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Challenges and opportunities for Deep and Meaningful Learning (DML) approaches: An overview of critical learning paradigms, the new curriculum in Indonesia

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Abstract

Identifying challenges early on is highly recommended, this aims to clarify opportunities for teachers in implementing the Deep and Meaningful Learning (DML) approaches. The study was conducted on 205 teachers from 151 vocational schools in East Java Province, Indonesia with more than 108.144 students. The target of the study was Natural and Social Sciences Project (NSS-P) teachers, how can they design their critical learning meaningfulness? The methods used were questionnaires and interviews, deeply data analysis using Milles & Huberman including reduction, presentation, and data validation. The results (1) in their design, most of the teachers have not optimized yet the digital platform provided, have not referred to the recommended instructional model; (2) opportunities, 83.41% of the teachers used extensive and varied learning resources, and 93.17% involved technology in learning. This research provided a contribution to what teachers should do before the critical learning process started with approach DML.

Keywords: Challenges and opportunities for DML, Critical learning, NSS-P subjects, The new curriculum in Indonesia

Introduction

Education is the main key for a country to be superior in global competition (Mahmud et al., 2018, pp. 3–4) , (Yaelasari & Yuni Astuti, 2022, p. 585) . Today, society is faced with modern technology and sophisticated services. This is evidence of the success of the education process, including vocational education, where technical competence and strong interaction between teachers and students are needed (Antera, 2022, p. 271) , which can contribute to the development of more specific vocational education content (Asplund et al., 2021, p. 161) . Vocational education is not just learning to carry out a profession practically, but there is vocational content that is linked to students' future professional competencies in order to be able to meet market demands (Asplund et al., 2021, p. 162; Jam et al., 2018) .

Meanwhile, it is suspected that in vocational schools there is still a gap between theory and practice, as well as between education and competency needs in the workplace (Sylte, 2020, p. 168) . Thus, the DML paradigm is important to note, namely student-centered learning, aimed at improving the competency of the skills they learn in vocational education, so that they become professionals (Brand, 2020, p. 8) . For this reason, it is important for teachers to use a learning model that presents competent, skilled and work-ready students (Takriti et al., 2023) . Therefore, teaching is more recommended being project-based, science projects encourage students to deepen meaningful knowledge and apply it to solving open problems (Brand, 2020) . Thus, Natural and Social Sciences Project (NSS-P) teachers are expected to provide students with experience, encouraging the development of an integrated understanding of ideas and scientific explanations in the real world (Brand, 2020, p. 7) , (Novak & Treagust, 2022, p. 1) , as a context for meaningful critical learning. So that close coherence is needed between subjects, pedagogy and didactics, this also aims to develop professional competence (teachers) comprehensively (Arispe & Hoye, 2023) .

In its development, the quality of education in Indonesia is influenced by the curriculum applied (Yaelasari & Yuni Astuti, 2022) . In the Merdeka Curriculum, teachers must be able to innovate, be creative, and practice effective learning methods during face-to-face learning in schools (Yaelasari & Yuni Astuti, 2022) , or online (Park & Doo, 2024) . Online learning is still relevant and needed to strengthen the use of technology that supports

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meaningful learning processes (Stracke et al., 2022), (Jalali et al., 2023) , (Adlington et al., 2024) , (Jung et al., 2024, p. 42) . Deep and Meaningful Learning (DML) is successful if the identification of potential challenges is utilized as a strength of opportunity to transform according to the demands of the times.

Therefore, this study focuses on the field of vocational education, especially in East Java, Indonesia. The aim is to explore the following two important questions:

1) What challenges do NSS-P teachers face in implementing DML in vocational schools?

2) How far is the clearest of the opportunities for NSS-P teachers to develop critical learning for meaningful critical learning in vocational schools in the future with the Approach DML ?

Both the questions above represented the perspective of how the new curriculum in Indonesia can ensure that educational transformation runs well, in accordance with aligned with national educational goals.

Method

This study used a scoping review to describe the knowledge base on challenges and opportunities for Natural and Social Sciences Project (NSS-P) teachers in implementing DML in the new curriculum in East Java. A scoping review is an ideal tool to explore the scope of a particular research topic, and provides a clear picture of the size and scope of research that has been conducted in the field (Solberg et al., 2023) . The data collection methods in this study were questionnaires and interviews, both of which were consulted several times with 2 NSS-P learning experts from 2 leading universities in Indonesia, then addressed to NSS-P teachers at several vocational institutions in East Java and filled in by 205 teachers.

