assessment stages, certainly has challenges faced by teachers. The challenges experienced by teachers include those conveyed in interviews as follows:

> *"LA is still very broad, you know, not very focused, more focused, look at this (Gakko Tosho package book)."* IC1

> *"That's why sometimes the differentiation in my opinion is there is one word, namely, tired of thinking about administration and lesson plan, you know, the difference between students."* IC2

"Ada yang dari 5 bab, yang 2 bab itu beda. Jadi yang kita nilai dari ...sekolah ini dengan yang lain beda. Itu yang kita nilai dari asesmen satu semester gasal ini, cuma yang kita ajarkan saja jadinya, tidak semua soal itu." IL1

"…There are some from 5 chapters, 2 of which are different. So what we assess from ... this school is different from the others. That's what we assess from this odd semester assessment, only what we teach, not all of those questions." IL2

The results of the analysis of open-ended questions regarding the challenge process in implementing the *Merdeka* Curriculum are summarized in Table 9.

Table 9. Challenges on Implementing The *Merdeka* Curriculum

Codes	Sub-Theme	Theme
Teachers do not know the format of the Teaching Module.	The challenges of creating Teaching Modules are ranging from format, translating LA, organizing materials, adjusting LO and summative assessment targets.	The challenges experienced by teachers in implementing the *Merdeka* Curriculum start from planning, implementation, assessment, and supporting facilities. At the planning stage, each component of the Teaching Module has a level of difficulty. In the implementation phase difficulties arise in the application and conditioning of students. At the assessment stage, there are difficulties in developing instruments and following up on analysis results. Then, supporting facilities are still insufficient for the successful implementation of the *Merdeka*
Readjusting LO if it is not possible to achieve it.		
Teachers have difficulty translating LA that is too broad.		
Teachers have difficulty organizing Teaching Modules by category.		
The LO and FLO determined vary for each school, but the summative assessment is the same throughout the district.		
Teachers still do not understand the various learning models in the *Merdeka* Curriculum	The challenges of implementing learning in the *Merdeka* Curriculum stem from factors involving both teacher and student such as understanding learning models and learning differentiation. Some students still struggle in arithmetic operations, understanding problems, reflecting, and feeling inferior.	
Students are not yet proficient in multiplication and division calculations.		
Students are not used to the teacher's teaching methods.		
It is difficult to get students to use the learning models used, such as PBL.		
Learning for students with low abilities takes a long time.		
Teachers have difficulty implementing content-differentiated learning.		
There are students who feel inferior when they find out that their friends are making faster progress.		
Students are unable to reflect (link projects to certain concepts) independently.		
Students are not accustomed to the assessment process carried out by teachers.	The challenges experienced by teachers in conducting assessments are not only in the process of compiling different or differentiated instruments and collecting data, but also in preparing students, analyzing excessive amount of data and following up on the results of the analysis.	
Map out students' needs comprehensively based on initial assessment.		
Mistakes in analyzing initial assessment.		
There is a gap between the results of the initial assessment and the results of the students' daily tests.		
The final assessment result is not optimal due to the material is not yet complete.		
Teachers have difficulty when they have to create different questions.		
The UAS grid from the department was given too close to the time limit.		
Students are less active and dishonest.		
Teachers do not yet know how to differentiate assessment.		
Teaching aids are still lacking because their procurement has not been facilitated.	Another challenge experienced by teachers is the availability of facilities and infrastructure to support	
The location of the class is far apart from the location of the demonstration equipment lab.		

Many computers are inoperated.	learning and assessment such as computers, projectors, wifi, assessment and learning applications.	Curriculum.
Not all classes are covered by projectors and wifi networks.		
Teachers have not made much use of learning applications because the devices do not support them.		
Students have difficulty using unfamiliar tools.		
Teachers are constrained by limited time in studying PMM.		

Challenges experienced by teachers occur at every stage of implementing the *Merdeka* Curriculum from planning the creation of Teaching Modules to teaching and learning activity, assessment, and using facilities and infrastructure to support its implementation. These challenges need to be managed with a correct strategy, thus can be resolved and prevented in the future. The teachers have prepared strategies to overcome the challenges that arise. The results of interviews regarding teacher strategies in dealing with these challenges can be found in Table 10.

