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Developing Performance-Based Teaching Materials to Support Lesson Planning Competence of Preservice Science Teacher

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Abstract

Preservice science teachers frequently struggle to design coherent lesson plans that align learning objectives, teaching methods, and assessment with current policy demands such as Merdeka Belajar Kampus Merdeka and the Indonesian National Qualifications Framework. This study aimed to develop, validate, and conduct a limited trial of performance-based teaching materials for a Science Instructional Design course, consisting of student worksheets and a textbook structured with the Kemp instructional design model. A design and development approach was employed, followed by a small-scale field implementation with one cohort in a science education program at an Islamic university. Data were collected through expert validation sheets addressing format, language, and content; a readability test with six students of high, medium, and low achievement; a performance rubric for lesson planning (competency analysis, indicator development, lesson plan construction, method selection); and student questionnaires on interest and motivation. Data were analyzed descriptively. The materials were rated valid to highly valid by experts, with high inter-rater agreement. Readability indices indicated that the textbook was easy to understand, with an average difficulty of about 5.5 percent. Most students achieved good to excellent ratings on competency analysis, indicator development, and lesson plan structure, while performance in method selection remained relatively weak. Student responses showed good interest and very good motivation, particularly in confidence to prepare lesson plans. Given the single-group, single-institution design and absence of a comparison group, the findings indicate feasibility and promise rather than demonstrated effectiveness in improving lesson-planning competence.

Keywords: Preservice Science Teachers; Lesson Planning; Performance-Based Teaching Materials; Instructional Design; Indonesian Higher Education

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INTRODUCTION

The preparation of preservice science teachers in lesson planning is a central but still fragile element of science teacher education. Lesson plans sit at the intersection of content knowledge, pedagogy, assessment, and classroom realities, yet many preservice science teachers (PSTs) struggle to translate what they learn in coursework into coherent, teachable designs. Studies on instructional design competence and pedagogical content knowledge (PCK) show that structured support can improve planning, but they also reveal persistent gaps between knowing and doing in actual lesson plan (*Rencana Pelaksanaan Pembelajaran*, RPP) construction.

Research on preservice science teachers' instructional design competence suggests that targeted training can strengthen their ability to structure lessons, align objectives, and choose suitable learning activities, but this competence does not arise automatically from exposure to theory. Zhang et al. report that preservice science teachers often find it particularly difficult to design concise, goal-oriented micro-lessons, even after instruction in design principles, which

signals a disconnect between theoretical frameworks and practical lesson planning (Zhang et al., 2017). Work on PCK in science teacher education reinforces this tension. Kim shows that well-designed science methods courses, with opportunities for discussion and reflection, can shift preservice science teachers' PCK and deepen their understanding of key concepts, yet these shifts still need to be enacted in concrete planning decisions (Kim, 2012, 2016). In a similar vein, Bakanay demonstrates that integrating the history of science can enrich preservice teachers' instructional strategies and support more contextually rich lesson plans, but this requires them to manage additional conceptual and contextual complexity (Bakanay, 2023). Collaborative models also appear promising but not sufficient in themselves. Canalita and Jugar describe internship-based collaborative lesson planning as a way to strengthen preservice teachers' capacity to design lessons, while at the same time acknowledging that lack of pedagogical knowledge and limited scaffolding remain significant obstacles in many programs (Canalita & Jugar, 2025).

These international findings connect directly to the current reform context in Indonesian teacher education. Policies such as *Merdeka Belajar Kampus Merdeka* (MBKM) emphasize student-centered learning, institutional and teacher autonomy, and stronger alignment of curriculum with local needs and authentic tasks in the field (A. U. Dewi, 2021; Hunaepi & Suharta, 2024). Under MBKM, teacher education institutions are expected to prepare preservice teachers who can adapt and design instruction rather than merely implement fixed packages. Empirical studies suggest that increased autonomy can positively influence classroom practices, but only when preservice teachers have the competences to use that autonomy responsibly (Nihayah et al., 2023). At the same time, the Indonesian National Qualifications Framework (*Kerangka Kualifikasi Nasional Indonesia*, KKNI) defines outcome-based competencies that teacher education programs must address. For science education, this includes the ability to design RPP that integrate scientific concepts, appropriate methods, and assessment strategies aligned with competency standards (Irawati & Ma'rifah, 2022; Prayoga et al., 2020). Studies on planning skills in Indonesian preservice teachers indicate that knowledge of curriculum design and structured training in RPP preparation are associated with better planning, but they also note variation across institutions and courses (A. U. Dewi, 2021; Faridah et al., 2020).

The Indonesian reforms also foreground performance-based learning in higher education. Instead of focusing only on mastery of theoretical content, teacher education programs are expected to provide learning experiences in which preservice teachers demonstrate their competences through authentic products and tasks, including lesson plans and teaching simulations (Abidin & Sabrun, 2019; Revina et al., 2023). This orientation has clear implications for courses on instructional design or "Desain Pembelajaran," where students are no longer simply expected to know what a "good lesson plan" is, but to produce and revise RPP that meet quality criteria and respond to real curriculum demands. The challenge, however, is that many programs still rely primarily on lectures and fragmented assignments, so preservice teachers may not receive a coherent, performance-based pathway that scaffolds them from curriculum analysis to complete, high-quality RPP.