Furthermore, the researcher asked for assistance from school supervisors in each district/city, learning communities via WhatsApp, contact persons, and others. The questionnaire was distributed through each coordinator. For example, the district/city school supervisor coordinator, and the NSS-P teacher group coordinator as a liaison. The questionnaire was opened on August 1, 2024, which was released on the questionnaire platform (https://bit.ly/3A7aA34_Instrument_Guru_Mapel_PIPAS). Validated spectrum data see Table 1, while the research sample was vocational institutions in East Java that had implemented the new Indonesian curriculum.

Table 1. Validated vocational education spectrum data

Identification	Verified	Ministry Policies	%
Expertise Program	> 28	50	>56.00
Expertise Concentration	> 45	105	>42.86

As with research questions, scoping reviews are useful for mapping real-world evidence, for identifying challenges and opportunities for clarity in research questions, and new research for further study. Here are the details of the questionnaire and interview indicators. See Table 2.

Table 2. Research questionnaire indicator data used

Teacher Data Questionnaire	Questionnaire Details
Biodata and Teacher Identity	School Name, School Status, Regency/City, Age, Employment Status, Employment Period, etc.
Numbers 1 – 21, Questions that Allow What the Teacher Has Felt, Known and Done in Preparation for Learning Planning.	Understanding of the New Curriculum, Training Participation, Independent Learning on Digital Platforms, Self-Reflection, Collaborative Efforts, The Role of the Principal, Student-Centered Learning, Teacher Readiness Related to Materials, Learning Environment, etc.
Numbers 22 – 30, Questions that Allow Teachers to Fill in Based on What Has Been Designed and Done in Learning. (Most Frequently/Dominant)	Assessment Models, Teaching Methods, The Role of Teachers in Learning, The Use of Technology and Extensive Learning Resources.

The questionnaire data which were entered have been done for in-depth validation. The data successfully recorded 216 teachers, 205 of whom were from vocational schools, so that the valid data was 94.91%. East Java Province includes 29 districts and 9 cities, while verified data came from 27 districts and 8 cities (92.11%). The areas contributing the most respondents included Trenggalek Regency (16.59%), Bondowoso Regency (11.22%), Nganjuk Regency (10.24%), Tulungagung Regency (8.78%), Bangkalan Regency (6.34%), Sumenep Regency (4.88%) and Surabaya City (4.39%).

Results

The merdeka curriculum reflection on pisa 2022 results

The Merdeka Curriculum is a new curriculum that is the government's effort to overcome the long-standing learning crisis, also due to the COVID-19 pandemic. This is proven by its influence on learning outcomes, creative thinking, character education, student literacy (Stracke et al., 2022) , (Akbar et al., 2023, p. 7) , (Chiappe et al., 2024) . According to OECD data, in Indonesia, 31% of students attained at least a baseline proficiency in creative thinking (Level 3), significantly less than on average across OECD countries (78%) (OECD, 2024, p. 3) , see Figure 1. For this reason, DML is expected to be the right solution.

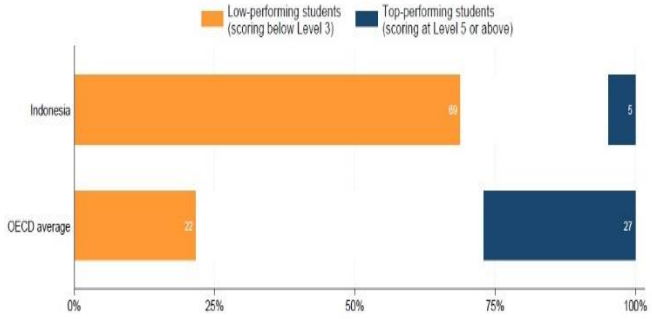


Figure 1. Top-performing and low-performing students in creative thinking
Note: Numbers inside the figure correspond to percentages
Source: OECD, PISA 2022 Database, Table III.B1.2.2

NSS-P Subjects

The NSS-P subject in the Merdeka Curriculum is a subject that develops projects, science and mathematics literacy related to aspects of natural and social sciences (Nuraeni et al., 2023, p. 5) , which are delivered contextually and realistically. Therefore, project-based learning is recommended (Markula & Aksela, 2022) . The key questions of this study are The Merdeka Curriculum presents meaningful, in-depth and effective learning assessments to improve noble character, through the Pancasila Project (Kemendikbudristek, 2024) , Pancasila is the ideology of the Indonesian nation.