Table 10. Strategy to Overcome The Challenges

Codes	Sub-Theme	Theme
The teacher first tested the Teaching Module in one of the classes.	The teacher's strategy for overcoming the challenges of compiling Teaching Modules is to collaborate with colleagues, utilize textbooks and daily journals, and test the teaching modules.	Teachers have thought about strategies to overcome challenges that arise in every aspect of the implementation of the *Merdeka* Curriculum. Strategies to overcome these challenges are carried out independently or in collaboration with students and colleagues. The implementation of these strategies is also an anticipation if similar obstacles occur in the future.
Teachers have a draft of the Teaching Module document as administration, even though the realization is different.		
Teachers seek information related to Teaching Modules in collaboration with the community and MTC.		
Teachers used the help of daily journals to match teaching modules that have not been successfully implemented.		
Teachers designed materials using textbooks.		
Teachers provided additional lessons to students with low abilities.	The strategy for overcoming the challenges of implementing learning is to differentiate the treatment of students with high, medium, and low abilities.	
The teacher repeated the parts that most students do not understand.		
The teacher provided additional exercises for students.		
Teachers provided direction and guidance to students during the learning process.		
Teachers motivated students.		
Teachers made thorough preparations, especially if they involve certain applications.		
The teacher made the reflection session simpler.		
Teachers focused on facilitating possible differentiation.		
Teachers provided other challenges for students with intermediate abilities.		
The teacher gave practice questions with different levels of difficulty.	Teachers' strategies in overcoming assessment constraints are carried out in various ways, such as looking for references for assessment forms, providing clues, observing students directly while they are working, motivating students to present and	
Teachers guided students during presentations at the final project assessment.		
Teachers carried out process assessments that teachers can and understand.		
The teacher directly checked the results of the students' work and motivates them to display it.		
The teacher provided a grid before the joint summative assessment.		
Teachers look for assessment reference sources such as		

other people's research on the internet.	conducting individual exams to train honesty.	
The teacher randomly appointed students for presentations.		
The teacher called students one by one to be tested individually.		
The teacher informed students who have laptops to bring them to school.	The strategy to overcome challenges in limited facilities is to utilize various possible learning resources, both from the environment and the internet, and to collaborate with students and colleagues to overcome the challenges together.	
Teachers focused on only important activities so that PMM can be learned.		
Teachers used the surrounding environment as a learning aid.		
Teachers used the internet independently in learning.		
Create a schedule for using facilities and infrastructure together with other teachers.		
Discussion with other teachers who have passed the real action curation at PMM.		
Teachers used alternatives to replace teaching aids.		
Teachers provided more assistance to students with special needs.		

Teachers are continuously attempting to implement strategies to overcome challenges in the implementation of the *Merdeka* Curriculum. They are consistently facing new challenge that arise during practice. It is hoped that with these strategies, the implementation of the *Merdeka* Curriculum can run optimally.

4. Discussion

Based on the findings, all respondents already know the important points of the changes in the *Merdeka* Curriculum compared to the previous curriculum. Respondents of Independently Sharing and Independently Changing have developed a complete Teaching Module according to the *Merdeka* Curriculum guidelines, but the respondents of Independently Learning school still use the previous curriculum format. All teachers have been able to design Learning Objectives (LO) from Learning Achievement (LA) through the adaptation and adoption process that are adjusted to the conditions of the school and students. Learning objectives that are in line with the conditions of students and school environments will make it possible to achieve these learning objectives (Siswondo & Agustina, 2021). Each learning objective can be developed into an assessment of several indicators, both cognitive, affective, and psychomotor domains (Mayasari, 2020).

Teachers were also been able to derive the Flow of Learning Objectives (FLO) and complete the Teaching Module in various aspects such as identity, activity design, and assessment. The teacher also explained that the Teaching Module is important for learning guidelines. Teachers always make lesson plans even before the *Merdeka* Curriculum implementation. This aligns with Richards (2002) belief that the teaching module serves as both guide for learning process and a tool for addressing learning challenges, as well as a record of acquired knowledge.

