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HUMAN CAPITAL DEVELOPMENT THROUGH PROBLEM-BASED LEARNING MICRO MODULE TRAINING

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ABSTRACT

This community service program strengthened vocational teachers' pedagogical and digital competencies in designing Problem-Based Learning (PBL) micro modules aligned with Indonesia's Merdeka Curriculum. Using a community-based training approach (preparation and needs assessment, concept reinforcement, and hands-on workshops), a team from Universitas Negeri Makassar facilitated training for X teachers at SMK Negeri 3 Jeneponto. Data were collected through observations, informal interviews, and participants' reflective notes, and were analyzed descriptively to capture competency changes and implementation constraints. Results indicate that participants improved their understanding of micro module structure and key PBL principles, enhanced their ability to formulate authentic, contextual problem scenarios, and increased confidence in using Canva and other digital tools to develop visually engaging teaching materials. As tangible outputs, teachers produced initial drafts of subject-specific PBL micro modules that are ready for refinement and classroom implementation. Persistent challenges included uneven teacher digital literacy and limited student access to digital devices, leading to a practical need for hybrid delivery and printed micro module versions. These findings imply that future programs should

incorporate differentiated digital support, provide low-tech design alternatives, and strengthen school–university collaboration to ensure sustainable implementation of innovative learning materials under the Merdeka Curriculum.

Keywords : Micro Module, Problem-Based Learning, Vocational Education, Teacher Professional Development, Digital Literacy
JEL Classification : I21, I25, O15

1. INTRODUCTION

The Merdeka Curriculum sets a clear mandate to strengthen the capacity of educational human resources—particularly teachers—so that learning is both effective and aligned with the demands of the 21st century. As Human Capital Theory has long established (Becker, 1993), institutional performance is heavily influenced by investing in the knowledge and skills of individuals. This concept remains relevant today, reinforced by frameworks like the OECD Skills Strategy (OECD, 2019) and supported by recent analyses of digital-era educational strategies (e.g., Johnson & Sampson, 2023).

Previous studies have clearly outlined the components of effective professional development (PD), emphasizing the need for content focus, active learning, and alignment with teachers' actual job contexts (Desimone, 2009). Yet a specific gap remains underexplored: the integration of Problem-Based Learning (PBL), micro-modules, and digital design into a unified professional development strategy. While PBL is well-documented for its effectiveness in building 21st-century skills (Strobel & van Barneveld, 2009) and microlearning is recognized for its ability to deliver focused, easily digestible content (Monib et al., 2024), the combination of these approaches in a digital format is a relatively new avenue

(see also Chen & Nguyen, 2023 for recent insights).

In other words, what's new here is the deliberate fusion of PBL, micro-module pedagogy, and digital competence-building into a cohesive human capital intervention for teachers. Our goal is to fill that gap by showing how this integrated approach can enhance teacher competence in line with the Merdeka Curriculum's goals.

In summary, this introduction clarifies what past research has established, identifies the specific gap we are addressing, highlights the novelty of integrating PBL with micro-modules and digital design, and ends with a clear statement of our contribution: to provide a structured, innovative PD model that aligns teacher development with 21st-century competency demands.

2. LITERATURE REVIEW

a) Human Capital Development in the Digital Education Era

Human capital theory posits that investments in knowledge and skills enhance individual productivity and long-term institutional performance (Gary Becker, 1993; Theodore Schultz, 1961). In contemporary educational settings, this perspective has evolved to emphasize not only cognitive knowledge, but also adaptive capabilities, digital competencies, and problem-solving skills required in the 21st century.

Recent global studies highlight that human capital development in education must be aligned with digital transformation and lifelong learning demands (OECD, 2021; World Bank, 2022). Teachers, as key agents of instructional delivery, represent strategic human capital whose competencies directly influence learning outcomes and innovation capacity in schools.

b) Teacher Profesional Development as a Strategic Investment

Micro modules align with microlearning, which emphasizes short, targeted, and goal-oriented learning units. Recent scholarship, however, clarifies that microlearning effectiveness is driven primarily by design quality—such as coherence, sequencing, and integration with broader learning—rather than by brevity alone (Monib et al., 2024). Teacher professional development (PD) is widely recognized as a primary mechanism for strengthening educational human capital. Effective PD programs are characterized by active learning, coherence with instructional practice, sustained duration, and collaborative engagement (Darling-Hammond et al., 2020; Desimone, 2009).

More recent evidence suggests that PD models must shift toward flexible, technology-supported, and practice-oriented approaches. For instance, Kohnke et al. (2024) demonstrate that microlearning-based PD enhances accessibility and engagement, while enabling teachers to integrate learning into their daily professional routines. Similarly, trust et al. (2021) argue that digital PD ecosystems support continuous teacher learning and adaptability in rapidly changing educational environments.