A second, closely related issue is the persistent gap between design theory and the practical ability to construct effective lesson plans. Research repeatedly documents that preservice teachers find it difficult to ensure coherence between learning objectives, activities, and assessment within a single lesson or sequence. Beyer and Davis show that, even when preservice teachers can critique and adapt existing curriculum materials, they often fail to embed reform-oriented, inquiry-based elements consistently in their own lesson plans (Beyer & Davis, 2011). Drost and Levine note that misalignment between stated objectives and assessment tasks is common in lesson plans, which undermines the intended learning experiences (Drost & Levine, 2015). Yulkifli et al. add that integrating higher-order thinking skills (HOTS) and appropriate assessment into lesson plans remains a specific weak point for

many preservice teachers (Yulkifli et al., 2019). These findings suggest that lesson planning support needs to move beyond general advice and towards structured, performance-based materials that explicitly model and require alignment among objectives, methods, and assessment.

Several strands of research point to strategies that could help narrow this theory practice gap. Design-based and collaborative approaches to TPACK development indicate that engaging preservice teachers in co-designing ICT-integrated lessons can strengthen their capacity to plan instruction that meaningfully combines technology, pedagogy, and content (Chai et al., 2020). Mentoring and coaching have been shown to play a useful but resource-intensive role in improving lesson planning skills, especially when they include feedback on coherence and assessment (Amalia & Imperiani, 2013). In the field of performance-based materials, Großmann and Krüger propose a rubric for assessing science lesson plans and provide empirical evidence for its use with preservice teachers, suggesting that clear criteria and structured feedback can support more reflective and coherent planning (Großmann & Krüger, 2023). Related work on the integration of 21st-century skills and performance tasks into lesson planning shows that explicit focus on creativity, critical thinking, and collaboration can push preservice teachers to move beyond conventional, lecture-centered designs, although these demands can also increase the complexity of planning (Jufriadi et al., 2022; Niswandia et al., 2024).

In Indonesian science education, these issues are further complicated by recent changes in the format and expectations of RPP. Simplification policies associated with MBKM may reduce administrative burden and encourage teachers to focus on core components of lesson design, but they also require preservice teachers to make more independent decisions about methods and assessments (mohune et al., 2022). Studies in science teacher education suggest that, while some preservice teachers can draft RPP that look acceptable on paper, they often struggle to implement them due to limited understanding of curriculum intent and of suitable pedagogical strategies for specific topics (Desti, 2025; Nuraeni et al., 2024). In this context, there is a strong argument for developing teaching materials that are themselves performance-based: materials that not only explain lesson planning concepts but also require PSTs to perform key planning tasks such as analyzing Kompetensi Dasar (KD), formulating indicators, constructing RPP, and justifying the selection of methods and assessments.

Against this backdrop, there appears to be a specific gap in the literature and in practice. Various studies have addressed individual components of lesson planning, such as PCK development, curriculum adaptation, TPACK, or rubric-based assessment of RPP quality, and some have explored performance-based approaches and collaborative lesson planning in both international and Indonesian settings (Beyer & Davis, 2011; Canalita & Jugar, 2025; N. D. L. Dewi et al., 2024; Forbes & Davis, 2010; Großmann & Krüger, 2023; Revina et al., 2023; Zhang et al., 2017). However, there is still limited evidence on integrated, validated sets of performance-based teaching materials for a specific science education course that systematically guide PSTs through the full sequence of lesson planning tasks in line with MBKM and KKNI demands. In particular, few studies in Indonesia have documented the development and expert validation of such materials, examined their readability for PSTs, and described how preservice science teachers actually perform when using them in a real course context.

The present study responds to this gap by developing and validating a package of performance-based teaching materials for the Desain Pembelajaran Biologi course in a science education program at an Indonesian Islamic university. The materials consist of student worksheets and a textbook that are designed using the Kemp instructional design model to scaffold PSTs through KD analysis, indicator formulation, RPP construction, and the selection of appropriate methods and assessments. The study aims to: (1) describe the development process of these performance-based materials; (2) examine their validity based on expert

judgment and their readability for preservice science teachers; and (3) describe PSTs' lesson-planning performance and responses during a limited field implementation. The scope of the study is deliberately modest: it involves a single cohort in one institution and does not employ a control group or experimental comparison, so the findings are intended to provide evidence of feasibility and promise rather than claims of generalizable effectiveness. Within these boundaries, the study seeks to contribute a documented example of how performance-based teaching materials can be developed and used to support lesson planning in science teacher education under the current Indonesian policy framework.

METHOD

Research Design

This study employed a design-and-development approach with a limited field implementation. The goal was to develop, validate, and try out a set of performance-based teaching materials for the *Desain Pembelajaran Biologi* course, consisting of student worksheets (Lembar Kerja Mahasiswa/LKM) and a textbook. The Kemp instructional design model guided the development, emphasizing iterative analysis, design, development, evaluation, and revision. Figure 1 presents the overall flow of the study, starting from needs analysis and proceeding through expert validation, readability testing, and classroom implementation.

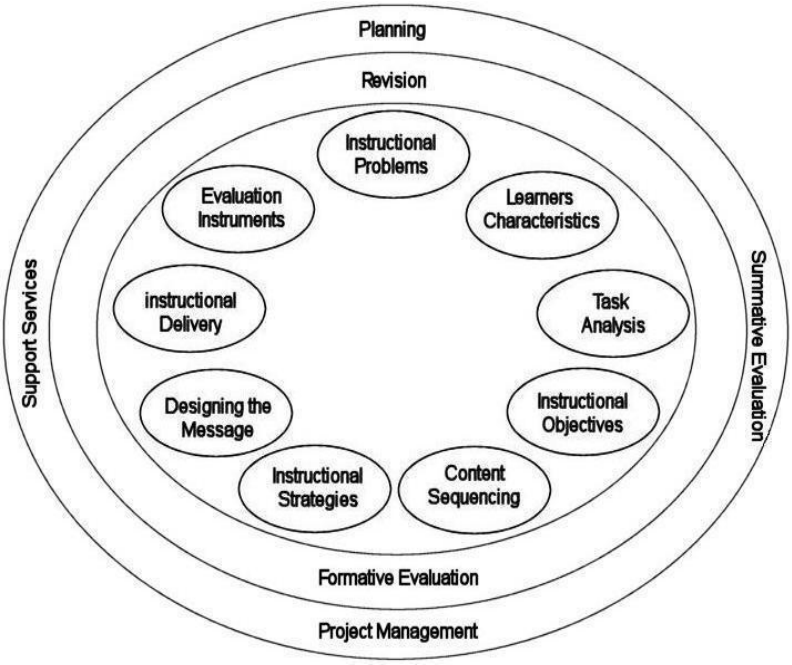

Figure 1. Stages of development and implementation of performance-based teaching materials based on the Kemp model

