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ANALYSIS OF THE NALO (NEEDS ANALYSIS, LEARNING, AND OUTPUT) EVALUATION FRAMEWORK FOR SENIOR HIGH SCHOOL PHYSICS LEARNING

Ryka Kaswati[1], Riyadi[2], Yetti Supriyati[3]
[1,2,3] Universitas Negeri Jakarta, Jakarta, Indonesia
Email: rykakaswati852@gmail.com[1], riyadi@unj.ac.id[2], yetti.supriyati@unj.ac.id[3]

Abstract:
The complexity of Physics learning in senior high schools requires an evaluation framework that not only measures learning outcomes but also identifies students' learning needs and the quality of instructional implementation. Existing evaluation models, such as CIPP and Hammond, have not comprehensively integrated these dimensions within a Physics-specific evaluation framework. This study aimed to develop the NALO Evaluation Model through a Systematic Literature Review. Relevant studies were identified from reputable international databases and analyzed using thematic synthesis to construct the conceptual dimensions and indicators of the proposed model. The findings revealed three interconnected evaluation components. The Needs Analysis component emphasizes diagnosing students' prior knowledge, misconceptions, cognitive and affective readiness, motivation, and learning context as the foundation for instructional planning. The Learning component evaluates teacher readiness, instructional planning, learning resources, teaching strategies, classroom interaction, formative assessment, and instructional organization to ensure effective implementation. The Output component extends evaluation beyond academic achievement to include conceptual understanding, scientific reasoning, science process skills, scientific attitudes, and twenty-first-century competencies comprising critical thinking, creativity, collaboration, and communication. The novelty of the NALO model lies in integrating these three components into a diagnostic and continuous evaluation framework that explains not only learning outcomes but also the underlying factors contributing to instructional effectiveness. The proposed model provides a comprehensive reference for evaluating and improving the quality of Physics learning in senior high schools.

Keywords: *Physics learning evaluation; NALO evaluation model; needs analysis; learning process; learning outcomes; systematic literature review; senior high school.*

INTRODUCTION

Education plays a crucial role in developing human resources capable of addressing the challenges of the twenty-first century. Physics is one of the core subjects that contributes to the development of critical thinking, analytical reasoning, and problem-solving skills. However, findings from both international and national assessments indicate that Physics learning achievement in Indonesia remains relatively low. The results of the Programme for International Student Assessment (PISA) 2022 revealed that Indonesian students' scientific literacy performance was below the OECD average, while the Academic Competency Test (Tes Kompetensi Akademik/TKA) 2025 also showed that the average achievement in Physics was lower than that of several other subjects. These findings highlight the need for continuous efforts to improve the quality of Physics instruction.

The relatively low achievement in Physics learning is influenced by multiple factors, including differences in students' prior knowledge, learning motivation, teacher readiness, instructional strategies, and the availability of learning resources and instructional media. Existing evaluation practices tend to emphasize summative assessment and learning outcomes, providing limited information about students' learning needs, the quality of instructional implementation, and the relationship between these factors and learning achievement. Consequently, a more comprehensive evaluation framework is required to support continuous improvement in Physics instruction.

Several evaluation models, including the Context, Input, Process, Product (CIPP) model, the Hammond Model, the Kirkpatrick Model, and the Stake Countenance Model, have been widely applied in educational program evaluation. Nevertheless, these models do not specifically integrate students' learning needs, instructional implementation, and learning outcomes into a single evaluation framework. Therefore, the Needs Analysis, Learning, and Output (NALO)framework is proposed as a more comprehensive alternative by connecting students' learning needs before instruction, the quality of the learning process, and the resulting learning outcomes within an integrated evaluation system. Based on this background, the present study employed a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify, analyze, and synthesize previous studies related to the Needs Analysis, Learning, and Output (NALO) components in senior high school Physics education. This study aims to provide a comprehensive understanding of the implementation of the NALO framework while identifying research gaps that can serve as a foundation for developing a more comprehensive evaluation model for Physics learning.

The research questions addressed in this study are as follows:

RQ1: How have the Needs Analysis components been implemented in senior high school Physics learning based on recent empirical studies?

RQ2: How has the Learning component been implemented in senior high school Physics learning based on the synthesis of previous research?

