

Integrating WASAKA Local Wisdom Into Scientific Learning to Enhance Pre-Service Physics Teachers' Competence

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Article Info	Abstract
Article history: Received: February 5, 2026 Accepted: April 28, 2026 Published: May 1, 2026 Keywords: Academic competence Pre-service physics teachers Scientific approach WASAKA local wisdom This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License © 2026 Vidya Karya	Strengthening the academic competence of pre-service physics teachers requires instructional designs that not only emphasize scientific processes but also draw on local wisdom as a meaningful learning context. This study examined the effectiveness of integrating the scientific approach with WASAKA local wisdom in improving the academic competence of physics education students. A quantitative method with a pre-experimental design was employed during the second semester of the 2024/2025 academic year. The study participants consisted of 9 students in the limited trial and 21 students in the extensive trial. Academic competence was assessed using pretest–posttest essay questions, while students' responses were analyzed through an ARCS-based questionnaire. The results indicate a clear improvement in students' academic competence following the intervention. The gain scores were in the moderate category for both the limited trial ($g = 0.55$) and the extensive trial ($g = 0.43$), suggesting a meaningful increase in academic performance. Improvements were observed across all competence indicators, with relatively higher achievement in conceptual understanding and experimental design skills, whereas mathematical reasoning showed a more moderate increase. Student responses were highly positive across all ARCS dimensions, reflecting strong attention, relevance, confidence, and satisfaction with the learning experience. These findings confirm that integrating the scientific approach with WASAKA local wisdom offers a promising contextual learning strategy in physics teacher education, with further emphasis recommended on scaffolding to strengthen mathematical reasoning.
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INTRODUCTION

Physics teacher education carries a dual responsibility: developing strong mastery of physics concepts and theories while simultaneously preparing prospective teachers to communicate these ideas through learning practices grounded in scientific inquiry. This

responsibility requires the development of interconnected academic and scientific competencies, including conceptual understanding, scientific reasoning, the ability to design and conduct experiments, and the capacity to relate physics concepts to technology and everyday phenomena (Banda & Nzabahimana, 2021; Hakim et al., 2022; Liu & Sun, 2020). These competencies are also aligned with professional standards for physics teachers, highlighting the need for teacher education programs to design curricula and learning experiences that position the scientific process as the core of instruction so that graduates are ready to fulfill their professional roles in schools (Kotsis, 2024a; Mykolaiko, 2023; Sengul, 2024).

In practice, however, a gap remains between these expectations and the instructional realities commonly found in higher education. A growing body of research and review studies reports that physics learning is still predominantly lecturer-centered, laboratory activities often take the form of verification exercises, and instruction tends to prioritize procedural routines and memorization rather than conceptual understanding and scientific reasoning (Assem et al., 2023; Banda & Nzabahimana, 2021; Resbiantoro et al., 2022). Such conditions contribute to misconceptions and limited science process skills among prospective teachers, which may later be transferred and reproduced in their classroom teaching. Consequently, a shift toward learning methods that emphasize scientific activity, reasoning, and reflective engagement is necessary to reduce this mismatch (Jamil et al., 2024; Strat et al., 2024; Zahara et al., 2025).

One approach widely recommended to address this need is the scientific approach. This approach engages students in a structured sequence of scientific activities—such as observing, questioning, designing experiments, collecting data, reasoning, and communicating findings—thereby promoting more active and evidence-based learning (Hayat et al., 2024; Humaira et al., 2022). Evidence from meta-analyses and systematic reviews further suggests that inquiry-based/scientific learning can enhance cognitive learning outcomes and science process skills, particularly when supported by adequate guidance and well-designed instruction (Ananda & Usmeldi, 2023; Rikizaputra et al., 2021; Santosa et al., 2021). Nevertheless, the effectiveness of the scientific approach is strongly influenced by the quality of its implementation and the extent to which learning activities are connected to learners' real-life contexts. In other words, while the scientific approach is promising, it still requires contextual reinforcement to ensure that its activities are more meaningful and generate broader educational impact.