Participants and Context

The study was conducted in the science education program of an Islamic university in Indonesia. Participants in the field implementation were preservice science teachers (PSTs) enrolled in the *Desain Pembelajaran Biologi* course in one semester; all students in the intact class were included. For readability testing, six PSTs were purposively selected to represent high, medium, and low achievement (two per group) based on previous academic records. Expert validators were three science education lecturers with experience in instructional design and lesson planning.

Instruments

Four main instruments were used:

1. Expert validation sheets for LKM and textbook, covering format/presentation, language, and content. Each indicator was rated on a four-point scale (1 = very poor to 4 = very good), with space for written comments.
2. Performance rubric for lesson planning, consisting of four dimensions: (a) analysis of Kompetensi Dasar (KD), (b) development of learning indicators, (c) preparation of lesson plans (RPP), and (d) selection of teaching methods. Each was rated on four levels (poor, fair, good, excellent) with explicit descriptors.
3. Student response questionnaires (interest and motivation). The interest questionnaire addressed clarity, attractiveness, and support for independent learning; the motivation questionnaire addressed confidence in preparing RPP, perceived practicality, and encouragement for active engagement. Both used a four-point Likert scale.
4. Readability test instrument for the textbook, using selected passages. Students read and completed cloze tasks, and difficulty percentages were calculated for each achievement group.

Procedure

Following the Kemp model (Figure 1), the procedure comprised:

1. Needs analysis: review of the course syllabus, existing RPP, and common planning difficulties reported by lecturers and PSTs.
2. Design and development: drafting LKM and textbook chapters that embed performance tasks (KD analysis, indicator formulation, RPP preparation, method justification).
3. Expert validation: experts completed validation sheets; quantitative scores and qualitative comments were analyzed to revise format, language, and content.
4. Readability testing: the revised textbook was tested with six PSTs; difficulty indices were computed and used to refine wording and layout.
5. Limited implementation: the validated materials were used throughout one semester in the *Desain Pembelajaran Biologi* course. PSTs worked with LKM and textbook during regular sessions, produced lesson plans, and then completed the response questionnaires.

Data Analysis and Ethics

Data analysis was descriptive. For validation and questionnaires, mean scores and categories were calculated; inter-rater agreement indices were examined for validation sheets, and internal consistency was checked for questionnaires. For performance, frequencies and percentages of PSTs in each rubric level (poor–excellent) were computed per dimension. Readability results were summarized as difficulty percentages by achievement group. No inferential statistics were applied, as the design did not include a control group or pre–post comparison.

RESULTS AND DISCUSSION

This section presents the findings and discussion in four parts: (1) expert validation of the LKM and textbook, (2) readability testing of the textbook, (3) preservice science teachers' lesson-planning performance, and (4) student responses in terms of interest and motivation. The tables requested by the reviewers are embedded in the text, and the interpretation is kept descriptive and cautious, given the limited design of the study.

Validation of the performance-based materials

Expert validation involved science education specialists who evaluated the student worksheets (Lembar Kerja Mahasiswa, LKM) and the student textbook on format/presentation, language, and content. The results for the LKM are shown in Table 1. The experts rated the LKM as valid to highly valid on all aspects, with high reliability across raters. Format and content reached the maximum mean score, while language was slightly lower but still in the "Valid" range. This pattern suggests that structurally and substantively the worksheets are

acceptable for use in a science education course, although some fine-tuning of wording may still be warranted. The textbook validation results are presented in Table 2.

Table 1. Validation Results of LKM

Aspect	Mean Score	Reliability (%)	Category
Format	4.0	100	Highly Valid
Language	3.8	94.3	Valid
Content	4.0	100	Highly Valid
Average	3.93	> 94	Valid–Highly Valid

All validators agreed that the textbook is highly valid on presentation, language, and content. The perfect reliability values indicate strong consensus rather than a single enthusiastic opinion. These outcomes are comparable with other development studies in science education where modules receiving expert ratings around 80–90% are considered ready for implementation after minor revision (Bala & Setiawan, 2021; Darmastuti et al., 2025; Fattahillah et al., 2023).

Table 2. Validation Results of the Student Textbook

Aspect	Mean Score	Reliability (%)	Category
Presentation	4.0	100	Highly Valid
Language	4.0	100	Highly Valid
Content	4.0	100	Highly Valid
Average	4.0	100	Highly Valid

At the same time, expert validation alone does not guarantee that materials will function effectively for all groups of preservice teachers. Studies on STEM-integrated e-modules and context-based resources show that products with high expert scores may still need pedagogical adjustment when used with different cohorts or in new institutional contexts (Puspita et al., 2024; Ramadhani et al., 2022; Setiyanika et al., 2023). The present validation results therefore indicate that the LKM and textbook meet basic quality standards and are worth trying in classroom use, but they should not be treated as definitive or universally optimal resources.

