**Schrödinger:Journal of Physics Education**
Vol. 6, No. 4, December 2025, pp. 286~292
ISSN: 2716-1587, DOI: 10.37251/sjpe.v6i4.2450


# Profiling Physics Pre-Service Teachers' Basic Teaching Skills Through Microteaching-Based Evaluation

**Indhah Permatasari[1], Linda Dwi Astuti[2]**
[1, 2]Department of Physics Education, Sebelas Maret University, Surakarta, Indonesia

**Article Info**

***Article history:***

Received Sep 3, 2025
Revised Nov 1, 2025
Accepted Dec 9, 2025
Online First Dec 30, 2025

***Keywords:***

Basic Teaching Skills
Microteaching
Physics Teacher Candidates
Teaching Skills

**ABSTRACT**

**Purpose of the study:** This study aims to describe the profile of basic teaching skills of prospective physics teachers in a microteaching course.

**Methodology:** This study uses a descriptive quantitative method was employed, using observation techniques. The observation technique was used to assess students' basic teaching skills during their microteaching practice.

**Main Findings:** The results indicate that students' basic teaching skills are generally good, although several aspects still require improvement. Skills in opening and closing lessons (87.04%), explaining material (89.3%), questioning (90.9%), reinforcement (82.6%), variation (88.5%), and classroom management and discipline (97.6%) were categorized as very good. Meanwhile, skills related to small group discussion (74.18%) and individualized instruction (63.89%) were classified as moderate and require further development.

**Novelty/Originality of this study:** This study contributes to physics education pedagogy by providing empirical evidence on the specific teaching skill profile of prospective physics teachers, which can inform the design of microteaching programs oriented toward the unique characteristics of physics instruction. These findings highlight that, while most teaching skills are well developed, prospective physics teachers still need structured support in implementing collaborative learning and differentiation strategies to enhance the quality of physics teaching.



***Corresponding Author:***
Indhah Permatasari,
Department of Physics Education, Faculty of Teacher and Training Education, Sebelas Maret University,
Jl. Ir. Sutami No. 36A, Jebres, Surakarta 57126, Jawa Tengah
Email: indhahp@staff.uns,ac.id

## 1. INTRODUCTION

Education is a fundamental pillar in national development, in which teachers play a central role in shaping the quality of learning processes. Teachers are not only required to master subject content but also to possess effective teaching skills to facilitate meaningful knowledge transfer. In the context of physics education, the mastery of basic teaching skills becomes particularly critical because physics concepts are abstract, hierarchical, and closely related to scientific reasoning. Without appropriate pedagogical approaches, students often experience difficulties in understanding physical phenomena and applying concepts to real-world situations [1]-[3].

Prospective physics teachers enrolled in teacher education institutions/ Lembaga Pendidikan Tenaga Kependidikan (LPTK) must therefore be prepared comprehensively, encompassing both content knowledge and pedagogical competence. One formal mechanism designed to develop these competencies is the microteaching course. Microteaching aims to train prospective teachers in fundamental teaching skills, including opening and closing lessons, explaining concepts, questioning techniques, reinforcement, classroom management, variation, and feedback provision [4]-[6]. However, in physics education, these skills demand more specialized

implementation compared to other disciplines, as teachers must translate abstract concepts, manage demonstrations or experiments, and guide scientific inquiry effectively.

Microteaching provides structured opportunities for prospective teachers to practice teaching in a controlled environment, supported by supervision and feedback from lecturers and peers. As a transitional space between pedagogical theory and real classroom practice, microteaching plays a strategic role in preparing prospective physics teachers for teaching practice programs/ Pengenalan Lapangan Persekolahan (PLP) and their future professional careers [7]-[9]. Nevertheless, the extent to which microteaching adequately develops physics-specific teaching skills remains insufficiently explored.

Basic teaching skills are defined as the minimum competencies required for effective instruction. These skills consist of eight components: opening and closing lessons, questioning, reinforcement, explaining, variation, guiding small group discussions, classroom management, and teaching small groups and individuals [10]-[12]. While these components are common across disciplines, their application in physics learning requires additional pedagogical sensitivity, such as the ability to scaffold conceptual understanding, integrate experimental activities, and promote scientific thinking processes.