A contextual strategy with considerable potential is the integration of local wisdom into instructional design. Recent international and local studies indicate that linking science content with cultural contexts and local experiences can increase the relevance of learning, strengthen student engagement, and support a deeper understanding of scientific concepts (Arma, 2024; Dewi et al., 2021; Isa et al., 2022). In Indonesia, the development of learning modules and instructional models grounded in local wisdom has been reported to effectively foster students' scientific literacy, critical thinking, and scientific attitudes (Arrafi et al., 2023; Hikmawati et al., 2021; Lubis et al., 2022; Sabat et al., 2024), although much of the existing research still emphasizes affective outcomes or character development. Therefore, local wisdom should not be viewed merely as a cultural symbol; instead, it can serve as a pedagogical context that enriches scientific processes in science learning.

In the context of South Kalimantan, WASAKA local wisdom (*Waja Sampai Kaputing*) stands out as a cultural value system emphasizing hard work, resilience, perseverance, and consistency (Masniah et al., 2024; Maulana et al., 2024). These values closely align with the nature of scientific work in physics, which demands accuracy, patience, and sustained commitment to the inquiry process—particularly when students design experimental procedures, test ideas through data, and refine their understanding based on evidence. Several local studies have reported that integrating WASAKA into

learning can strengthen work-related character and learning motivation (Masniah et al., 2024; Sa'adah, 2024). However, most existing research has positioned WASAKA primarily as a means of reinforcing attitudes or character, while its contribution to measurable academic competence among prospective physics teachers—such as conceptual understanding, scientific reasoning, conceptual application, and experimental design skills—remains insufficiently explored through empirical investigation.

Addressing this gap is crucial because prospective teachers who lack strong academic competence may carry misconceptions and overly procedural thinking into school classrooms, which can ultimately affect the quality of physics teaching at the secondary level. At the same time, the scientific approach has been widely promoted as an effective pathway to strengthen conceptual understanding and scientific skills, yet its impact depends on instructional design quality and on how far scientific activities are enriched through contexts that are meaningful to learners. Therefore, systematic empirical evidence is needed to evaluate the effectiveness of a scientific learning design contextualized through local wisdom, particularly within the setting of physics teacher education.

Building on this framework, the present study aims to examine the effectiveness of a physics instructional design grounded in the scientific approach and integrated with WASAKA local wisdom in improving the academic competence of prospective physics teachers. Academic competence in this study refers to mastery of physics concepts and principles, mathematical and scientific reasoning ability, the capacity to apply physics concepts to technological and everyday-life contexts, and the skill to design simple physics experiments. The novelty of this study lies in the systematic integration of WASAKA values into each stage of the scientific approach. Thus, WASAKA is not positioned merely as an additional cultural context, but rather as a pedagogical framework intentionally embedded to support the development of prospective teachers' academic competence. In contrast to prior studies that typically examine the scientific approach or local wisdom separately and tend to focus on affective outcomes, this research provides empirical evidence on the impact of combining both elements on students' conceptual understanding, scientific reasoning, conceptual application skills, and experimental design competence in physics teacher education.

METHODS

This study employed a quantitative approach using a pre-experimental design to examine the effectiveness of a physics instructional design based on the scientific approach and integrated with WASAKA local wisdom in enhancing the academic competence of prospective physics teachers. A pre-experimental design was selected because this research constituted an effectiveness testing phase of an instructional development product; therefore, the intervention was implemented in a single group without a comparison group. Academic competence was measured through an initial competence test (pretest) and a final competence test (posttest) to capture changes in students' abilities after participating in the implemented learning program.

The study was conducted during the second semester of the 2024/2025 academic year in the Physics Education Program at a higher education institution in South Kalimantan, Indonesia. The participants were physics education students enrolled in courses during the semester and were positioned as prospective physics teachers. The research was carried out in two stages: the limited trial involving nine students and the extensive trial involving twenty-one students. All participants were first-year students taking the Basic Physics II course and were therefore considered to have sufficient academic readiness to engage in learning activities designed around the scientific approach.