Readability of the student textbook

Readability testing was conducted with six preservice science teachers representing high, medium, and low academic achievement. The results are summarized in Table 3.

Table 3. Readability Test Results of the Student Textbook

Student Ability Level	Number of Students	Range of Difficulty (%)	Average Difficulty (%)
High	2	0.0 – 5.2	2.6
Medium	2	2.5 – 8.4	5.5
Low	2	6.3 – 10.7	8.5
Overall	6	0.0 – 10.7	5.5

The difficulty percentages are low for all groups, with an overall average of 5.5%. Even students in the low-achievement group reported relatively modest difficulty. This suggests that, for this small sample, the language level and structure of the textbook are generally accessible. These findings are in line with studies where high readability values (often above 80% on their respective scales) are associated with better comprehension and more positive student responses to modules and e-learning materials (Fahrana et al., 2025; Fitriadi et al., 2025; Siswati, 2025).

However, the small number of participants limits the strength of any inference. Readability studies with larger and more diverse samples often reveal issues that are invisible in small groups (Darmastuti et al., 2025). Moreover, the test here focused on perceived difficulty rather than on objective comprehension measures. The results in Table 3 therefore indicate that there is no obvious linguistic barrier in the textbook for this cohort, but further cycles of testing would be needed before making stronger claims about readability across institutions or student populations.

The combination of high expert ratings in Table 2 and low difficulty scores in Table 3 is still informative. It suggests that the textbook is not only judged sound by experts but is also understandable for typical preservice science teachers, which is a necessary condition if it is to function as a scaffold for performance-based tasks in lesson planning.

Preservice science teachers' lesson-planning performance

The implementation of the performance-based materials in the Desain Pembelajaran Biologi course produced performance data on four aspects of lesson planning: analysis of basic competencies (KD), development of indicators, preparation of lesson plans (RPP), and selection of teaching methods. These results are presented in Table 4.

Table 4. Student Performance in Lesson Planning

Rated Aspect	Excellent (%)	Good (%)	Fair (%)	Poor (%)
Analysis of Basic Competencies (KD)	55	40	5	0
Development of Indicators	50	42	8	0
Preparation of Lesson Plans (RPP)	48	45	7	0
Selection of Teaching Methods	30	50	15	5
Overall Average	46	44	9	1

For KD analysis, indicator development, and RPP preparation, most students achieved ratings in the "Good" or "Excellent" categories, with very few classified as "Fair" and none as "Poor". This pattern suggests that the combination of textbook and LKM provided adequate scaffolding for preservice science teachers to handle the structural components of lesson planning. The tasks embedded in the materials guided them through identifying competencies, translating those into indicators, and assembling lesson plans with coherent objectives, content, and evaluation.

These findings are consistent with research showing that structured instructional frameworks and guided materials can support preservice teachers in organizing lesson components more coherently. Frameworks such as EIMA and similar model-based or inquiry-based structures have been shown to improve the quality of lesson plans by building on prior knowledge and emphasizing alignment between goals, activities, and assessment (Beyer & Davis, 2011; Lehan et al., 2024; Schwarz & Gwekwerere, 2006). The present data suggest that performance-based materials designed with a systematic model (such as Kemp) can play a comparable role in a science education context.

The results for method selection are notably weaker. Only 30% of students reached the "Excellent" category, and 20% were rated as "Fair" or "Poor". This echoes a well-documented difficulty in the teacher education literature: preservice teachers often understand multiple instructional methods in theory but struggle to choose and justify those methods in relation to specific content, student characteristics, and learning goals (Sondlo & Ramnarain, 2022; Tröbst et al., 2019). Many novice teachers fall back on teacher-centered approaches or familiar routines, even after exposure to inquiry-based and student-centered models (Alhamad, 2018; Chandran et al., 2022; Jao et al., 2018).

From this perspective, it is not surprising that method selection lags behind other planning components in Table 4. The LKM and textbook require students to choose methods

and strategies, but written materials alone may not provide enough experiential grounding for sophisticated pedagogical decisions. Research on mentoring and microteaching suggests that method-selection skills usually develop through cycles of planning, teaching, feedback, and reflection with strong support systems, rather than through text-based tasks alone (Amalia & Imperiani, 2013; Arshavskaya & Whitney, 2014; Shahat et al., 2023; Shi, 2020).

The pattern in Table 4 can therefore be read in a balanced way. On one hand, it indicates that the materials have some success in supporting foundational aspects of instructional design (KD, indicators, RPP structure). On the other hand, it shows that method selection remains a weak point that will likely require complementary interventions, such as structured microteaching, case-based discussions, or collaborative analysis of classroom video, rather than only further refinement of the written materials.

Student responses: interest and motivation

Student responses were examined through two sets of questionnaire items: interest (clarity, attractiveness, and perceived support for independent learning) and motivation (confidence, practicality, and perceived encouragement for active engagement). The interest results are summarized in Table 5.

Table 5. Student Interest Responses

Indicator of Interest	Mean Score	Category
Clarity of worksheets (LKM)	3.9	Good
Attractiveness of presentation	3.8	Good
Support for independent learning (textbook)	4.0	Good
Average	3.9	Good

Students generally agreed that the worksheets were clear and well structured and that the textbook supported independent learning. The “Good” category on all indicators suggests that the materials were acceptable and useful, even if not perceived as exceptionally attractive or innovative. Studies on contextualized and locally grounded materials show similar patterns: when preservice teachers judge materials as relevant and understandable, they are more willing to use them as models for their own planning (Lutfianto et al., 2020; Mahmudah et al., 2023; Setiyanika et al., 2023). This is also consistent with findings that collaborative design within the Merdeka Curriculum framework can strengthen preservice teachers’ interest in lesson planning tasks (Brillianandа et al., 2025). Motivational responses are presented in Table 6.