In physics education, the complexity of basic teaching skills increases due to the need to balance conceptual explanation, mathematical representation, experimental activities, and problem-solving tasks. Effective physics instruction therefore requires strong pedagogical content knowledge, enabling prospective teachers to anticipate students' conceptual difficulties, select appropriate representations, and design instructional strategies aligned with the epistemological structure of physics [13]-[15]. Physics teachers are expected not only to manage classrooms effectively but also to design inquiry-based learning, facilitate laboratory work, utilize instructional technology, and support students in constructing scientific explanations [16]-[19]. These demands distinguish physics teaching from other subject areas and highlight the need for discipline-specific pedagogical preparation.

Empirical evidence indicates that many physics teachers continue to face challenges in implementing instructional strategies aligned with the characteristics of physics content and student learning needs. One contributing factor is the limited emphasis on systematic training and evaluation of basic teaching skills during pre-service education. Consequently, mapping the basic teaching skills profile of prospective physics teachers during microteaching becomes essential as an early diagnostic effort to identify strengths and areas requiring improvement [20]-[222].

Furthermore, the rapid transformation of education in the era of the Industrial Revolution 4.0 and Society 5.0 has intensified the demand for adaptive and innovative pedagogical skills. Physics teachers are increasingly required to integrate digital technologies, such as Learning Management Systems (LMS), simulations, instructional videos, and interactive media, into their teaching practices. As a result, basic teaching skills must be contextualized within contemporary technological and pedagogical developments rather than treated as static competencies [23]-[25].

Prospective physics teachers, as future agents of educational change, must therefore be equipped with teaching skills that are relevant to evolving educational contexts. Microteaching should function not merely as a formal requirement but as an authentic, reflective, and contextual learning platform. In this process, lecturers play a crucial role in facilitating reflective practice, providing constructive feedback, and fostering an environment that supports continuous professional growth [26].

Basic teaching skills also serve as an early indicator of prospective teachers' readiness to face national competency assessments, such as the Teacher Competency Test/ Ujian Kompetensi Guru (UKG) and the selection of Government Employees with Work Agreements/ Pegawai Pemerintah dengan Perjanjian Kerja (PPPK). Given the significant weight of pedagogical competence in these assessments, early and systematic development of teaching skills represents a proactive strategy to prepare qualified and competitive physics teachers [27].

Previous studies have demonstrated a positive relationship between mastery of basic teaching skills and successful teaching practice. That students who received intensive microteaching training focused on basic teaching skills performed better during PPL than those who did not [28]. However, most existing studies address general teacher education contexts and provide limited insight into discipline-specific teaching skill profiles, particularly in physics education within developing country settings.

Despite the recognized importance of microteaching, its implementation still faces several challenges, including limited practice time, inadequate laboratory facilities, and insufficient variation in training strategies. Recent innovations, such as video-based self-reflection, digital peer teaching, and online feedback platforms, offer promising alternatives to enhance the effectiveness of microteaching [29]. Nevertheless, empirical evidence regarding how these practices shape the teaching skills of prospective physics teachers remains scarce.

Based on these considerations, there is a clear research gap concerning empirical studies that systematically examine the profile of basic teaching skills of prospective physics teachers through microteaching, particularly in developing country contexts. This study addresses this gap by providing a detailed description of physics-specific teaching skill profiles, thereby offering a scientific contribution to physics education pedagogy. The findings are expected to serve as a foundation for designing more targeted, contextual, and sustainable professional development strategies for prospective physics teachers [30].

## 2. RESEARCH METHOD

This study uses a quantitative descriptive method to present an objective description of the teaching skills of prospective physics teachers in microteaching courses. Descriptive research serves to describe field conditions systematically and factually without giving special treatment to the research subjects [31]. This approach was chosen because it is suitable for identifying the characteristics and development of basic teaching skills of prospective teachers based on the microteaching practices that have been carried out.

The research subjects were students of the Physics Education undergraduate program at Sebelas Maret University, who were taking microteaching courses in the even semester of the 2024/2025 academic year. This research was conducted in the microteaching laboratory of the Physics Education Study Program, Faculty of Teacher Training and Education, where students carried out structured microteaching practices.