Thus, vocational teachers need different teaching strategies to train diverse students, with specific skills according to competency needs in certain fields or industries in the world of work (TM & M. van der Merwe, 2016) , (Sylte, 2020) , see Figure 2.

Researchers' views on learning achievement

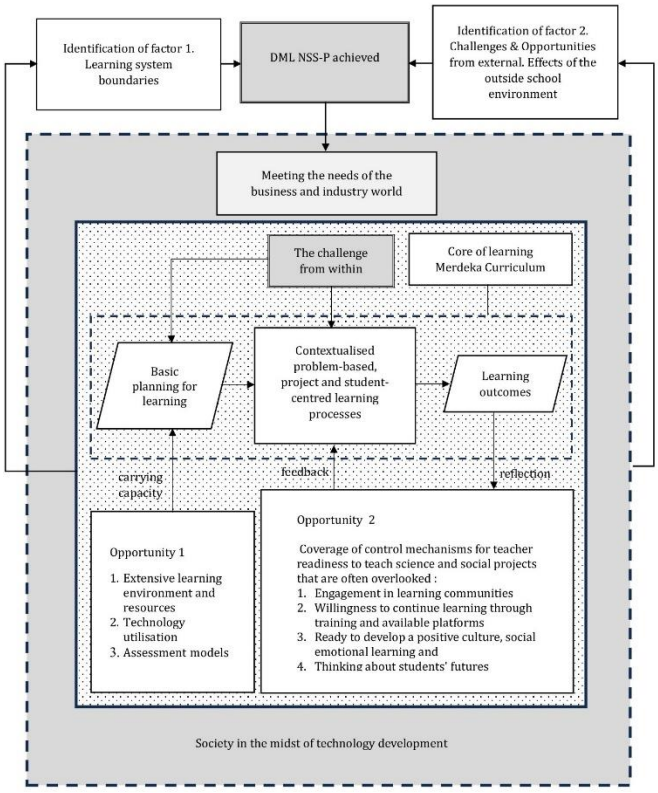


Figure 2. Challenges and opportunities in the researcher's review

Table 3. Details for questionnaire

Research Questions	Item Details Questionnaire	Survey Question Number	Description
RQ1	Understanding and Implementing of the New Curriculum, Self-development	1, 2, 3	External Challenges
	Implementation of Contextual Learning, Learning Innovation Strategies, Student Co-operation and Collaboration Skills, Resource Management, Reflect and Conduct Learning Feedback Results, Facilities and Infrastructure, Designing Student-Centred Learning, Designing Learning that Centers on Student Diversity	7, 11 to 13, 15 to 16, 19 to 21, 22 to 24, 26	Internal Challenges
RQ2	Learning Environment and Resources, Utilization of Technology	4 to 6, 14, 25, 27 to 30	Opportunity 1
	Teachers' Understanding of Student Character Building	8 to 10, 17 to 18	Opportunity 2

Table 4. Questionnaire normality test results

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		205
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	3,88087166
Most Extreme Differences	Absolute	0,047
	Positive	0,033
	Negative	-0,047
Test Statistic		0,047
Asymp. Sig. (2-tailed)		,200[c,d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Meanwhile, the results of the normality test of the questionnaire data using IBM SPSS Statistics 25 showed that the significance (sig.) or p-value 0.200 > 0.05, so it was concluded that the questionnaire data was normally distributed, see Table 4.

Meanwhile, the results of the validity and reliability test of the instrument items using IBM SPSS Statistics 25 show that the r-count of each SQ is > from the r-table value (*df* = n-2 = 205; 5% = r 0.05) which is 0.1364 and the significance value (sig.) of each SQ < 0.05. Furthermore, *the Cronbach's Alpha* value of RQ1 and RQ2 is > 0.6, so it is concluded that the questionnaire data is valid and reliable, see Table 5.