Table 6. Student Motivation Responses

Indicator of Motivation	Mean Score	Category
Confidence in preparing lesson plans (RPP)	4.3	Very Good
Practicality of teaching materials	4.1	Very Good
Encouragement for active engagement	3.9	Very Good
Average	4.1	Very Good

The means for motivation lie between 3.9 and 4.3 and fall in the “Very Good” category. The highest score appears on confidence in preparing RPP, suggesting that engaging with the performance-based materials contributed to a stronger sense of self-efficacy in lesson planning. Students also viewed the materials as practical and conducive to active participation.

These results align with studies where preservice teachers gain confidence and motivation through hands-on design activities, whether in metaverse-based environments, STEM-focused digital modules, or garden-based technology integration (Choi, 2024; Ingram et al., 2024; Ramadhani et al., 2022). Positive perceptions often arise when materials make explicit connections between theory and teaching practice and when students experience themselves as active designers rather than passive recipients (Badmus & Jita, 2024; Torres &

Vasconcelos, 2019). Emerging work on AI-supported lesson design also suggests that tools which reduce the mechanical workload of planning can free cognitive resources for higher-order pedagogical thinking, which in turn can enhance motivation (Asman et al., 2023; Weathers, 2025).

Again, these are self-reported perceptions from a single cohort, so they should not be over-interpreted. Perceived confidence does not automatically translate into high-quality performance across all planning dimensions, as the method-selection data in Table 4 already indicate. Nevertheless, it is difficult to ignore the combination of "Good" interest and "Very Good" motivation scores in Tables 5 and 6. If preservice teachers find the materials clear, practical, and confidence-boosting, they are more likely to engage seriously with the performance-based tasks they contain, which is a necessary condition for any longer-term impact.

Synthesis and limitations

Across the six tables, a consistent pattern emerges. The LKM and textbook are judged valid by experts (Tables 1 and 2) and are readable for a small sample of preservice science teachers (Table 3). In the implementation, most students achieve good to excellent performance on KD analysis, indicator development, and RPP structure, while method selection remains a notable weakness (Table 4). Students report good levels of interest and very good motivation, particularly in terms of confidence in preparing lesson plans and perceptions of the practicality of the materials (Tables 5 and 6).

These findings are broadly compatible with broader work on performance-based and STEM-oriented teaching materials in teacher education. Carefully designed modules and e-resources can support key aspects of lesson-planning competence, especially where tasks are explicit, sequenced, and linked to authentic curricular demands (Beyer & Davis, 2011; Menon & Devadas, 2019; Puspita et al., 2024; Ramadhani et al., 2022; Schwarz & Gwekwerere, 2006). At the same time, the persistent difficulty in selecting methods confirms that some dimensions of pedagogical reasoning are more resistant to change and likely require intensive, practice-based experiences, mentoring, and reflective support (Amalia & Imperiani, 2013; Shi, 2020; Sondlo & Ramnarain, 2022; Tröbst et al., 2019).

Several limitations remain central. The study uses a single cohort in one institution, with no control group and no pre–post comparison, so it cannot demonstrate causal improvement. The readability test involves only six students. The performance ratings and perception scales, though informed by expert input, have not yet been subjected to large-sample psychometric analysis. Given these constraints, the most defensible reading of the results is that the developed performance-based materials are valid, readable, and positively received, and that they appear to support some important components of lesson planning for preservice science teachers, while leaving method selection as an unresolved challenge for future course and program design.

CONCLUSION

This study developed and examined a set of performance-based teaching materials for the Desain Pembelajaran Biologi course, consisting of student worksheets and a textbook structured with the Kemp instructional design model. Expert judgment indicated that both products met good to very good standards of content, presentation, and language, while readability testing suggested that the textbook was accessible for preservice science teachers in this context. Classroom use showed that most students achieved good or excellent performance in analyzing competencies, developing indicators, and structuring lesson plans, although many still struggled to select and justify appropriate teaching methods. Student responses indicated that the materials were perceived as clear, practical, and supportive of confidence in preparing lesson plans. Given the single-cohort, single-institution design and the

absence of a control group, these findings are best interpreted as evidence of feasibility and promise rather than proof of effectiveness in improving lesson-planning competence.

RECOMMENDATIONS

Future work should extend the implementation of these materials to multiple cohorts and institutions, accompanied by more rigorous designs that include pre–post measures or comparison groups. Method selection needs explicit reinforcement through integrated microteaching, case analysis, and mentoring, rather than relying only on written tasks. The instruments used to assess lesson planning and student responses should be refined and subjected to broader psychometric testing. It would also be useful to adapt the materials to incorporate STEM integration, local contexts, and digital formats, so their relevance under the Merdeka Belajar Kampus Merdeka policy can be examined more systematically.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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Lalu Muktar		✓				✓	✓	✓	✓	✓	✓	✓		

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

REFERENCES

Abidin, Z., & Sabrun, S. (2019). Peningkatan Pedagogical Content Knowledge (Pck) Calon Guru Matematika Melalui Perancangan RPP Berkerangka Kerja Elpsa. *Jpin Jurnal Pendidik Indonesia*, *2*(2), 60–67. https://doi.org/10.47165/jpin.v2i2.78

Alhamad, R. (2018). Challenges and Induction Needs of Novice English as a Foreign Language Teachers in Saudi Arabia. *International Journal of Education and Literacy Studies*, *6*(1), 50. https://doi.org/10.7575/aiac.ijels.v.6n.1p.50