The research procedure began with administering an initial competence test (pretest) to identify students' baseline academic competence prior to the intervention. Students then participated in physics learning activities designed according to the stages of the scientific

approach, including observing, questioning, collecting data through experimental activities, reasoning, and communicating learning outcomes. WASAKA's local wisdom values were consistently embedded across each learning stage to strengthen the contextual relevance and meaning of the scientific activities. After the entire instructional sequence was completed, a final competence test (posttest) was administered to measure students' academic competence following the learning intervention.

The primary research instrument was an achievement test consisting of six essay items. The test was used for both the pretest and posttest with identical indicators and measurement objectives, while employing different problem narratives to minimize test–retest effects. Both test forms were designed to be equivalent and aligned with the same academic competence indicators. The test was developed to assess five academic competencies of prospective physics teachers: (1) mastery of fundamental physics facts, concepts, principles, and theories; (2) the ability to formulate and apply mathematical reasoning to explain physical phenomena; (3) the ability to design simple physics experiments; (4) the ability to understand and explain physical phenomena and their applications in technology and everyday life; and (5) the ability to apply physics concepts in the context of designing simple experiments within the topic of dynamic electricity. Competencies related to direct experiment execution were not assessed through a performance-based test; however, these skills were practiced and observed throughout the learning process.

The construction of the test items was guided by the revised Bloom's taxonomy, with two questions targeting the *understanding* level and one question each addressing the levels of *applying*, *analyzing*, *evaluating*, and *creating*. With this distribution, the test was intended not only to assess students' conceptual mastery but also to capture higher-order thinking skills that are essential to the academic competence of prospective physics teachers.

In addition to the achievement test, a supporting instrument in the form of a student response questionnaire was administered to collect data on students' perceptions of physics learning based on the scientific approach integrated with WASAKA local wisdom. The questionnaire was developed using Keller's (2010) ARCS motivational model—Attention, Relevance, Confidence, and Satisfaction. This framework was employed to examine the extent to which the implemented learning design was able to attract students' attention, align with their learning needs and contexts, foster confidence in understanding the content, and provide satisfaction with both the learning process and its outcomes. The questionnaire was distributed after the completion of the entire instructional sequence, allowing students' responses to reflect their learning experiences in a comprehensive manner.

Test data were analyzed quantitatively by calculating students' pretest and posttest scores, followed by determining the gain score (Hake, 1998) to evaluate the effectiveness of the implemented learning design in improving students' academic competence. Meanwhile, data from the student response questionnaire were analyzed descriptively using percentage distributions to portray students' response tendencies across each ARCS dimension. These results served as supporting evidence in assessing the overall effectiveness of the learning design, particularly in terms of students' engagement, motivation, and perceptions of physics learning based on the scientific approach integrated with WASAKA local wisdom.

RESULTS AND DISCUSSION

This section presents the findings related to the academic competence attainment of prospective physics teachers following the implementation of a physics instructional design based on the scientific approach integrated with WASAKA local wisdom. The results are reported progressively, beginning with students' learning outcomes across academic competence indicators in the limited trial, followed by an analysis of gain scores as a

measure of instructional effectiveness. The same reporting structure is then applied to the extensive trial to provide a more comprehensive picture of the findings. Finally, students' responses and perceptions of the implemented learning design are described using the ARCS dimensions.

Results of the Limited Trial

Students' learning outcomes in the limited trial, based on each academic competence indicator, are presented in Figure 1.