Table 5. Results of instrument validity and reliability tests scale: data validity

Data Correlations SQ				Data Correlations SQ		
			Total SQ			Total SQ
RQ1	SQ01	Pearson Correlation	,285 **	SQ04	Pearson Correlation	,346 **
	SQ02	Pearson Correlation	,404 **	SQ05	Pearson Correlation	,322 **
	SQ03	Pearson Correlation	,403 **	SQ06	Pearson Correlation	,247 **
	SQ07	Pearson Correlation	,344 **	SQ08	Pearson Correlation	,559 **
	SQ11	Pearson Correlation	,560 **	SQ09	Pearson Correlation	,631 **
	SQ12	Pearson Correlation	,622 **	SQ10	Pearson Correlation	,615 **
	SQ13	Pearson Correlation	,649 **	SQ14	Pearson Correlation	,499 **
	SQ15	Pearson Correlation	,605 **	SQ17	Pearson Correlation	,446 **
	SQ16	Pearson Correlation	,561 **	SQ18	Pearson Correlation	,393 **
	SQ19	Pearson Correlation	,547 **	SQ25	Pearson Correlation	,535 **
	SQ20	Pearson Correlation	,642 **	SQ27	Pearson Correlation	,524 **
	SQ21	Pearson Correlation	,619 **	SQ28	Pearson Correlation	,574 **
	SQ22	Pearson Correlation	,411 **	SQ29	Pearson Correlation	,669 **
	SQ23	Pearson Correlation	,445 **	SQ30	Pearson Correlation	,621 **

	SQ24	Pearson Correlation	,383 **	Total	Pearson Correlation	1
	SQ26	Pearson Correlation	,364 **		Sig. (2-tailed)	
	Total	Pearson Correlation	1		N	205
		Sig. (2-tailed)		**. Correlation is significant at the 0.01 level (2-tailed).		
		N	205	*. Correlation is significant at the 0.05 level (2-tailed).		
	**. Correlation is significant at the 0.01 level (2-tailed).					
	*. Correlation is significant at the 0.05 level (2-tailed).					

Table 6. Scale: All variables reliability

Case Processing Summary				Reliability Statistics RQ1		Reliability Statistics RQ2	
		N	%	Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
Cases	Valid	205	100.0	0.748	16	0.768	14
	Excluded [a]	0	0.0				
	Total	205	100.0				

a. Listwise deletion based on all variables in the procedure

Other results from the OECD (2024, p. 8) state that in Indonesia, 67% of students use digital devices for learning purposes for one hour a day or more at school, and 45% outside of school on regular holidays (OECD average: 55% and 50%). This creates opportunities for teachers to design learning that focuses on communication spaces, collaboration, student-centered technology integration for student knowledge development, (Cox & Prestridge, 2020) , and the use of technology.

Meanwhile, to form a theoretical and practical

understanding of a subject (Semilarski et al., 2022) that can run well, an interactive, holistic, integrative, scientific, contextual, effective, collaborative and student-centered method is needed, this is the core of vocational education (Yaelasari & Yuni Astuti, 2022, p. 586) .

The researcher's perspective on the achievement of DML for NSS-P teachers, including; identification of factors, challenges and opportunities

Identification factor 1: This factor is called the limit of the learning activity system, namely the school environment, including the implementation of the critical learning process according to the applicable curriculum, support, reflection, and feedback, curriculum plays a role in critical learning (Gallart, 2025, p. 60), see Figure 2. So far, the government has continued to strive to ensure the continuity of quality of education (quality of curriculum and teaching) (Hoekstra, 2023, p. 8) in the modern era, which is full of challenges, because widespread and increasing digitalization and openness of education continue to impact human life and society both locally and globally (Ossiannilsson et al., 2016, p. 161) , (Stracke et al., 2022) .

The seriousness started from the learning design to the development of a relevant curriculum structure applied to the progress of students (Mogale, 2023) . Reflection, feedback and follow-up of curriculum development by teachers are also emphasized, so that they can improve their knowledge and adaptation of various methods (TM & M. van der Merwe, 2016, p. 30) , thus, the DML design is centered on students with precise, measurable assessments that are easy to do.

The challenges within the limits of learning systems

More flexible curriculum structure, focusing on essential materials (Akbar et al., 2023) , the use of extensive and varied learning resources and

environments, and assessments of the use of digital technology are very important. The biggest challenge in implementing the new curriculum actually lies in the readiness of teachers as agents of change in the learning environment, including the mindset and awareness of teachers (Takriti et al., 2023, p. 1324) , (Jung et al., 2024) . Figure 3 shows how teachers can actually accept the presence of the new curriculum, understand, follow the teaching steps, solve problems if they arise, plan DML and implement them, validated 39.02% of their project-based learning models. Few (23.41%) of them involve the family environment in their learning design, proven to be in line with Lemessa's research (Lemessa et al., 2023, p. 7) , see Figure 3.