These findings indicate that modern PD is not merely a training activity, but a continuous human capital investment process that integrates pedagogical, technological, and contextual competencies.

c) Microlearning and Micro Modules in Teacher Capacity Building

Microlearning has gained increasing attention as an effective instructional approach characterized by short, focused, and goal-oriented learning units. Recent systematic reviews indicate that microlearning improves knowledge retention, engagement, and learning flexibility, particularly in digital environments (Buchem &

Hamelmann, 2022; Kohnke et al., 2024).In teacher education contexts, micro modules function as structured instructional tools that translate microlearning principles into practice. Studies show that well-designed micro modules support instructional clarity, reduce cognitive load, and facilitate the implementation of complex pedagogical approaches (Monib et al., 2024). This aligns with Cognitive Load Theory, which emphasizes the importance of segmented learning materials in optimizing working memory capacity. Furthermore, recent research suggests that microlearning-based materials are particularly effective in professional development settings where time constraints and practical relevance are critical factors (Zhang & West, 2023).

Within this frame, PBL-based micro modules are relevant because they can package PBL phases—problem orientation, investigation, solution development, and reflection—into structured, teachable steps that help teachers implement PBL more consistently.

d) Problem-Based Learning for Higher-Order Competency Development

Problem-Based Learning (PBL) is widely recognized for its effectiveness in fostering higher-order thinking, problem-solving, and collaborative skills. Contemporary studies confirm that PBL not only enhances student learning outcomes, but also strengthens teachers' pedagogical competence when integrated into training programs (Yew & Goh, 2016; Loyens et al., 2022). Recent empirical research indicates that teacher training programs incorporating PBL significantly improve instructional design capabilities and promote student-centered learning practices (Hazard et al., 2025). Moreover, PBL is particularly relevant in vocational education contexts, where learning is expected to be contextual, applied, and aligned with real-world problems.

These findings reinforce the role of PBL as a critical component in developing applied human capital, where knowledge is operationalized into practical teaching strategies.

e) Digital Competence and Technology Integration

In the digital era, teacher human capital is increasingly defined by digital competence. The TPACK framework highlights that effective teaching with technology requires the integration of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). Recent studies extend this framework by demonstrating that digital tools enhance instructional design, collaboration, and personalized learning experiences (Wang et al., 2025). Similarly, the DigCompEdu framework emphasizes educators' ability to create and manage digital resources as a core competency in modern education.

Moreover, emerging research on AI-supported teacher development indicates that digital platforms can significantly accelerate skill acquisition and instructional innovation (Holmes et al., 2022). This suggests that integrating digital tools into PD programs is essential for sustainable human capital development.

3. METHODOLOGY

a. Program Design

This community service activity utilizes a community-based participatory training design that emphasizes the involvement of school partners in needs mapping, training implementation, and output agreement. Conceptually, the program is positioned as an intervention to develop teacher human capital through increased digital-

pedagogical capacity, observable through changes in practice and the quality of teaching materials.

The program is structured in three interrelated stages. First, preparation and coordination include coordination with school principals, determining priority needs, and developing needs-based training modules. Second, it focuses on understanding the principles of PBL and the structure of micro-modules as concise instructional design products that still have a flow of activities/syntax and assessment. Finally, the core activity consists of directed practice, where participants design PBL-based micro-modules, receive feedback, revise, and present the results.

b. Participants

The program partner is State Vocational High School 3 Jeneponto. The primary participants are teachers deemed in need of reinforcement in developing micromodule-based teaching materials and PBL. The school actively participates in selecting participants, providing training space, and supporting the smooth running of the program.

c. Data Collection and Analysis

Data for analysis purposes in this article were obtained from: (1) observations of the training process; (2) reflection notes from facilitators and participants; and (3) a review of the initial micro module designs produced by teachers. Data were analyzed descriptively and qualitatively to describe changes in teacher competency and the challenges that emerged during the training.

4. RESULTS AND ANALYSIS

a. Initial Conditions and Needs: Baseline of Teacher human Capital

Initial surveys and discussions indicate that teachers at SMK Negeri 3

Jeneponto exhibited limitations in several key dimensions of human capital. From the perspective of Gary Becker, human capital encompasses knowledge, skills, and the capacity to perform tasks effectively. In this context, teachers' initial conditions reflect gaps in both conceptual knowledge and applied pedagogical skills.

Specifically, teachers (1) had limited understanding of micro module concepts, (2) experienced difficulties in designing authentic problems as triggers for Problem-Based Learning (PBL), (3) predominantly relied on lecture-based approaches, and (4) had not previously participated in structured training on PBL-based micro module development.

In addition, variations in digital literacy indicate unequal levels of digital human capital, where some teachers were already familiar with platforms such as Canva and Google Classroom, while others required intensive guidance. This finding aligns with recent studies showing that disparities in digital competence remain a critical challenge in teacher professional development (Trust et al., 2021; Kohnke et al., 2024).

Figure 1. Greeting by the School Principal

b. Strengthening Conceptual Knoledge as Human Capital Formation

I The conceptual reinforcement sessions functioned as a knowledge investment process, strengthening teachers' understanding of PBL and micro module design. Teachers were introduced to the structured stages of PBL—problem identification, organization, investigation, solution development, and reflection—and guided to integrate these stages into micro modules.