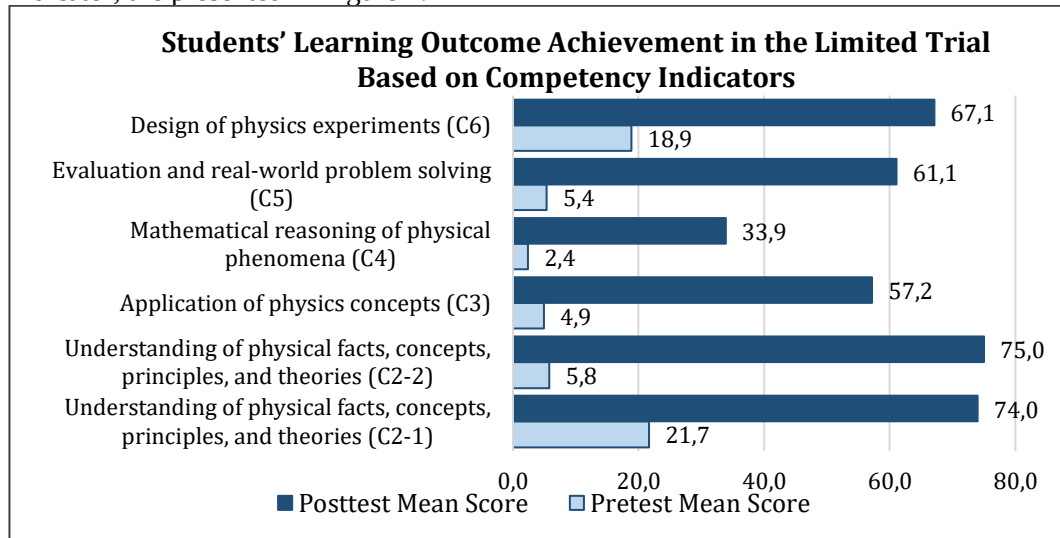


Figure 1 Students' learning outcome achievement in the limited trial based on competency indicators

Overall, Figure 1 indicates improvements in students' learning outcomes across all academic competence indicators after the implementation of the learning intervention. The average posttest scores for each indicator were substantially higher than the corresponding pretest scores, suggesting a consistent enhancement of students' academic competence. More pronounced gains were observed in the indicators of conceptual understanding of fundamental physics (C2) and the ability to design physics experiments (C6), where the mean posttest scores increased markedly, reaching more than two-thirds of the maximum score.

In contrast, the indicator of mathematical reasoning in relation to physical phenomena (C4) showed a more moderate improvement compared with the other indicators, although a clear difference between the initial and final scores was still evident. The range of minimum and maximum posttest scores also suggests variation in mastery levels among students; nevertheless, the overall direction of change remained positive across all measured indicators.

To examine the effectiveness of the implemented learning design more comprehensively, gain scores were calculated based on students' pretest and posttest results in the limited trial. A summary of the gain score calculations is presented in Table 1.

Table 1 Descriptive statistics of the limited trial results

Statistical Measure	Pretest	Posttest
Mean	10	59.7
Standard Deviation	3	15
Maximum Score	13.7	83.5
Minimum Score	6.3	40.1
Gain Score (g)	0.55 (moderate)	

The gain score calculation yielded a value of 0.55, which falls within the moderate category. This finding suggests that physics learning based on the scientific approach integrated with WASAKA local wisdom was effective in improving students' academic competence in the limited trial. The marked increase in the mean posttest score compared with the pretest score indicates that the implemented learning design generated meaningful learning gains, although some variation in achievement across individual students remained evident.

Results of the Extensive Trial

Students' learning outcomes in the extensive trial, based on the academic competence indicators, are presented in Figure 2.