Proportional levels of parental involvement in education at school

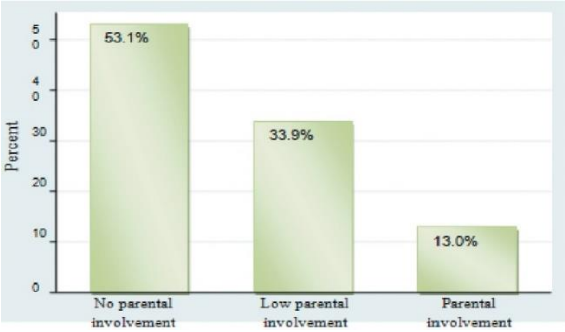
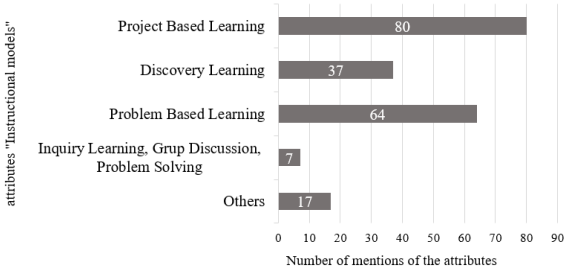


Figure 3. a. Lemessa's research results



b. Teacher's model of learning the merdeka curriculum

Meanwhile, the validation of the type of task is contrary to the model used, see Figure 4. Teachers should create an inclusive environment that supports and encourages the development of each student (Lestari, 2023) , including fair and objective assessments according to the learning model used.

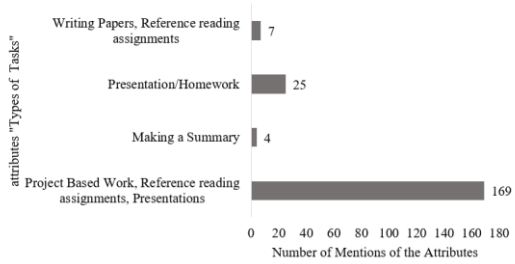


Figure 4. Types of tasks used in learning by teachers

How to teach NSS-P subjects?

Designing NSS-P subjects can be done depending on how teachers reflect on past learning outcomes, formulate trigger questions according to contextual problems, and students can explore ideas and steps to solve them effectively. Two-way interaction, one of the important aspects of teaching, openness, individualization, high student activity and producing solutions, giving students the opportunity to speak and realize that their teachers want to know their opinions and give them the freedom to voice them (Fischer & Barabasch, 2023, p. 14) , thus students are motivated, become more active and serious in learning.

Perform assessment according to initial mapping/diagnostics

Vocational education has an important role in realizing students who are skilled, ready to work, emotionally, intellectually and spiritually intelligent (Tsuroyah & Rasyad, 2019, p. 72) . For this reason, assessment becomes an important part of the critical learning process from just assessing, the DML process can be successful if it goes through proper planning, implementation, and accurate assessment (Estrada-Molina et al., 2024, p. 387) .

Thus, diagnostic identification must be carried out by teachers to map the style, readiness, and learning methods of students, then a formative assessment is carried out throughout the learning process, continuously monitoring student progress, when using simple tests, class discussions, simple projects, or routine feedback. Furthermore, a summative assessment is carried out at the end of the learning stage, aiming to evaluate student performance as a whole, see Figure 5.

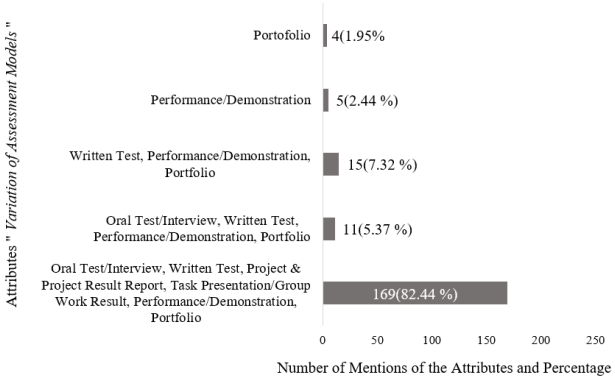


Figure 5. Variation of assessment models in learning by teachers (optional)

Chance 1

Opportunity 1 for NSS-P teachers within the limits of the learning system is to change the way students learn, namely by generating critical ideas by utilizing information technology to improve the ability to learn information comprehensively and practically, fostering an innovative spirit and lifelong learning abilities to face developments in the era and future needs (Penuel et al., 2022, p. 19) , through the design of environmental involvement, resources and technology and project-based learning assessment (Chiappe et al., 2024, p. 178) .