RQ3: How have the Output components been evaluated in senior high school Physics learning according to recent research findings?

RESEARCH METHODS

This study employed a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The SLR approach was selected because it enables researchers to systematically identify, screen, evaluate, and synthesize existing evidence in a transparent and rigorous manner, thereby providing comprehensive conclusions regarding the Needs Analysis, Learning, and Output (NALO) components in senior high school Physics education. The review process consisted of four stages in accordance with the PRISMA framework: identification, screening, eligibility, and inclusion. During the identification stage, relevant studies were retrieved from several reputable databases, including Scopus, ScienceDirect, SpringerLink, ERIC, and Google Scholar. The search strategy employed combinations of the following keywords: "Needs Analysis" AND "Physics Learning", "Learning Evaluation"

AND Physics, "Learning Outcomes" AND "Physics Education", "Physics Education", "Program Evaluation", and "Senior High School Physics". To ensure the relevance and currency of the evidence, only studies published between 2020 and 2025 were considered.

During the screening stage, duplicate records were removed, followed by an initial selection based on article titles, abstracts, and keywords. Subsequently, the eligibility stage involved a full-text review using predefined inclusion and exclusion criteria. The inclusion criteria were: (1) empirical studies examining Needs Analysis, Learning, or Outputin senior high school Physics education; (2) articles published in accredited national journals or reputable international journals; (3) availability of full-text articles; and (4) studies employing clearly described research methodologies. The exclusion criteria included studies unrelated to Physics education, non-academic conference proceedings, editorials, and publications lacking sufficient research data. The selected studies were analyzed using content analysis and thematic analysis. The extracted data included publication characteristics (authors, year, country, and research methodology), study characteristics, findings related to the Needs Analysis, Learning, and Output components, and their implications for Physics education. This methodological approach is consistent with the objective of the study, which is to synthesize scientific evidence regarding the Needs Analysis, Learning, and Output (NALO) components in senior high school Physics education. The review provides a comprehensive understanding of the implementation of the NALO framework, identifies prevailing research trends, and highlights its implications for improving the quality of Physics teaching and learning.

RESULTS AND DISCUSSION

Needs Analysis Component in Senior High School Physics Learning

The findings of the Systematic Literature Review (SLR) indicate that the quality of Physics learning in senior high schools is influenced by multiple interrelated factors, including student characteristics, teacher competence, instructional design, learning resources, and the evaluation system. The synthesis of previous studies demonstrates that learning needs in Physics extend beyond academic achievement to encompass the readiness of all instructional components that support meaningful learning. From the teacher perspective, Physics instruction remains predominantly teacher-centered, limiting students' opportunities to actively explore concepts, engage in discussions, ask questions, and construct scientific knowledge independently (Wu et al., 2024; Supratman et al., 2023). Furthermore, the limited contextualization of learning makes it difficult for students to relate Physics concepts to real-life phenomena, thereby reducing conceptual understanding. Many teachers also report insufficient professional development in innovative and differentiated instructional approaches, indicating that pedagogical readiness remains a significant challenge (Bouchée et al., 2023; Smith et al., 2022). These findings are consistent with Magiera and Heathcock (2020), who emphasized that designing instruction capable of accommodating diverse student characteristics requires substantial time, resources, and professional expertise. From the perspective of instructional materials and learning resources, the review reveals that Physics learning is constrained by the limited availability of adaptive teaching materials that accommodate students' diverse abilities, interests, and learning preferences (Deta et al., 2024; Liou et al., 2023). Many schools also lack adequate laboratory facilities and access to educational technologies, such as virtual simulations, learning management systems, and interactive software, which are essential for visualizing abstract Physics concepts (Pramana et al., 2021; Langelaan et al., 2024; Kim, 2024). Considering that Physics concepts are inherently abstract, mathematical, and hierarchically structured, effective learning requires multiple representations, practical investigations, and visualizations to facilitate gradual conceptual development (Park, 2022; Ngoc, 2024). Consequently, the availability of diverse instructional media constitutes an essential aspect of students' learning needs.