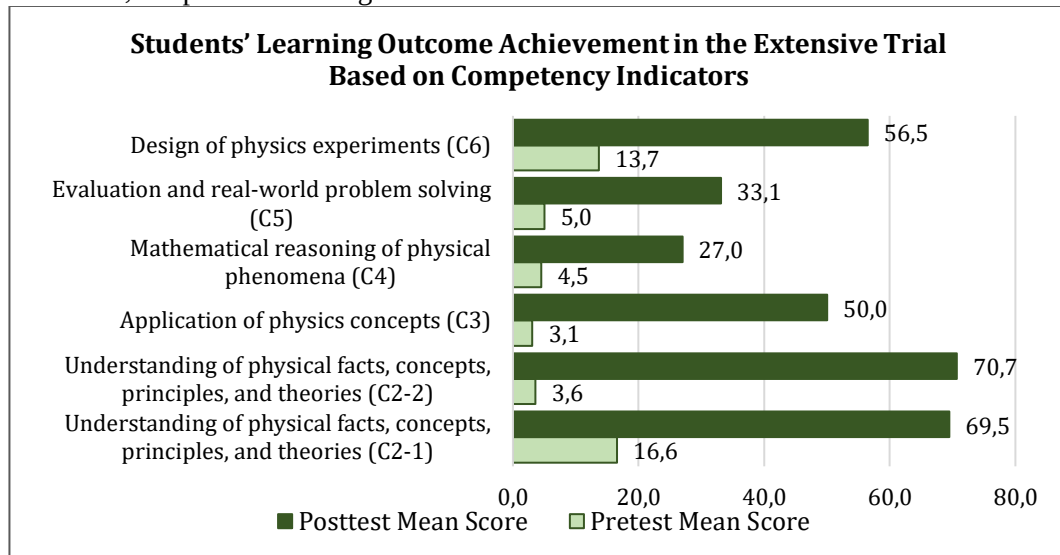


Figure 2 Students' learning outcome achievement in the extensive trial based on competency indicators

The results from the extensive trial revealed a pattern consistent with the limited trial. All academic competence indicators showed an increase in mean scores from the pretest to the posttest. Steady improvements were particularly evident in conceptual understanding (C2) and physics experiment design (C6), indicating that the instructional design remained effective when implemented with a larger number of participants.

Nevertheless, gains in mathematical reasoning (C4) and real-world problem evaluation (C5) were relatively lower than those observed in other indicators. This was reflected in posttest mean scores that remained at a moderate level, despite clear improvements from the baseline condition. The relatively wide range between the maximum and minimum scores suggests heterogeneous academic competence among students in the extensive trial.

The effectiveness of the learning implementation in the extensive trial was further examined using gain scores, as summarized in Table 2.

Table 2 Descriptive statistics of the extensive trial results

Statistical Measure	Pretest	Posttest
Mean	8.0	47.5
Standard Deviation	3.8	18.8
Maximum Score	14.9	91.6
Minimum Score	2.7	17.4
Gain Score (g)	0.43 (moderate)	

A gain score of 0.43 indicates that the effectiveness of the learning intervention in the extensive trial falls within the moderate category. Although this gain score is lower than that obtained in the limited trial, the result still suggests a meaningful improvement in students' academic competence after the implementation of the instructional design. The difference in gain values between the limited and extensive trials reflects the learning dynamics within a more heterogeneous group, yet it does not alter the overall trend that the implemented learning approach contributed positively to the academic achievement of prospective physics teachers.

Students' Responses to the Learning Design

Students' responses to the implementation of the physics instructional design based on the scientific approach integrated with WASAKA local wisdom were analyzed using a questionnaire grounded in the ARCS model (Attention, Relevance, Confidence, and Satisfaction). The response results are reported separately for the limited trial and the extensive trial in order to examine the consistency of students' perceptions across different scales of implementation.

Students' responses in the limited trial, categorized by ARCS dimensions, are presented in Figure 3.

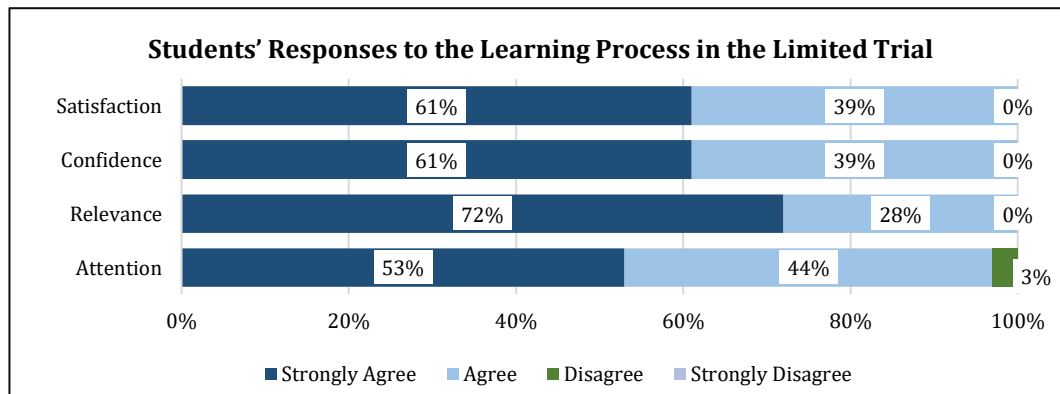


Figure 3 Students' responses to the learning process in the limited trial based on the arcs aspects

Overall, the results presented in Figure 3 show that students' responses to the learning intervention fell into the highly positive category. Almost all students selected "agree" and "strongly agree" across the four ARCS dimensions. The relevance dimension achieved the highest level of agreement, with all respondents indicating agreement or strong agreement, suggesting that the learning experience was perceived as strongly connected to students' learning needs and contexts.