Amalia, L. L., & Imperiani, E. D. A. (2013). Mentor Coaching to Help Pre-Service Teachers in Designing an Effective Lesson Plan. *Indonesian Journal of Applied Linguistics*, *2*(2), 275. https://doi.org/10.17509/ijal.v2i2.171

Arshavskaya, E., & Whitney, A. E. (2014). Promoting Pre-Service Second Language (L2) Teacher Learning via Narrative: A Sociocultural Perspective. *Journal of Language Teaching and Research*, *5*(4). https://doi.org/10.4304/jltr.5.4.731-741

Asman, J., Poobalan, G., Mustapha, M., Talip, R., Padan, R., Kaliappan, S., Ali, S. A. S., & Aris, A. M. (2023). Factors Affecting Teacher Workload in Low-Enrollment Schools: A Survey of Sarawak State Schools, Malaysia. *International Journal of Academic Research in Progressive Education and Development*, *12*(4). https://doi.org/10.6007/ijarped/v12-i4/19541

Badmus, O. T., & Jita, L. C. (2024). Preservice Teachers' Level of Knowledge on Elements and Rationale for Nature of Science: Towards Advancing Quality Instruction. *International Journal of Cognitive Research in Science Engineering and Education*, *12*(1), 77–87. https://doi.org/10.23947/2334-8496-2024-12-1-77-87

Bakanay, Ç. D. (2023). Using the History of Science as a Tool for Teaching: Strengths and Weaknesses of Pre-Service Biology Teachers. *Ondokuz Mayis University Journal of Education Faculty*. https://doi.org/10.7822/omuefd.1316627

Bala, W. K., & Setiawan, D. C. (2021). Pengembangan Modul Berbasis Articulate Storyline Pada Materi Sistem Sirkulasi Darah Kelas XI. *Prosiding Seminar Nasional Ikip Budi Utomo*, *2*(01), 335–344. https://doi.org/10.33503/prosiding.v2i01.1450

Beyer, C. J., & Davis, E. A. (2011). Learning to Critique and Adapt Science Curriculum Materials: Examining the Development of Preservice Elementary Teachers' Pedagogical Content Knowledge. *Science Education*, *96*(1), 130–157. https://doi.org/10.1002/sce.20466

Brilliananda, C. C., Herwin, H., & Praheto, B. E. (2025). Preservice Teachers' Skill to Design Lesson Plans in the Merdeka Curriculum. *Anatolian Journal of Education*, *10*(1), 45–58. https://doi.org/10.29333/aje.2025.1014a

Canalita, E. E., & Jugar, R. R. (2025). Development and Evaluation of a Collaborative Lesson Planning Model for Science Teacher Internships. *International Journal of Learning Teaching and Educational Research*, *24*(6), 588–608. https://doi.org/10.26803/ijlter.24.6.27

Chai, C. S., Rahmawati, Y., & Jong, M. S. (2020). Indonesian Science, Mathematics, and Engineering Preservice Teachers' Experiences in STEM-TPACK Design-Based Learning. *Sustainability*, *12*(21), 9050. https://doi.org/10.3390/su12219050

Chandran, V. N., Intan Safinas Mohd Ariff Albakri, Shukor, S. S., Ismail, N., Tahir, M. H. M., Mokhtar, M. M., & Zulkepli, N. (2022). Malaysian English Language Novice Teachers' Challenges and Support During Initial Years of Teaching. *Studies in English Language and Education*, *9*(2), 443–461. https://doi.org/10.24815/siele.v9i2.22974

Choi, S. Y. (2024). A Case Study on the Promotion of Instructional Design Competencies Among Preservice Home Economics Teachers in Class Using the Metaverse. *Human Ecology Research*, *62*(1), 81–100. https://doi.org/10.6115/her.2024.007

Darmastuti, I., Zulfiani, & Mardiati, Y. (2025). Development of E-Modules Based on Project Based Learning on Virus Material to Improve Students' Creative Thinking. *Quagga Jurnal Pendidikan Dan Biologi*, *17*(1), 16–23. https://doi.org/10.25134/quagga.v17i1.340

Desti, D. (2025). Kesiapan Guru PAK Dalam Mengimplementasikan Kurikulum Merdeka Belajar Pada Kelas XI Di SMAN 1 Palangka Raya. *JRM*, *3*(1), 108–117. https://doi.org/10.69748/jrm.v3i1.265

Dewi, A. U. (2021). Curriculum Reform in the Decentralization of Education in Indonesia: Effect on Students' Achievements. *Jurnal Cakrawala Pendidikan*, *40*(1), 158–169. https://doi.org/10.21831/cp.v40i1.33821

Dewi, N. D. L., Darmayanti, V., & Arif, M. B. S. (2024). Kemampuan Calon Guru Sekolah Dasar Untuk Menciptakan Sumber Belajar Menggunakan Tpack. *Scholaria Jurnal Pendidikan Dan Kebudayaan*, *14*(2), 133–143. https://doi.org/10.24246/j.js.2024.v14.i2.p133-143

Drost, B. R., & Levine, A. C. (2015). An Analysis of Strategies for Teaching Standards-Based Lesson Plan Alignment to Preservice Teachers. *Journal of Education*, *195*(2), 37–47. https://doi.org/10.1177/002205741519500206

Fahrana, D. N., Berlian, L., & R. AHMAD ZAKY EL ISLAMI. (2025). Pengembangan E-Modul IPA Berbasis Question Prompt Scaffolding Tema Tekanan Hara Pada Si Hijau Untuk Menumbuhkan Kemampuan Argumentasi Siswa Kelas VIII. *Pendipa Journal of Science Education*, *9*(2), 507–516. https://doi.org/10.33369/pendipa.9.2.507-516