The literature further highlights considerable variation among students in terms of prior knowledge, learning motivation, interest in Physics, self-efficacy, and cognitive readiness (Settlage, 2020; Yu et al., 2022; J et al., 2020). Such diversity requires teachers to obtain diagnostic information before instruction begins to ensure that learning strategies, instructional materials, and assessment methods are appropriately aligned with students' characteristics. Without systematic identification of learning needs, instruction tends to adopt a uniform approach that fails to address differences in students' abilities and learning readiness. The review also indicates that current evaluation practices in Physics education remain largely focused on measuring final learning outcomes rather than examining the learning process itself (Rahmawati, 2023). Predominantly summative evaluation provides limited diagnostic information regarding the factors contributing to students' learning difficulties. Effective evaluation should not only assess learning achievement but also identify students' learning needs, monitor instructional implementation, and provide continuous feedback for instructional improvement (Strielkowski et al., 2025). Accordingly, previous studies recommend formative, participatory, and improvement-oriented evaluation approaches to enhance the quality of Physics instruction (Zhang & Chen, 2022; Lee et al., 2023).

These findings collectively demonstrate that Needs Analysis constitutes the fundamental stage preceding both instruction and evaluation. Unlike conventional evaluation models that typically begin after program implementation, the synthesized literature emphasizes that identifying students' initial conditions and the readiness of the learning environment is critical for successful Physics instruction. The review indicates that students' learning needs encompass not only cognitive aspects, such as prior knowledge and misconceptions, but also affective dimensions, including motivation, learning interest, self-efficacy, and environmental support. Therefore, the Needs Analysis component of the NALO model is designed to comprehensively identify the gap between students' existing conditions and expected competencies, thereby providing a foundation for designing more adaptive and responsive instructional strategies. The literature synthesis further demonstrates that established evaluation models, including the Context, Input, Process, Product (CIPP) model, have made significant contributions to educational program evaluation by examining contextual factors, resources, implementation processes, and learning outcomes (Dizon, 2023; Pertiwi et al., 2021). Nevertheless, these models do not explicitly position students' learning needs assessment as an independent evaluation component before instruction begins. The SLR findings reveal a clear need for an evaluation component specifically designed to assess the readiness of students, teachers, learning environments, and supporting instructional factors. Accordingly, the Needs Analysis component of the NALO model was developed as a baseline evaluation that provides comprehensive diagnostic information regarding the initial learning conditions, thereby supporting more informed decisions during the Learning and Output evaluation stages.

Rather than serving merely as an administrative procedure, Needs

Analysis functions as the foundation for evidence-based, adaptive, and effective Physics instruction. This component represents the primary innovation of the NALO Evaluation Model by positioning students' learning needs as the starting point for instructional planning, implementation, and comprehensive evaluation of learning outcomes.

Implementation of the Learning Component in Physics Learning at Senior High Schools

The findings indicate that the success of physics learning is determined not only by identifying students' learning needs but also by the quality of learning implementation that effectively responds to those needs. The synthesis of previous studies demonstrates that the Learning component serves as the bridge between students' initial needs and the achievement of learning outcomes. Consequently, the quality of instructional implementation becomes the primary determinant of the effectiveness of physics learning programs at the senior high school level. Numerous studies consistently identify teacher readiness as the most influential factor in successful physics instruction. Teachers are expected not only to possess strong content knowledge but also pedagogical competence in selecting instructional strategies that align with the characteristics of physics concepts and students' learning needs. The reviewed literature indicates that teachers who integrate inquiry-based learning, problem-based learning, experimental activities, and digital technologies achieve higher levels of student engagement than those who continue to rely on teacher-centered approaches (Wu et al., 2024; Supratman et al., 2023). Conversely, inadequate pedagogical competence, limited professional development opportunities, and insufficient readiness to integrate educational technology remain persistent challenges in physics education (Bouchée et al., 2023; Smith et al., 2022).

Beyond teacher readiness, the synthesis reveals that instructional program readiness is another essential prerequisite for effective implementation. Learning programs should be supported by comprehensive instructional resources, including teaching modules, clearly defined learning objectives, diagnostic and formative assessments, instructional media, and well-designed laboratory activities. Careful instructional planning enables teachers to adapt teaching strategies to students' diverse learning needs, resulting in more meaningful and responsive learning experiences (Magiera & Heathcock, 2020). In contrast, inadequate instructional resources and poor alignment among learning objectives, teaching methods, and assessment practices frequently reduce instructional effectiveness.