A key transformation observed was a shift in teachers' perception of PBL. Initially perceived as complex, PBL became more accessible when structured through micro modules. This indicates an increase in cognitive human capital**,** where abstract pedagogical concepts are translated into understandable and applicable frameworks.

This finding supports prior research indicating that effective professional development enhances teachers' conceptual understanding when it is directly linked to classroom practice (Darling-Hammond et al., 2020). It also aligns with recent microlearning studies showing that structured and segmented learning materials improve comprehension and instructional clarity (Monib et al., 2024).

c. Development of Digital and Pedagogical Skills through Practice

The workshop on digital micro module design represents a critical stage in transforming knowledge into applied human capital. Through hands-on activities, teachers developed skills in designing instructional materials using Canva, including layout design, visual communication, and alignment with PBL learning flows. The diversity in participants' digital skills highlights that human capital development is not uniform. Teachers with higher initial digital competence progressed more quickly, while others required individualized support. However, all

participants were able to produce initial micro module drafts, demonstrating a measurable improvement in both digital capability and instructional design skills**.**

Figure 2. Explanation of Micro Module Compilation Using Canva

This outcome is consistent with the TPACK framework, which emphasizes the integration of technological, pedagogical, and content knowledge in effective teaching (Mishra & Koehler, 2006). Recent studies also confirm that digital-based professional development enhances teachers' instructional design competence and adaptability (Wang et al., 2025).

d. Observed Outcomes: Integrated Human Capital Development

The training program resulted in improvements across multiple dimensions of teacher human capital: (1) Enhanced conceptual knowledge, reflected in teachers' understanding of micro modules and PBL structure. (2) Strengthened pedagogical competence, particularly in designing contextual problems and inquiry-based learning activities. (3) Improved digital competence, evidenced by teachers' ability to use digital tools to create structured and visually engaging learning materials. (4)

Transformation of instructional mindset, shifting from teacher-centered to student-centered and problem-solving-oriented approaches.

These findings demonstrate that the program facilitated integrated human capital development, where knowledge, skills, and attitudes are developed simultaneously. This supports recent literature emphasizing that effective professional development must address multiple competency domains to produce sustainable changes in teaching practice (Buchem & Hamelmann, 2022; Loyens et al., 2022).

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Figure 1. Micromodule Drafting by Participants

e. Challenges and Contextual Constraints

Despite these positive outcomes, several constraints affect the sustainability of human capital development. First, disparities in teachers' digital literacy indicate the need for differentiated training approaches. Second, limited student access to digital devices presents a structural barrier, potentially reducing the effectiveness of digital-based instructional innovations. This highlights that human capital development must be

supported by adequate institutional infrastructure.

Figure 2. Sharing and Discussion with Participants

Third, the absence of quantitative evaluation (e.g., pre–post measurement) limits the ability to assess the magnitude of competency improvement. While qualitative evidence indicates positive changes, future programs should incorporate measurable indicators to strengthen the empirical basis of human capital development outcome.

5. CONCLUSION, LIMITATION, AND RECOMMENDATION

a. Conclusion

The PBL-based micromodule development training for teachers at SMK Negeri 3 Jeneponto was conducted through preparation and coordination stages, concept reinforcement, and a digital design workshop. This program successfully increased teachers' understanding of the micromodule and PBL concepts, strengthened their skills in designing authentic problems and investigative learning flows, and encouraged the use of digital applications such as Canva in developing teaching materials,

including the development of micromodules in digital/e-book format. Teachers produced initial micromodule designs that were ready for further development for implementation in the classroom..

This program also contributes to strengthening cooperation between universities and partner schools in supporting the implementation of the Independent Curriculum through innovative learning oriented towards increasing teacher capacity (human capital).

b. Limitation

This article presents qualitative data-based findings from a single partner school with a limited number of participants, so generalizations should be made with caution. The lack of quantitative pre-post data hinders analysis of the magnitude of teacher competency improvements in numerical terms. Furthermore, students' limited access to digital devices has not been fully addressed within the program's framework..

c. Recommendation

Based on these results and limitations, several recommendations are proposed: (1) For teachers, internal forums and communities of practitioners at the school level are needed to continue developing and sharing best practices for micro modules on a regular basis, including digital design practices using Canva and preparing micro modules in e-book format; (2) For schools, it is necessary to facilitate collaborative work between teachers across subjects to maintain consistent quality of micro modules and explore schemes for providing printed or hybrid versions to address the disparity in digital access; and (3) For universities, follow-up programs can be designed with a focus on strengthening advanced digital literacy, authentic assessment in micro modules, and quantitative measurement of training impact.

For future researchers, it is recommended to develop studies that test the effectiveness of implementing PBL-based micro modules on student learning outcomes and 21st-century skills in various vocational school contexts.

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