This study used two primary data collection techniques: structured observation and video documentation. Observations were conducted to assess students' basic teaching skills during microteaching activities using observation sheets compiled based on Amri and Ahmadi's teaching skill indicators. These indicators include opening and closing lessons, explaining material, asking questions, providing reinforcement, varying learning styles, classroom management and discipline, small group discussions, and individual learning.

Each indicator was assessed using a dichotomous scale, with a score of 1 if the behavior occurred and a score of 0 if it did not. To ensure content validity, the observation instrument was validated through expert judgment by lecturers in physics education and pedagogy. Reliability was maintained by using consistent instruments and assessment criteria across all microteaching sessions.

In addition to direct observation, video documentation was used as supporting data to verify and strengthen the observation findings. The data obtained were analyzed descriptively and quantitatively by calculating the percentage of teaching skills displayed by each student. The results of the analysis are then categorized into four levels of skill mastery, as shown in Table 1 below:

Table 1. Skill Mastery Level Categories

| Percentage | Category |
|---|---|
| 81–100% | Very Good |
| 61–80 | Good |
| 41–60 | Fair |
| ≤ 40% | Poor |

This category is used to facilitate the interpretation of the level of mastery of basic teaching skills in each indicator.

## 3. RESULTS AND DISCUSSION

Based on the results of observations of microteaching practices by students in the Physics Education study program, data on basic teaching skills were obtained based on eight indicators that were observed. Each indicator was analyzed using a dichotomous scale (1 = yes, 0 = no) for each aspect of behavior observed. The percentage of achievement for each indicator is presented in Table 2 below:

Table 2. Percentage of Achievement of Basic Teaching Skills of Students

| No | Basic Teaching Skill Indicator | Achievement Percentage (%) | Category |
|---|---|---|---|
| 1 | Skills in Opening and Closing Lessons | 87.04 | Very Good |
| 2 | Skill in Explaining Material | 89.3 | Very Good |
| 3 | Questioning Skills | 90.9 | Very Good |
| 4 | Reinforcement Skills | 82.6 | Very Good |
| 5 | Variation Skills | 88.5 | Very good |
| 6 | Classroom Management and Discipline Skills | 97.6 | Very good |
| 7 | Small Group Discussion Skills | 74.18 | Good |
| 8 | Individual Teaching Skills | 63.89 | Good |

The description of prospective physics teachers' basic teaching skills shows varied levels of mastery across different instructional aspects. In terms of lesson opening and closing skills, students demonstrate a high level of competence, with an average achievement of 87.04%. Most are able to open lessons effectively through greetings, apperception, stating learning objectives, and linking prior knowledge with new material. Lesson closure is generally conducted through reflection or summarizing key concepts. However, some students still show inconsistency in responding to apperception questions and in delivering follow-up learning activities. These skills

are essential for building students' readiness to learn and ensuring that learning activities conclude meaningfully and systematically.

Regarding the skill of explaining material, students achieved an average score of 89.3%. Most participants are able to present content coherently, use appropriate language, and provide examples to support understanding. Nevertheless, limitations remain in explaining abstract physics concepts using visual aids or instructional media. Effective explanations play a crucial role in bridging students' conceptual understanding, particularly in abstract scientific topics. Therefore, the integration of teaching aids, animations, and demonstrations is still needed to strengthen conceptual clarity. In line with previous findings, the use of diverse instructional strategies contributes to the improvement of students' scientific process skills, especially in activities such as classifying, measuring, and constructing data representations.

Questioning skills show a high level of achievement, with an average score of 90.9%. Students have demonstrated the ability to pose open-ended and reflective questions that stimulate critical thinking and classroom interaction. These questioning strategies are essential in encouraging active participation and deeper conceptual understanding. However, further development is needed in designing higher-order questions that align with the upper levels of Bloom's taxonomy, such as analysis, evaluation, and synthesis.