The teaching module created by the teacher also contains various learning strategies including packaging materials in the form of students' worksheet, managing class in groups or traditional forms, and considering psychological differences and student characteristics. This align with the belief that a good teaching module is characterized by having components such as the material being studied, learning models and strategies, time allocation for learning, detailed learning activity designs, consideration of affective and psychomotor aspects, various assessments, and feedback or reflection (Arends, 2015). Planning in the teaching module helps teachers to identify unplanned possibilities in implementation and determine the alternatives (Zubainur & Bambang, 2017). A good Teaching Module enables teachers to effectively conduct teaching and learning to achieve learning objectives (Farhang et al., 2023).

In learning activities, some teachers have utilized innovative learning models based on projects and daily problems such as games familiar to the students. Teachers are familiar with learning models like guided discovery, problem-based learning (PBL), problem-solving, project-based learning (PjBL), and cooperative learning. Several studies conducted by Darmawan (2018), Kurniawati et al. (2020), Nasrullah and Marsigit (2016), Purnomo (2011), Rochani (2016), and Sardin (2015) mention the effectiveness of various project-based learning models, everyday problems, and cooperative learning in terms of learning achievement. Effective learning models in mathematics learning can impact student learning outcomes (Sulistyawati, 2018). Additionally, reflecting on less effective steps can help to find solution to overcome them in future learning activities.

In the learning process, some teachers have been able to implement differentiated learning in both the process and the product. They have differentiated the learning approaches to accomodate students with varying abilities and interests. Tomlinson and Imbeau (2010) emphasized that key aspect of differentiated learning is adjusting the learning approach based on students' characteristic such as interests, readiness to learn, self-confidence, gender, language, supporting learning systems, and others. Implementing the differentiated learning process must be careful, especially if differentiating based on ability as it may lead low-ability students to feel inferior and unconfident.

With regards to integrating learning implementation with P5, many teachers have not widely adpoted this approach due to lack of understanding. This is in line with the findings of research by Sulistyawati and Radite (2024), which indicated that the integration of P5 to learning activities is not yet prominent. Generally, there are similarities between P5 in the *Merdeka* Curriculum and the teaching character that must be realized through learning in the 2013 Curriculum (Sukriyatun, 2022). However, in the *Merdeka* Curriculum, these character traits are more highlighted through students' projects. Integrating character education through P5 in learning can help achieve learning objectives across the cognitive, affective, and psychomotor domains.

Students' character education values are linked to their learning outcomes (Khadijah et al., 2021). Moreover, incorporating P5 into learning can effectively enhance students' mathematical literacy skills and learning outcomes (El Wa'fa et al., 2023; Rini et al., 2024). By integrating P5 into learning, students are expected to develop cognitive, psychomotor, and affective abilities. There are strategies for implementing P5 in learning (Kurniawaty et al., 2022). Teachers can choose strategies such as integrating a project-based contextual learning model and differentiated learning (Martanti et al., 2022; Rini et al., 2024).

Some teachers have been able to conduct diagnostic assessments and final assessments although they are not yet optimal according to the Curriculum's recommendation. Other teachers are still in the trial stage and have not been fully successful. Diagnostic assessments need to be conducted to help teachers analyze students' needs from various aspects such as character, initial abilities, and interests (Nugraheni & Hadi, 2023). The results of diagnostic assessments can be utilized by teachers to design appropriate learning strategies.

In the final assessment, teachers were able to conduct assessments following assessment objectives, but they lacked variety. Most teachers tended to give written tests. These findings complement the research of Radite and Retnawati (2023) which concluded that teachers' ability to implement assessment and evaluation of the *Merdeka* Curriculum was very low. Assessment is a crucial aspect of learning as it is used to measure the effectiveness of learning activities in achieving learning objectives (Prijowuntato, 2016). Therefore, the assessment must be in line with the indicators of each learning objective that has been designed.

Teachers who have implemented the *Merdeka* Curriculum at the IS and IC stages have integrated several technologies in mathematics learning and assessment. However, there are still obstacles such as the availability of tools and students' abilities in mathematical operation. Chrisdiyanto et al. (2023) stated that the use of technology to achieve learning goals effectively must ensure its availability and the ability of teachers and students to use it optimally. The integration of technology in learning and assessment aims to facilitate its implementation, not to complicate it due to teachers or students not being able to use it

optimally. Some technologies are specifically designed for purposes such as objective assessment, interactive learning, and online discussions.