Chance 2

Meanwhile, accurate and in-depth data from research on identifying the readiness of NSS-P teachers within the limits of the learning system shows a positive trend, especially supported by the highest interest of East Java teachers in learning technology in Indonesia (Editorial Team, 2021) see Figure 6.

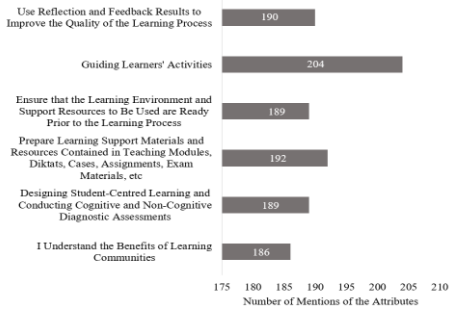
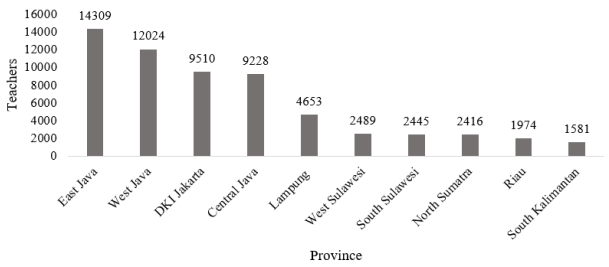


Figure 6. a. Recapitulation of in-depth data on teacher readiness



b. East Java teachers' interest in learning information and communication technology highest in Indonesia

The challenge of availability and retention of qualified NSS-P teachers: NSS-P learning is very important in the Merdeka Curriculum, because it is the basis of other subjects to strengthen hard skills and soft skills competencies. In this case, students are trained to develop various positive cultures, sensitivity to problems around them and be able to solve them.

In the DML approach, students become the center of attention of teachers to improve their critical learning process, so that they are competent and professional. However, sometimes science teachers are worried about their ability to teach, due to lack of skills (Mahmud et al., 2018) . For this reason, training opportunities through digital platforms must be utilized well by teachers and should not be missed often (Stracke et al., 2022, p. 7) , (Gerard et al., 2022) .

Of the 34 districts/cities validated in this study, the distribution of teacher availability varies in each region. Teacher sensitivity to developments around them, taking advantage of training opportunities, communication with other teachers through learning communities and willingness to adapt to student learning needs are still in the low category (68.29%), see Figure 7.

Identification factor 2

This factor is beyond the boundaries of the learning activity system. In various countries, the key to teacher success in implementing the critical learning process is determined by the understanding of the curriculum (Panggut, 2022) . Validated data shows that teachers are less motivated on the available platforms, so it is feared that it will have an impact on

their understanding, readiness to face challenges, opportunities and the effects of the outside school environment on the new curriculum, see Figure 7.

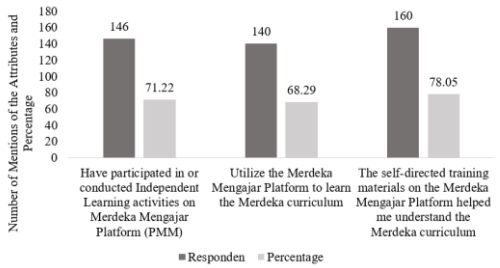


Figure 7. Utilization of digital platforms by teachers

Challenges from beyond the boundaries of the learning system

The transformation of education initiated by the government through the Ministry of Education is accompanied by the provision of a platform for teachers to facilitate learning. The digital platform is designed to support the implementation of the new curriculum, helping teachers get references, inspiration, and an understanding of meaningful learning (Gerard et al., 2022) .

Teachers must understand more deeply the action of implementing meaningful NSS-P learning design in every training opportunity (Gerard et al., 2022) . Learning success is when students are happy and do not feel burdened. Therefore, teachers must create a comfortable learning atmosphere, project-based, generate creative ideas and are contextual (Markula & Aksela, 2022) . All of this can be achieved, as long as teachers understand the learning objectives, learning objective flow, and teaching modules (Kinskey & Newton, 2024) , see Figure 8, But Participation Is Still Low.