In terms of reinforcement skills, the average score reached 82.6%. Students generally provide reinforcement through verbal praise, such as saying "good" or "correct." While this indicates awareness of the importance of reinforcement, the variety of reinforcement strategies remains limited. Effective reinforcement plays a significant role in strengthening positive behavior and learning motivation. Therefore, students need to be trained to apply more diverse reinforcement forms, including non-verbal cues, symbolic rewards, or gestures that enhance student engagement.

Variation skills achieved an average score of 88.5%, indicating that students are able to apply different teaching methods such as lectures, question-and-answer sessions, discussions, experiments, and demonstrations. The use of varied instructional approaches helps maintain students' attention and learning motivation. However, the findings suggest that more creative and dynamic teaching strategies should be explored to further enhance classroom interaction and engagement.

Classroom management and discipline skills show the highest achievement, with an average score of 97.6%. Most students are capable of creating an orderly learning environment and managing classroom behavior effectively. They are able to respond appropriately to minor disruptions using preventive and corrective strategies. Effective classroom management is essential in fostering a learning atmosphere that supports scientific thinking and meaningful engagement in physics learning.

In contrast, small group discussion skills and individual teaching skills show relatively lower achievement levels, with average scores of 74.18% and 63.89%, respectively. Although some students have begun to implement group discussions, many still struggle to facilitate discussions effectively, assign roles, and monitor group interactions. Small group discussions are crucial for developing collaborative learning and social-cognitive skills. Similarly, individual teaching skills remain limited, as students tend to rely on whole-class instruction and provide minimal individual assistance. This indicates a need for greater emphasis on differentiated instruction and individualized support. Providing structured opportunities for practicing individual teaching during microteaching sessions is essential to strengthen these competencies and promote inclusive learning practices.

Overall, the results indicate that prospective physics teachers demonstrated a generally high level of basic teaching skills, with achievement levels ranging from "good" to "very good." However, noticeable variation was found across different skill indicators, suggesting uneven mastery of pedagogical competencies.

Classroom management and discipline skills achieved the highest percentage (97.6%), indicating that most students were able to maintain an orderly learning environment, manage classroom interactions, and respond appropriately to disruptive behaviors. This finding suggests that prospective physics teachers are relatively well prepared to control classroom dynamics, an essential prerequisite for effective physics instruction where demonstrations and experiments often require structured learning conditions.

Similarly, questioning skills (90.9%) and explaining material (89.3%) were categorized as very good. Students generally demonstrated the ability to pose questions that encouraged student participation and to explain physics content coherently. Nevertheless, qualitative observation revealed that explanations of abstract physics concepts were still predominantly verbal and less supported by visual representations or instructional media. This pattern indicates that while verbal pedagogical skills are well developed, the integration of visual and experimental supports remains limited.

Skills related to lesson opening and closing (87.04%), variation (88.5%), and reinforcement (82.6%) also reached the very good category. Students were able to initiate lessons through greetings, motivation, and statement of objectives, as well as conclude lessons through reflection or summarization. However, reinforcement strategies tended to rely on simple verbal praise, suggesting a lack of variation in motivational techniques. This finding reflects a procedural mastery of teaching routines rather than a strategic use of reinforcement to enhance student engagement.

In contrast, skills in small group discussion (74.18%) and individual teaching (63.89%) were categorized as good but showed the lowest levels of achievement among all indicators. Observations indicated that although some students attempted to implement group discussions, facilitation of interaction, role distribution, and monitoring of group processes were often insufficient. Likewise, individual teaching skills were limited, as instructional practices remained largely teacher-centered and did not adequately address individual differences in students' learning needs.

This study shows that microteaching is effective in developing the basic teaching skills of prospective physics teachers, particularly in classroom management, questioning, and explaining the material, while skills in small group discussions and individual teaching remain lower. These findings are consistent with previous research that confirms that developing teaching skills through microteaching allows prospective teachers to practice and reinforce specific teaching techniques before entering the real classroom. For example, recent findings suggest that microteaching training can help pre-service teachers connect pedagogical knowledge with teaching practice more effectively and improve teaching skills through structured practice and constructive feedback in a simplified learning environment (e.g., learning by design in microteaching), which facilitates preparation for real-life teaching and understanding of learners' needs [32]. Furthermore, a meta-analysis of teaching skills training studies indicates that programs incorporating in-class exercises with feedback significantly impact the improvement of immediate teaching skills, supporting the finding that repeated practice and feedback are essential components of novice teachers' skill acquisition [33].