Faridah, S., Djatmika, E. T., & Utaya, S. (2020). Kompetensi Profesional Dan Pedagogik Guru Dalam Pengelolaan Pembelajaran Di Sekolah Dasar. *Jurnal Pendidikan Teori Penelitian Dan Pengembangan*, *5*(9), 1359. https://doi.org/10.17977/jptpp.v5i9.14059

Fattahillah, N., Sriyati, S., & Amprasto, A. (2023). Banyuwangi Custom Ritual Ethnobotany-Based Module Development on Biodiversity Materials to Train Plant Literacy and Problem-Solving Ability. *Bioedukasi*, *21*(1), 45. https://doi.org/10.19184/bioedu.v21i1.36980

Fitriadi, F., Slamet, St. Y., & Salimi, M. (2025). Design of Science E-Modules Based on Guided Inquiry to Improve Science Literacy Using Canva and Heyzine. *Multidisciplinar (Montevideo)*, *3*, 223. https://doi.org/10.62486/agmu2025223

Forbes, C. T., & Davis, E. A. (2010). Curriculum Design for Inquiry: Preservice Elementary Teachers' Mobilization and Adaptation of Science Curriculum Materials. *Journal of Research in Science Teaching*, *47*(7), 820–839. https://doi.org/10.1002/tea.20379

Großmann, L., & Krüger, D. (2023). Assessing the Quality of Science Teachers' Lesson plans: Evaluation and Application of a Novel Instrument. *Science Education*, *108*(1), 153–189. https://doi.org/10.1002/sce.21832

Hunaepi, H., & Suharta. (2024). Transforming Education in Indonesia: The Impact and Challenges of the Merdeka Belajar Curriculum. *Path of Science*, *10*(6), 5026–5039. https://doi.org/10.22178/pos.105-31

Ingram, E., Hill, P. W., Harshbarger, D., & Keshwani, J. (2024). Improving Elementary Pre-Service Teachers' Science Teaching Self-Efficacy Through Garden-Based Technology Integration. *Education Sciences*, *14*(1), 65. https://doi.org/10.3390/educsci14010065

Irawati, H., & Ma'rifah, D. R. (2022). Potret Keterampilan Penyusunan RPP Kurikulm 2013 Calon Guru Biologi. *Jurnal Ilmiah Profesi Pendidikan*, *7*(1), 47–52. https://doi.org/10.29303/jipp.v7i1.342

Jao, L., Wiseman, D., Kobiela, M., Gonsalves, A. J., & Savard, A. (2018). Practice-Based Pedagogy in Mathematics and Science Teaching Methods: Challenges and Adaptations in Context. *Canadian Journal of Science Mathematics and Technology Education*, *18*(2), 177–186. https://doi.org/10.1007/s42330-018-0009-0

Jufriadi, A., Huda, C., Aji, S. D., Pratiwi, H. Y., & Ayu, H. D. (2022). Analisis Keterampilan Abad 21 Melalui Implementasi Kurikulum Merdeka Belajar Kampus Merdeka. *Jurnal Pendidikan Dan Kebudayaan*, *7*(1), 39–53. https://doi.org/10.24832/jpnk.v7i1.2482

Kim, S. Y. (2012). Changes of Preservice Biology Teachers' Pedagogical Knowledge and Science Teaching Efficacy Belief Through Science Pedagogy Course. *Journal of the Korean Association for Science Education*, *32*(3), 467–476. https://doi.org/10.14697/jkase.2012.32.3.467

Kim, S. Y. (2016). Construction of Preservice Biology Teachers' NOS Pedagogical Content Knowledge Within Biology Teaching Context. *Journal of the Korean Association for Science Education*, *36*(1), 147–158. https://doi.org/10.14697/jkase.2016.36.1.0147

Lehan, A. A. D., Wonda, H., Koro, M., Lala, S. G. U., Ratu, K. T. R., Adoe, T. Y. N., Koten, G., Nauk, I. M., & Pada, D. A. (2024). Development of a Science Module Based on Local Culture of NTT to Enhance Critical Thinking Skills of Prospective Elementary School Teachers. *Jurnal Penelitian Pendidikan Ipa*, *10*(11), 9044–9053. https://doi.org/10.29303/jppipa.v10i11.8629

Lutfianto, Moch., Syarifuddin, A., Suhartono, S., & Atok, R. M. (2020). Development of Data Presentation Instructional Material Based on Local Wisdom for Preservice Teachers. *Journal of Physics Conference Series*, *1470*(1), 012035. https://doi.org/10.1088/1742-6596/1470/1/012035

Mahmudah, S., M, A. S., & Dewantara, D. (2023). Development of Physics Teaching Materials Containing Local Wisdom to Train Students Critical Thinking Skills. *Berkala Ilmiah Pendidikan Fisika*, *11*(1), 28. https://doi.org/10.20527/bipf.v11i1.14059

Menon, D., & Devadas, M. S. (2019). Engaging Preservice Secondary Science Teachers in an NGSS-Based Energy Lesson: A Nanoscience Context. *Journal of Chemical Education*, *96*(3), 528–534. https://doi.org/10.1021/acs.jchemed.8b00169

mohune, A. R., Arifin, A., & Razak, I. A. (2022). Pengelolaan Program Merdeka Belajar. *Student Journal of Educational Management*, 202–213. https://doi.org/10.37411/sjem.v2i2.1723

Nihayah, R. W., Dina, W. F., Wijayanti, D., & Asyah, A. N. (2023). How Does Granting Teacher Autonomy Influence Classroom Instruction? Lessons From Indonesia's Curriculum Reform Implementation. *Jurnal Penelitian Kebijakan Pendidikan*, *16*(1). https://doi.org/10.24832/jpkp.v16i1.768