The implementation of physics instruction is also strongly influenced by the availability of supporting resources. The reviewed studies demonstrate that laboratories, experimental equipment, visual media, virtual simulations, and digital technologies substantially enhance students' conceptual understanding, particularly when learning abstract physics concepts (Pramana et al., 2021; Langelaan et al., 2024; Kim, 2024). The use of multiple representations—including computer simulations, three-dimensional visualizations, graphs, diagrams, and virtual experiments—helps students connect mathematical models with real-world phenomena, thereby reducing misconceptions and strengthening conceptual understanding (Park, 2022). Nevertheless, the review also highlights considerable disparities in educational facilities across schools, limiting the equitable implementation of technology-enhanced physics instruction. Another critical aspect identified in the literature is the appropriateness of instructional methods. Inquiry-based learning, problem-solving approaches, collaborative learning, and contextual learning consistently produce more positive effects on conceptual mastery, critical thinking, and scientific reasoning than conventional lecture-based instruction (Wu et al., 2024; Settlage, 2020). Learning environments that encourage students to design experiments, formulate hypotheses, analyze data, and communicate scientific findings significantly improve both science process skills and conceptual understanding.

The review further emphasizes the importance of instructional organization in creating effective learning experiences. This aspect includes the systematic sequencing of learning materials, classroom time management, group organization, continuous formative feedback, and ongoing formative assessment. Since physics concepts are hierarchically structured, instructional content should be organized progressively to enable students to develop conceptual understanding step by step (Ngoc, 2024). Moreover, formative assessment conducted throughout the learning process enables teachers to identify learning difficulties at an early stage and implement timely instructional interventions before students proceed to more advanced concepts (Zhang & Chen, 2022). These findings demonstrate that the Learning component extends beyond evaluating classroom implementation by also assessing the readiness of the entire instructional system prior to implementation. Based on the synthesis of the reviewed literature, this component comprises five major dimensions: (1) teacher readiness, (2) instructional program readiness, (3) student readiness, (4) appropriateness of instructional methods, and (5) instructional organization. These dimensions consistently emerge across the literature as the principal determinants of instructional quality in senior high school physics education.

Unlike the CIPP evaluation model, which assesses Input and Process as separate evaluation components, the NALO Model integrates these dimensions into a single Learning component. This integration is supported by the findings of the systematic literature review, which indicate that program readiness and implementation quality are inseparable determinants of instructional effectiveness. Well-designed instructional programs cannot produce effective learning without high-quality implementation, while effective implementation cannot be achieved without adequate teacher preparedness, instructional resources, and supporting facilities. Accordingly, the Learning component in the NALO Model was developed as an integrated evaluation construct that simultaneously assesses instructional readiness and implementation quality. Overall, the findings of this systematic literature review confirm that the Learning component represents the operational core of the NALO Model, connecting the results of the Needs Analysis with the achievement of Output. This component generates diagnostic information regarding the quality of instructional implementation, enabling evaluators not only to determine whether a learning program is successful but also to identify the implementation factors contributing to its success or failure. The integration of instructional readiness and implementation quality therefore represents one of the principal innovations of the NALO Model for evaluating physics learning in senior high schools.

The Output Component in Physics Learning at Senior High Schools

The findings indicate that the effectiveness of physics learning cannot be assessed solely through academic achievement or final examination scores. The synthesis of the reviewed studies demonstrates that successful physics learning should be evaluated comprehensively, encompassing conceptual understanding, scientific reasoning, science process skills, scientific attitudes, and the development of twenty-first-century competencies throughout the learning process. Therefore, the evaluation of learning Output should reflect the full range of competencies expected from physics education. Numerous studies identify conceptual understanding and scientific reasoning as the primary indicators of successful physics learning. Conceptual understanding extends beyond the ability to memorize formulas or solve numerical problems; it includes students' ability to explain natural phenomena using fundamental physics principles, establish connections among related concepts, and apply these concepts to real-world situations (Park, 2022; Ngoc, 2024). The findings of this systematic literature review (SLR) further reveal that poor physics achievement is frequently associated with persistent misconceptions that remain unidentified during the early stages of instruction. Consequently, learning outcome evaluation should pay particular attention to students' conceptual change throughout the learning process.