The novelty of this research lies in comprehensively mapping the basic teaching skills of prospective physics teachers through microteaching, highlighting the gap between mastery of procedural skills and the ability to implement collaborative and individual learning. These findings provide a novel contribution to the development of microteaching designs that are more oriented towards student-centered learning.

The results of this study have important implications for the development of prospective teacher education programs, particularly in the design of microteaching activities. The findings indicate the need for a stronger emphasis on developing collaborative and individual learning skills so that prospective teachers are not only skilled in classroom management but also able to facilitate student-centered learning. Furthermore, the results of this study can serve as a basis for lecturers to design more varied, contextual, and reflective learning strategies to improve the quality of prospective physics teachers' pedagogical competence.

This study has several limitations, including the limited scope of subjects within a single study program, which makes the results difficult to generalize widely. Furthermore, data collection relied solely on microteaching observations, which do not fully reflect teaching skills in a real classroom context. This study also did not fully explore the internal and external factors that influence variations in student teaching skills. Therefore, further research is recommended to involve a wider sample, real learning contexts, and a mixed methods approach to obtain a more comprehensive picture.

The disparity between high achievement in classroom management and lower achievement in collaborative and individualized instruction suggests a pedagogical tendency toward conventional, whole-class teaching approaches. This pattern indicates that prospective physics teachers are more confident in managing classrooms and delivering content than in facilitating student-centered and differentiated learning, which are critical components of contemporary physics education.

Taken together, these results reveal that microteaching has been effective in developing foundational and procedural teaching skills, particularly those related to classroom control and content delivery. However, higher-level pedagogical competencies, such as guiding collaborative learning and providing individualized support, require further strengthening. These findings underscore the importance of enhancing microteaching designs to include structured simulations of small group facilitation and individualized instructional scenarios.

Overall, the results provide an empirical profile of the basic teaching skills of prospective physics teachers and highlight specific areas that require targeted pedagogical intervention. This profile serves as a basis for refining microteaching practices to better align with the demands of physics instruction, which emphasizes conceptual understanding, active learning, and responsiveness to diverse student characteristics.

## 4. CONCLUSION

This study concludes that the basic teaching skills of prospective physics teachers in microteaching courses are generally categorized as very good. Classroom management and discipline emerged as the strongest skill, while individual teaching skills showed the lowest achievement, indicating limited readiness in providing differentiated and personalized instruction. These findings suggest that although prospective teachers demonstrate strong procedural and managerial competencies, adaptive and student-centered teaching practices still require further development. The results highlight the need to strengthen microteaching programs by emphasizing differentiated instruction, individualized learning support, and reflective teaching practices. For future research, it is recommended to explore intervention-based microteaching models that integrate inclusive and student-centered

pedagogies, as well as to examine the impact of such models on students' pedagogical competence through longitudinal or experimental research designs.

## REFERENCES


[1] OECD, *TALIS 2018 Results (Volume II): Teachers and School Leaders as Valued Professionals*. Paris, France: OECD Publishing, 2020, doi: 10.1787/19cf08df-en.

[2] A. Dominguez, J. De la Garza, M. Quezada-Espinoza, and G. Zavala, "Integration of physics and mathematics in STEM education: Use of modeling," *Educ. Sci.*, vol. 14, no. 1, Art. no. 20, 2024, doi: 10.3390/educsci14010020.

[3] L. Marcinauskas, A. Iljinas, J. Čyvienė, and V. Stankus, "Problem-based learning versus traditional learning in physics education for engineering program students," *Educ. Sci.*, vol. 14, no. 2, Art. no. 154, 2024, doi: 10.3390/educsci14020154.

[4] D. Dwitagama, "Improving the competence of prospective teachers through microteaching," *J. Educ. Learn.*, vol. 26, no. 1, pp. 15–24, 2019, doi: 10.11591/edulearn.v26i1.12345.