The attention, confidence, and satisfaction dimensions also demonstrated consistently positive trends, with responses dominated by "strongly agree" and "agree." Although a small proportion of students reported "disagree" responses in the attention dimension, this percentage was very limited and did not affect the overall positive pattern of students' perceptions toward the implemented learning design.

Furthermore, students' responses in the extensive trial, based on the ARCS dimensions, are presented in Figure 4.

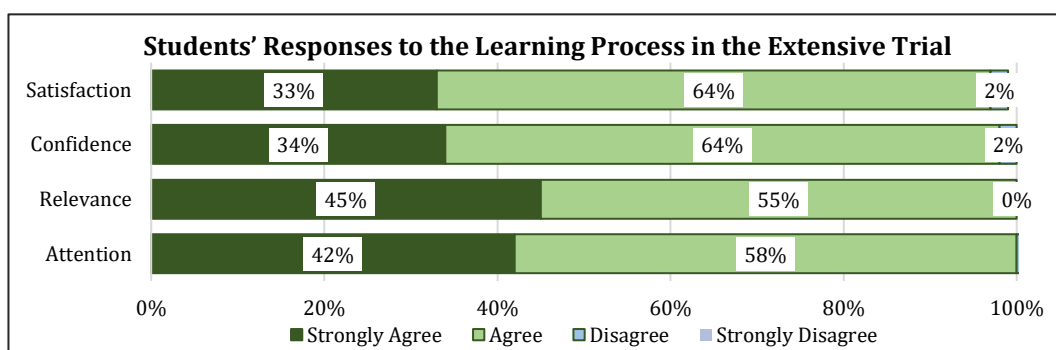


Figure 4 Students' responses to the learning process in the extensive trial based on the ARCS aspects

Based on Figure 4, students' responses in the extensive trial also demonstrate positive tendencies across all ARCS dimensions. Most students selected "agree" and "strongly agree" toward the implemented learning design, although the proportion of "strongly agree" responses was relatively lower than in the limited trial. The attention and relevance dimensions continued to show complete agreement, with no "strongly disagree" responses, indicating that the learning intervention was able to sustain students' attention and was perceived as relevant even when implemented in a larger and more heterogeneous group.

For the confidence and satisfaction dimensions, a small percentage of "disagree" responses was still observed. However, this proportion remained limited and did not alter the overall trend that the majority of students felt reasonably confident and satisfied with the learning experience. Differences in response distributions between the limited trial and the extensive trial suggest some variation in students' perceptions as the number of participants increased; nevertheless, overall student responses remained within a positive range.

The findings from the limited trial and the extensive trial reveal a consistent pattern of improvement in students' academic competence following the implementation of the scientific-approach-based instructional design integrated with WASAKA local wisdom. The gain scores obtained in the limited trial (0.55; moderate category) and the extensive trial (0.43; moderate category) indicate meaningful learning effects. From a theoretical perspective, this outcome can be explained by the nature of the scientific approach, which engages students in a systematic sequence of scientific activities—observing phenomena, formulating questions, designing and conducting experiments, reasoning from data, and communicating findings—thereby supporting deeper reconstruction of conceptual understanding (Hayat, 2024; Humaira et al., 2022; Pulungan et al., 2021; Sutiani et al., 2021). This finding is also in line with constructivist learning theory (Almulla, 2023; Mishra, 2023), which posits that knowledge is actively constructed through engagement with phenomena and reflective inquiry processes. Nevertheless, prior studies emphasize that the effectiveness of inquiry-based/scientific learning is not automatic; rather, it is shaped by instructional design quality, facilitation support, and learners' readiness to engage in cognitively demanding activities that require higher-order thinking (Sam, 2024).