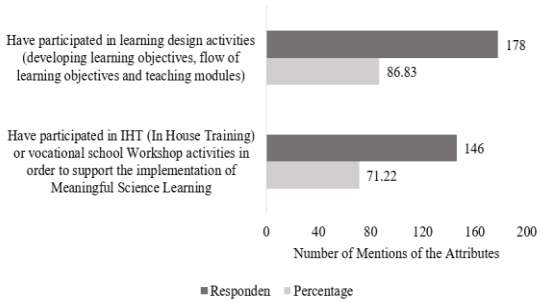


Figure 8. Teacher's challenge to design learning

The Merdeka curriculum was first introduced in a limited and massive manner, studied by a limited circle of people, but along with positive developments, educational transformation and policies in the reform of Merdeka learning, starting from the 2024-2025 academic year, it was ratified as the national curriculum (Khairina et al., 2024) . The following is the positive impact of the World Bank teacher mobilization program, see table Figure 9.

Table 3. Characteristics of Impact Evaluation Sample Teachers

Description	Prospective Teacher Movers (%)	Control (%)
Participated in Teacher Training in the Last 12 Months	100	94,9
School Participates in the Organization Drive Programme	68,3	22,6
School Participated in the Mobilizing Schools Programme	24,3	7,3
Participated in Self-Training Through on Merdeka Mengajar Platform (PMM)	9,5	36,9
The principal or other teachers participated in Teacher Movers Program (PGP)	69,3	39,4
Learned About Student-Centred Learning	100	96,9
Learned About the Restitution Process	99,6	79,2
Learned About Differentiated Learning	99,6	88,5

Figure 9

Source : The world bank research results, 2023 : p.11

Discussion

Up to now, in every curriculum transformation policy, teachers have been the center of discussions about understanding, interpretation, attitudes, development, situational factors and how they ultimately implement plans in learning practices (Mogale, 2023) , (Moremoholo, 2023) . New curriculum policies always bring up recommended teaching and assessment models. In the Merdeka Curriculum, project-based learning is associated with contextual, problem-based learning around students, aimed at aligning vocational programs with improving students' work skills (Alvunger, 2024) , for which performance-based assessment is a priority. Research data shows that (82.44%) teachers have used performance-based assessments, but on the other hand, 39.02% of their learning models are project-based.

Regardless of the results, teachers should still provide students with experiences that encourage the development of an integrated understanding of scientific ideas (Mikeska et al., 2022) placed in the real-world (Penuel et al., 2022, p. 2) , meaningful contexts when students are asked to apply their knowledge (Novak & Treagust, 2022, pp. 17–18) .

Thus, the teaching model, the use of technology, resources and a broad learning environment, involving the role of teachers as mentors, teachers continue to encourage students to communicate with each other, work together, help, and collaborate (Cox & Prestridge, 2020, p. 9) , will strengthen student-teacher cooperation, as a result the quality of theory-practice increases.

In addition, the deep and meaningful learning of NSS-P supports strengthening students' character, project-based learning fosters students' curiosity and builds understanding of core ideas in science (Penuel et al., 2022, p. 2) , (L. Zhao et al., 2023, p. 3) , (Markula & Aksela, 2022) , enables students to solve problems and become responsible citizens with scientific literacy (Y. Zhao & Wang, 2022) , and provide learning opportunities with the environment. Science learning can explore the construction of a culture of communication, cooperation, collaboration between students and between subjects. Adopting this culture in the classroom will help students shape their thoughts, beliefs, and actions (Moremoholo, 2023) .

Thus, in the future, teachers will continue to be encouraged to help each other, forming learning communities that prioritize teacher-student interactions as the focus of learning (Asplund et al., 2021, p. 161) , (Antera, 2022) , (McDonald, 2023, p. 31) , (Estrada-Molina et al., 2024, p. 372) . Project-based learning continues to be developed, because it is more effective than conventional learning approaches in science education (Y. Zhao & Wang, 2022) , (Markula & Aksela, 2022) , so that meaning is created. The meaning of NSS-P learning supports the development of student activities in exploring great ideas (Penuel et al., 2022) . The DML process through the involvement of broad learning sources and environments will produce students with strong characters both in terms of competence and maturity of thinking (Falode & Mohammed, 2023) , of course they are ready to work according to the needs of the business world and industry see figure 2.

Problems and challenges of DML NSS-P subjects

As previously stated, the challenges in vocational education are the lack of coherence, the gap between theory and practice, because students do not understand the theory well. The results of the study showed that the learning steps and utilization of the platform are still in the low category, due to the minimal understanding of teachers related to the post-training of the Merdeka Curriculum on digital platforms (Kusumaningrum et al., 2024) , and the planning of the learning system is less than optimal (Akbar et al., 2023) . Student-teacher interaction has not been a priority for teacher design.