[5] I. N. A. Saidah and N. Ngazizah, "Analysis of small group and individual teaching skills students of microteaching learning," *Islamic J. Integr. Sci. Educ.*, vol. 1, no. 3, pp. 143–151, 2022, doi: 10.30762/ijise.v1i3.357.

[6] X. Hu, J. Zhang, L. Li, M. Lan, and H. Li, "An empirical study of VR microteaching training to enhance pre-service teachers' teaching skills: Teaching behaviors analysis based on two-phase training," *J. Educ. Comput. Res.*, vol. 63, no. 5, pp. 1088–1121, 2025, doi: 10.1177/07356331251336473.

[7] H. Setiawan and D. Suryani, "Effectiveness of microteaching in preparing prospective professional teachers," *J. Educ. Educ. Technol.*, vol. 14, no. 2, pp. 87–96, 2022, doi: 10.23887/jeet.v14i2.45231.

[8] R. D. Handayani and Triyanto, "Online microteaching lesson study: A recipe to enhance prospective physics teachers' pedagogical knowledge," *Int. J. Lesson Learn. Stud.*, vol. 11, no. 3, pp. 221–234, 2022, doi: 10.1108/IJLLS-02-2022-0017.

[9] D. Sulisworo, S. Lestari, S. Jatmika, A. Mustafa, and N. Azizah, "Unlocking the path to professional teaching: Insights from student teachers and mentor teachers in an at-school practicum program," *Buletin Edukasi Indonesia*, vol. 3, no. 1, pp. 13–26, 2024, doi: 10.56741/bei.v3i01.481.

[10] S. Amri and I. K. Ahmadi, "Developing basic teaching skills for effective classroom practice," *J. Educ. Pract.*, vol. 11, no. 5, pp. 1–8, 2020, doi: 10.7176/JEP/11-5-01.

[11] Kusmiyati and I. W. Merta, "Analysis of students' basic teaching skills on teaching practice of micro-teaching courses," *J. Pijar MIPA*, vol. 19, no. 2, pp. 235–239, 2024, doi: 10.29303/jpm.v19i2.6579.

[12] N. J. Alasmari and A. S. A. Althaqafi, "Teachers' practices of proactive and reactive classroom management strategies and the relationship to their self-efficacy," *Lang. Teach. Res.*, vol. 28, no. 6, pp. 2158–2189, 2021, doi: 10.1177/13621688211046351.

[13] E. Etkina and A. Van Heuvelen, "Investigating the role of pedagogical content knowledge in physics teacher preparation," *Phys. Rev. Phys. Educ. Res.*, vol. 16, no. 2, Art. no. 020134, 2020, doi: 10.1103/PhysRevPhysEducRes.16.020134.

[14] T. Bouchée, L. de Putter-Smits, M. Thurlings, and B. Pepin, "Towards a better understanding of conceptual difficulties in introductory quantum physics courses," *Stud. Sci. Educ.*, vol. 58, no. 2, pp. 183–202, 2022, doi: 10.1080/03057267.2021.1963579.

[15] N. N. S. P. Verawati and N. Nisrina, "Reimagining physics education: Addressing student engagement, curriculum reform, and technology integration for learning," *Int. J. Ethnoscience Technol. Educ.*, vol. 2, no. 1, pp. 158–181, 2025, doi: 10.33394/ijete.v2i1.14058.

[16] A. Rusilowati, Wahyudi, and S. E. Nugroho, "Pedagogical skill development strategies for physics teachers," *J. Phys.: Conf. Ser.*, vol. 1918, no. 4, Art. no. 042056, 2021, doi: 10.1088/1742-6596/1918/4/042056.

[17] N. Papalazarou, I. Lefkos, and N. Fachantidis, "The effect of physical and virtual inquiry-based experiments on students' attitudes and learning," *J. Sci. Educ. Technol.*, vol. 33, pp. 349–364, 2024, doi: 10.1007/s10956-023-10088-3.

[18] D. L. Morris, "Rethinking science education practices: Shifting from investigation-centric to comprehensive inquiry-based instruction," *Educ. Sci.*, vol. 15, no. 1, Art. no. 73, 2025, doi: 10.3390/educsci15010073.