The relatively stronger gains observed in the indicators of mastery of fundamental physics concepts and the ability to design experiments suggest that learning experiences grounded in experimentation and authentic problem solving play a key role in strengthening students' academic competence. Within scientific learning, theoretical concepts are not treated as isolated formulas; instead, they are linked to observable phenomena and supported through empirical evidence. This pattern aligns with previous research reporting that engagement in experiments and data-driven discussions can enhance conceptual stability and experimental design skills among science education students (Arma, 2024; Dewi et al., 2021; Isa et al., 2022; Kotsis, 2024b; Maharani & Muliati, 2025). Similar

findings have been reported in prior studies, where students exposed to experiment-based learning demonstrated stronger conceptual retention and application skills compared to more traditional instructional approaches (Corral & Carpenter, 2025; U-senyang, 2024). In addition, development-oriented studies have suggested that connecting science content with local wisdom contexts can increase perceived relevance and learning motivation, which may subsequently support students' engagement in both practical and conceptual activities (Khoiriyah et al., 2021; Lestari et al., 2024).

In contrast, the mathematical reasoning indicator (C4) showed a more moderate improvement than the other indicators. This finding is consistent with research in physics and mathematics education suggesting that mathematical reasoning often requires more targeted pedagogical scaffolding—such as graduated practice, the use of multiple representations, and metacognitive support—to achieve more substantial gains, particularly within heterogeneous student groups (Alanazi et al., 2024; Munfaridah et al., 2021; Pasigon, 2024; Yana et al., 2023). Accordingly, the present results indicate that while the scientific approach is effective as an overarching instructional framework, additional strategies are still needed to optimize the development of mathematical competence among prospective physics teachers.

The difference in gain scores between the limited trial and the extensive trial also offers important insights regarding the implementation of the instructional design. The reduction in the average gain when the number of participants increased ($0.55 \rightarrow 0.43$) is commonly reported in development-oriented studies, as small-scale trials often allow stronger instructional control and more intensive facilitation. When implemented with larger and more diverse cohorts, variation in students' initial readiness and classroom dynamics may reduce the overall average effectiveness. Therefore, this difference does not negate the effectiveness of the learning design; rather, it suggests that broader implementation requires additional support strategies, such as differentiated instruction, strengthened facilitation, or enrichment and remedial schemes (Sam, 2024).

The integration of WASAKA local wisdom into scientific learning provides contextual and affective reinforcement that enriches students' learning experiences. Within instruction, local wisdom can function as a bridge that helps students connect scientific concepts with values, everyday experiences, and cultural identities that are familiar to them. Studies have shown that science learning linked to local cultural contexts tends to be more meaningful and relevant, thereby supporting deeper conceptual sense-making (Arma, 2024; Dewi et al., 2021; Isa et al., 2022). WASAKA values such as perseverance, consistency, and an unwavering spirit also resonate with the nature of scientific work in physics, which requires sustained effort and resilience. When these values are embedded across the stages of scientific learning, students may engage more seriously and reflectively in the learning process.

The overall positive pattern of student responses in the attention and relevance dimensions further supports the view that the learning design was perceived as engaging and closely aligned with students' needs and contexts as prospective physics teachers. Motivation literature highlights that perceived relevance and personal value connection can strengthen both cognitive and affective engagement and sustain learning effort over time. This is consistent with motivational theories—particularly within the frameworks of the ARCS model and expectancy-value theory—which posit that perceived relevance, or utility value, functions as a central determinant in initiating and sustaining learners' cognitive engagement over time (Jansen et al., 2022; Keller, 2010). In line with this, recent studies report that science learning grounded in local contexts and cultural values can enhance students' engagement and participation (Arrafi et al., 2023; Sabat et al., 2024). Positive responses in the confidence and satisfaction dimensions also suggest that students experienced learning that supported a sense of competence and meaningful achievement. In inquiry-based learning, academic confidence is particularly important because students

must navigate uncertainty, confront potential errors, and revise their understanding when necessary. Research indicates that inquiry learning accompanied by appropriate guidance and constructive feedback can foster learners' confidence and satisfaction, especially in science education and teacher education contexts (Fang et al., 2024; Mamun, 2022).