Since the beginning of the implementation of the *Merdeka* Curriculum, several studies have explored the readiness of mathematics teachers in secondary schools to implement the *Merdeka* Curriculum in various aspects ranging from planning, implementation, and assessment and evaluation (Kurnia & Novaliyosi, 2023; Nisak & Yuliastuti, 2022; Pertiwi et al., 2023). Teacher readiness in developing Teaching Modules and designing learning activities is an aspect with the lowest achievement (Harefa & Harefa, 2023). This is related to differentiation where teachers must design three activities at once if they differentiate the process based on the interests or readiness of students.

Challenges are often faced by teachers when they start implementing a new curriculum. These challenge include such as understanding recommended learning model, encouraging students to adapt to the learning model, conducting assessments, involving students in designing learning objectives, and lack of preparation (Husadaningsih & Darajat, 2019). Meanwhile, mathematics teachers encounter challenges and difficulties in implementing the *Merdeka* Curriculum such as designing learning tools, implementing differentiated learning, and implementing diagnostic assessments (Kurniati & Kusumawati, 2023).

Another challenge for mathematics teachers in implementing the *Merdeka* Curriculum is the lack of understanding of mathematics teachers in deriving learning achievements to learning objectives and conducting formative assessments. Additionally, teachers struggle to reflect on the learning process as they cannot identify, translate, and conclude the implementation effectively. The limitations of mathematics teachers are also found in other things, namely facilities and infrastructure, connecting subject matter with other relevant knowledge, creating curiosity questions, presenting materials in language that is easy for students to understand, and addressing students' psychological condition (Nurcahyono & Putra, 2022).

To implement the *Merdeka* Curriculum properly, teachers must possess necessary competencies to operationalize the curriculum. Mathematics teachers need a combination of mathematical skills, the ability to organize learning materials according to students' needs, accommodate differences among students, and utilize various assessment and evaluation techniques (Radite & Sulistyawati, 2023). Therefore, regular training should be organized by schools and relevant agencies. Besides, consistent monitoring or supervision (especially providing feedback to teachers) are crucial to ensure standardized interpretations and improve the quality of the *Merdeka* Curriculum implementation.

5. Conclusion

This study concluded that teachers have good knowledge regarding the important points of changes in the *Merdeka* Curriculum from the previous curriculum. During the development of the Teaching Module, respondents from the Independently Sharing school were able to develop independently, while respondents from the Independently Changing and Independently Learning schools are still in the process of adopting several components such as learning objectives (LO) and the flow of learning objective (FLO). In the implementation stage of learning, all respondents were able to carry out project and problem-based learning. Additionally, respondents from the Independently Sharing school were able to integrate with P5. At the assessment stage, all respondents can use various forms of tests as per the National Assessment framework, however, respondents from the Independently Learning school are unable to carry out diagnostic assessments.

The challenges experienced by respondents in implementing the *Merdeka* Curriculum include organizing materials due to the lack of adequate learning resources, differences in flow of learning objective (FLO), diverse initial abilities of students making it difficult for teachers to differentiate, teacher assignments outside of teaching hours from both schools and offices and the lack of availability of facilities and infrastructure. Teachers' strategies to overcome these challenges include using available learning resources through internet collaboration, providing matriculation for students with less basic abilities, assigning structured assignments, and scheduling the use of facilities and infrastructure with other teachers.

The research conducted is inseparable from the limitations experienced by the researcher. These limitations include the learning observation process only being carried out in one meeting for each teacher, no observation of the assessment implementation process or analysis of test instruments made by teachers and no analysis of the factors that support the successful implementation of the *Merdeka* Curriculum. Therefore, for future research, a comprehensive evaluation of the implementation of the *Merdeka* Curriculum in schools that have implemented Independently Sharing is necessary. Moreover, research can also be conducted on teachers' abilities in designing innovative mathematics learning that is integrated with P5.

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