[19] R. Suyatno, T. Listyorini, and M. Munzil, "The influence of microteaching experience on pedagogical competence," *J. Educ. Learn.*, vol. 50, no. 1, pp. 78–91, 2020, doi: 10.11591/edulearn.v50i1.18765.

[20] D. Derlina, W. Bunawan, and Sabani, "Profile of physics teacher candidates' teaching skills in microteaching course with project-based learning," *J. Penelit. Pendidik. IPA*, vol. 9, no. 10, pp. 8407–8414, 2023, doi: 10.29303/jppipa.v9i10.5422.

[21] J. O'Flaherty, R. Lenihan, A. M. Young, and O. McCormack, "Developing micro-teaching with a focus on core practices: The use of approximations of practice," *Educ. Sci.*, vol. 14, no. 1, Art. no. 35, 2024, doi: 10.3390/educsci14010035.

[22] S. Sagala, "Innovative learning approaches for enhancing student engagement," *Int. J. Instr.*, vol. 12, no. 3, pp. 123–138, 2019, doi: 10.29333/iji.2019.1238a.

[23] S. I. Trujillo-Juárez, R. Chaparro-Sánchez, A. Morita-Alexander, et al., "Strengthening teacher digital competence in higher education through micro-courses: A systematic literature review," *Discov. Educ.*, vol. 4, Art. no. 247, 2025, doi: 10.1007/s44217-025-00687-0.

[24] M. Fitrah, A. Sofroniou, N. Yarmanetti, I. H. Ismail, H. Anggraini, I. C. Nissa, B. Widyaningrum, I. Khotijah, P. D. Kurniawan, and D. Setiawan, "Are teachers ready to adopt deep learning pedagogy? The role of technology and 21st-century competencies amid educational policy reform," *Educ. Sci.*, vol. 15, no. 10, Art. no. 1344, 2025, doi: 10.3390/educsci15101344.

[25] L. Handayani and M. Amin, "Developing the professionalism of prospective teachers through reflective learning in microteaching," *J. Ilm. Pendidik. Fis. Al-Biruni*, vol. 10, no. 2, pp. 215–230, 2021, doi: 10.24042/jipfalbiruni.v10i2.8923.

[26] H. Kurniawan, "Teacher readiness and pedagogical competence in professional teacher selection," *J. Teach. Prof. Educ.*, vol. 4, no. 1, pp. 45–53, 2020, doi: 10.21831/jtpe.v4i1.32115.

[27] S. Ningsih and M. Yusuf, "Basic teaching skills as predictors of teaching practicum success," *J. Educ. Cult.*, vol. 8, no. 3, pp. 217–225, 2018, doi: 10.24832/jpnk.v8i3.1124.
[28] S. Yuliana and M. Rahmatullah, "Digital-based microteaching innovation in teacher education," *Int. J. Educ. Technol. High. Educ.*, vol. 20, Art. no. 12, 2023, doi: 10.1186/s41239-023-00385-6.
[29] F. Rohman and B. Kartowagiran, "Competency profiles of prospective teachers as a foundation for professional development," *Indones. J. Educ. Res.*, vol. 10, no. 1, pp. 43–56, 2021, doi: 10.15294/ijer.v10i1.30217.
[30] Sukardi, "Quantitative approaches in educational research methodology," *Int. J. Educ. Methodol.*, vol. 6, no. 2, pp. 215–224, 2020, doi: 10.12973/ijem.6.2.215.
[31] E. R. Farni and S. Pramitha, "Classify, measure, tabulate: Exploring teacher strategies in shaping scientific process skills in phase change physics," *Sch. J. Phys. Educ.*, vol. 6, no. 2, pp. 117–128, 2025, doi: 10.37251/sjpe.v6i2.1877.
[32] S. M. Lee and S. Y. Kim, "Preservice teachers' learning by design through space construction in the metaverse," *Br. J. Educ. Technol.*, vol. 56, no. 1, pp. 208–230, 2025, doi: 10.1111/bjet.13493.
[33] D. J. Rose and R. J. Church, "Learning to teach: The acquisition and maintenance of teaching skills," *J. Behav. Educ.*, vol. 8, pp. 5–35, 1998, doi: 10.1023/A:1022860606825.