In addition to conceptual mastery, experimental skills and science process skills consistently emerge as essential indicators of learning outcomes in physics education. Physics instruction aims not only to develop theoretical understanding but also to cultivate students' abilities to conduct observations, design experiments, collect and analyze data, draw evidence-based conclusions, and communicate scientific findings effectively. Accordingly, student achievement should be assessed through authentic assessment methods capable of evaluating the application of scientific inquiry rather than relying exclusively on written examinations. The literature synthesis also indicates that twenty-first-century physics education seeks to develop students' higher-order thinking skills alongside essential 21st-century competencies. Previous studies consistently report that inquiry-based learning, problem-based learning, experimental activities, and collaborative learning significantly enhance students' critical thinking, creativity, communication, and collaboration skills (Wu et al., 2024; Supratman et al., 2023). These four competencies constitute integral learning outcomes because students are expected to analyze scientific problems, develop evidence-based solutions, collaborate effectively during experimental activities, and communicate their findings systematically.

Beyond cognitive achievement and practical skills, the SLR findings demonstrate that physics learning also contributes substantially to the development of scientific attitudes. These attitudes are reflected in students' curiosity, objectivity, accuracy, responsibility, openness to scientific evidence, and willingness to evaluate alternative scientific explanations. Such dispositions develop through learning environments that encourage both independent and collaborative scientific inquiry, enabling students not only to acquire knowledge but also to cultivate scientific character in addressing complex problems. Based on the synthesis of the reviewed literature, the Output component of the NALO Model comprises four major dimensions: (1) conceptual understanding and scientific reasoning, (2) experimental and science process skills, (3) scientific attitudes, and (4) twenty-first-century competencies, including critical thinking, creativity, collaboration, and communication (4C). These dimensions consistently represent the comprehensive learning outcomes recommended across the literature as indicators of high-quality physics education. Unlike conventional evaluation models that primarily define learning outcomes in terms of academic achievement or test scores, the NALO Model conceptualizes Output as a comprehensive representation of the competencies developed through the learning process. This component not only measures the extent to which learning objectives have been achieved but also provides diagnostic information regarding the quality of program implementation. When students fail to attain the expected outcomes, evaluators can determine whether the underlying causes originate from inadequately identified learning needs during the Needs Analysis stage or from weaknesses in instructional implementation within the Learning component. Consequently, evaluation extends beyond measuring final achievement to provide a solid basis for planning follow-up actions and continuous instructional improvement.

The findings of this systematic literature review further confirm that the relationship among Needs Analysis, Learning, and Output forms an integrated evaluation system. Needs Analysis identifies students' initial conditions as the foundation for instructional planning, Learning evaluates the readiness and quality of instructional implementation, and Output measures program effectiveness through students' competency achievement. The integration of these three components represents the principal innovation of the NALO Model, providing an evaluation framework that is not only summative but also diagnostic and oriented toward continuous improvement in senior high school physics learning.

CONCLUSION

This study developed the NALO (Needs Analysis, Learning, and Output) Evaluation Model through a systematic literature review to provide a comprehensive framework for evaluating Physics learning in senior high schools. The findings identified three interconnected components. Needs Analysis serves as the foundation by identifying students' prior knowledge, misconceptions, cognitive and affective readiness, motivation, and learning context. Learning evaluates the quality of instructional implementation, including teacher readiness, instructional planning, learning resources, teaching methods, classroom interaction, and formative assessment. Output measures learning effectiveness through conceptual understanding, scientific reasoning, science process skills, scientific attitudes, and twenty-first-century competencies (critical thinking, creativity, collaboration, and communication). The novelty of the NALO model lies in integrating these three components into a single diagnostic evaluation framework that explains not only learning outcomes but also the factors influencing instructional effectiveness. The model is expected to support educators and policymakers in improving the quality of Physics learning through evidence-based evaluation. Future studies should validate the model empirically through expert judgment and large-scale implementation in senior high schools.

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