In the context of local wisdom integration, previous studies in Indonesia have generally highlighted its influence on affective outcomes, particularly in strengthening character and scientific attitudes (Hikmawati et al., 2021; Lubis et al., 2022). The present study extends this line of work by demonstrating that integrating WASAKA local wisdom into the scientific approach may also contribute to improving the academic competence of prospective physics teachers. Accordingly, the main contribution of this study lies in combining two approaches that have often been examined separately—the scientific approach and local wisdom—into a single contextual and relevant instructional design for physics teacher education.

From a pedagogical perspective, these findings imply that physics learning in teacher education programs should be designed not only to emphasize content mastery but also to strengthen scientific processes and value-based contexts that foster meaningful learning. The scientific approach can serve as the primary instructional framework, while local wisdom such as WASAKA can be utilized to enhance learning relevance and student motivation. Moreover, to optimize improvement in specific competencies—particularly mathematical reasoning—scientific learning should be complemented with more focused and sustained scaffolding. Through such an approach, physics teacher education programs are expected to produce graduates who not only master core concepts but also demonstrate stronger academic and pedagogical readiness.

Although the findings of this study demonstrate positive outcomes and pedagogical relevance, several limitations should be acknowledged. The study employed a pre-experimental design without a comparison group; therefore, conclusions regarding the effectiveness of the learning intervention must be interpreted with caution and cannot be fully attributed to causal relationships. In addition, the relatively small number of participants and their recruitment from a single institution limit the diversity of student characteristics and learning contexts represented in the study. The assessment of experimental competence also focused primarily on students' ability to design experiments, while hands-on experimental skills were not directly evaluated through performance-based instruments. These limitations highlight opportunities for future research to employ more rigorous experimental designs, involve larger and more diverse samples, and develop performance assessment tools in order to obtain a more comprehensive picture of the academic competence of prospective physics teachers.

CONCLUSION

The physics instructional design based on the scientific approach integrated with WASAKA local wisdom was effective in improving the academic competence of prospective physics teachers. This improvement was reflected in students' learning outcomes and moderate gain scores in both the limited trial and the extensive trial, indicating meaningful changes in academic performance following the implementation of the learning design. The integration of WASAKA served as a contextual enhancer that increased the relevance, engagement, and meaningfulness of scientific learning activities. As a result, the learning intervention not only supported students' conceptual mastery and academic competence but also enriched their overall learning experience. These findings confirm that local wisdom, when systematically embedded within the scientific approach, can function as a pedagogical framework that supports the development of academic competence among prospective physics teachers.

Nevertheless, this study is subject to several limitations, including the use of a pre-experimental design without a comparison group, a relatively small number of participants,

and the assessment of experimental skills that did not incorporate direct performance-based evaluation. Accordingly, it is recommended that scientific learning approaches grounded in local wisdom—particularly WASAKA—be considered as alternative contextual instructional designs in physics teacher education programs and be further examined using more rigorous experimental designs and across more diverse educational contexts. Future instructional development should also place greater emphasis on strengthening mathematical reasoning through more targeted scaffolding in order to optimize gains in students' academic competence.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could have influenced the results or the research process.

AUTHOR CONTRIBUTION STATEMENT

AbS, AgS, APP, and YR made substantial contributions to this study and to the preparation of the manuscript, including research planning and implementation and data analysis and interpretation, as well as drafting and refining the paper. All authors have read, reviewed, and approved the final version of the manuscript.

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AI DISCLOSURE STATEMENT

The authors used ChatGPT during the manuscript preparation process for translation and language refinement purposes. After using the tool, the authors thoroughly reviewed and edited the entire manuscript and take full responsibility for the substance and accuracy of the work. All research design, data collection, data analysis, and conclusion drawing were conducted entirely by the authors without the assistance of artificial intelligence.

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