Niswandia, A. Z., Supeno, S., Rahmawati, R., Putri, D. A., Sari, D. N. I., Tantri, A. K., Zahiro, I. H. R., Nurjihan, W., & Muliana, S. (2024). Implementasi Kampus Mengajar Dalam Program Merdeka Belajar Kampus Merdeka Sebagai Sarana Untuk Meningkatkan Kemampuan Numerasi Siswa. *Jurnal Pendidikan Mipa*, *14*(1), 19–25. https://doi.org/10.37630/jpm.v14i1.1450

Nuraeni, F., Putri, H. E., Hikmatunisa, N. P., Sari, R. P., Alindra, A. L., & Ravy, H. (2024). Examining Lesson Quality: An in-Depth Analysis of STEM-based Lesson Design Crafted by Preservice Elementary Teachers. *Journal of Innovation in Educational and Cultural Research*, *5*(2), 337–348. https://doi.org/10.46843/jiecr.v5i2.1369

Prayoga, A., Dian, D., & Anwar, A. M. (2020). Strategi Peningkatan Kompetensi Pedagogik Pendidik Dalam Penyusunan Rencana Program Pembelajaran. *Jurnal Manajemen Pendidikan Islam Al-Idarah*, *5*(1), 29–39. https://doi.org/10.54892/jmpialidarah.v5i1.63

Puspita, L., Abdurrahman, A., Jalmo, T., Maulina, D., Komarudin, K., Luthfi, N. F., & Rakhmawati, I. (2024). PBL-STEM Integrated Interactive E-Module in Improving Creative Thinking Skills and Collaboration Skills: Needs Analysis in Biology Education. *E3s Web of Conferences*, *482*, 04009. https://doi.org/10.1051/e3sconf/202448204009

Ramadhani, D., Kenedi, A. K., Rafli, M. F., & Handrianto, C. (2022). Advancement of STEM-Based Digital Module to Enhance HOTS of Prospective Elementary School Teachers. *Jurnal Pendidikan Progresif*, *12*(2), 981–993. https://doi.org/10.23960/jpp.v12.i2.202245

Revina, S., Pramana, R. P., Björk, C., & Suryadarma, D. (2023). Replacing the Old With the New: Long-Term Issues of Teacher Professional Development Reforms in Indonesia. *Asian Education and Development Studies*, *12*(4/5), 262–274. https://doi.org/10.1108/aeds-12-2022-0148

Schwarz, C. V., & Gwekwerere, Y. (2006). Using a Guided Inquiry and Modeling Instructional Framework (EIMA) to Support Preservice K-8 Science Teaching. *Science Education*, *91*(1), 158–186. https://doi.org/10.1002/sce.20177

Setiyanika, N., Ngabekti, S., & Parmin, P. (2023). Development of Local Potential-Based Ecosystem Modules in Grobogan Regency to Improve Students' Critical Thinking Ability. *Journal of Innovative Science Education*, *12*(2), 254–261. https://doi.org/10.15294/jise.v12i2.72482

Shahat, M. A., Al-Balushi, S. M., & Al-Amri, M. (2023). Measuring Preservice Science Teachers' Performance on Engineering Design Process Tasks: Implications for Fostering STEM Education. *Arab Gulf Journal of Scientific Research*, *42*(2), 259–279. https://doi.org/10.1108/agjsr-12-2022-0277

Shi, J. L. (2020). A Critical Analysis of the Assessment for Micro-Teaching Program for English Language Teachers in the Secondary Education in Mainland China. *Theory and Practice in Language Studies*, *10*(2), 168. https://doi.org/10.17507/tpls.1002.04

Siswati, B. H. (2025). Innovation of Web-Based Learning Modules: Improving Biology Understanding and Computational Thinking of High School Students. *International Journal of Applied Educational Research (Ijaer)*, *3*(2), 73–84. https://doi.org/10.59890/ijaer.v3i2.19

Sondlo, A., & Ramnarain, U. (2022). *Factors Influencing the Physical Sciences Pre-Service Teacher's Pedagogical Orientations in One of the Universities in South Africa*. 99–110. https://doi.org/10.36315/2022ead09

Torres, J., & Vasconcelos, C. (2019). Prospective Science Teachers' Views of Nature of Science: Data From an Intervention Programme. *Eurasia Journal of Mathematics Science and Technology Education*, *16*(1). https://doi.org/10.29333/ejmste/110783

Tröbst, S., Kleickmann, T., Depaepe, F., Heinze, A., & Kunter, M. (2019). Effects of Instruction on Pedagogical Content Knowledge About Fractions in Sixth-Grade Mathematics on Content Knowledge and Pedagogical Knowledge. *Unterrichtswissenschaft*, *47*(1), 79–97. https://doi.org/10.1007/s42010-019-00041-y

Weathers, A. (2025). The Role of Generative AI in Mathematics Instruction: Effects on Preservice Teachers' Lesson Planning and Attitudes. *Jtate*, *33*(3), 529–553. https://doi.org/10.70725/287565oescsc

Yulkifli, Y., Ningrum, M. V., & Indrasari, W. (2019). The Validity of Student Worksheet Using Inquiry-Based Learning Model With Science Process Skill Approach for Physics Learning of High School. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *5*(2), 155–162. https://doi.org/10.21009/1.05210

Zhang, R., Liu, X., Yang, Y., Tripp, J. N., & B. Jiang J.K. Lv W. Shao. (2017). Preservice Science Teachers' Instructional Design Competence: Characteristics and Correlations. *Eurasia Journal of Mathematics Science and Technology Education*, *14*(3). https://doi.org/10.12973/ejmste/81553