Meanwhile, the data of the study`s report from the ministry, a survey of 57,595 educational units in October 2023, there are 77% of educational units have learning communities, 38.8% of which carry out activities once a week. About 46.8% of these learning communities are effective in supporting the improvement of learning quality (Wahyudin et al., 2024) . Data obtained findings from most of these studies reveal that teachers are at fault because of their unpreparedness, in competencies, attitudes and beliefs, frustrations, and resistance to reforms' intentions (Chimbunde & Moreeng, 2024) . Teachers are less enthusiastic in utilizing the platforms provided, even though the interest of East Java teachers in learning technology is relatively high.

Take advantage of the opportunity to focus on students' future

Orientation towards the need for skilled workers, ready to work in the business world and industry is the main focus for vocational institutions and teachers (Ahmid et al., 2023) to be aware of preparing DML. Integration and innovation of teacher readiness, institutions, and mindsets and communication networks between teachers in the context of teaching (Cox & Prestridge, 2020) , is a trend in the development of educational transformation in the future. The Merdeka curriculum has a concept that provides institutions with the flexibility to develop a curriculum according to the needs and characteristics of students in their respective school environments, student-centered learning (Cox & Prestridge, 2020, p. 11) , (Khlaif & Farid, 2018, pp. 7–8) , placing students as active subjects in learning, feeling comfortable and understanding their needs. Teachers guide students to find their interests, talents, and competencies by involving everyday

problem phenomena that cause doubt and confusion in them (Penuel et al., 2022) .

Therefore, extensive learning resources and environments, the use of information technology such as the internet are the best choices for the development of modern vocational education. Students with innovative characteristics are better prepared to adapt to evolving technology, take advantage of new opportunities, and contribute to the world of work effectively (Ahmid et al., 2023, p. 290) . The development of DML by quality teachers see Figure 10, in line with technological developments in the industrial sector, is crucial to continue developing education to prepare students to become professional workers, skilled in certain fields, have specializations, and can adapt to shifting demands in the industrial world.

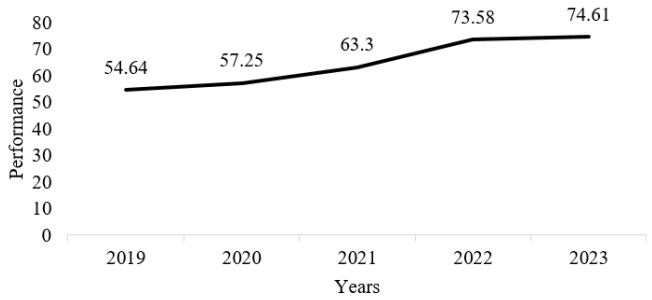


Figure 10. Percentage of improvement in the quality of teachers and education personnel in east java report 2024 improving the quality of teachers and education personnel

In addition, the skills of integrating technology into the teaching process and effectively improving the quality of teaching, adapting to resource trends, both learning resources and the environment and the involvement of the family environment are open education (Stracke et al., 2022) that teachers must consider (Estrada-Molina et al., 2024) .

This enriches and broadens the scope of vocational education and ensures the development of skilled, work-ready, broad-minded, and highly competitive talents. Discussions will be successful if all stakeholders synergize, at the same time supervisors also ensure that learning materials are tailored to the diverse needs and backgrounds of students, thereby increasing learning achievement (Allen Cris Montillano, 2024) , in addition to motivating teachers about the importance of the success of the DML process for educational transformation and the future of students in the future.

Conclusion

After analyzing and validating more deepthly the questions and questionnaires used as references in this study, the results of the study concluded that; (1) identified challenges for NSS-P teachers in implementing DML, there were (23.66%) teachers who did not understand the new curriculum and (31.71%) who had not actively utilized independent learning activities on the digital platform. Some (39.02%) teachers still referred to project-based learning, (2) opportunities, 83.41% of teachers utilized extensive and varied learning resources, and 93.17% involved technology in learning. 85% of teachers understood the benefits of learning communities and there were many other opportunities in the results of this study used as a basis for realizing a meaningful NSS-P the critical learning process.

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Author contributions

“Author1” is the first author who contributed to the conception, review, and the initial draft writing. “Author2” and “Author3” contributed to the conception. “Author4” and “Author5” contributed collection and processing the data.

Conflict of Interest

There is no conflict of interest at all in writing this article. The author is responsible for the content of this article.

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