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Integrating Higher-Order Thinking Skills into PBL Modules to Enhance Students' Critical Thinking Skills

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Keywords

HOTS, problem-based learning, module, critical thinking

Abstract

Grammar mastery is essential in English as a Foreign Language (EFL), particularly for academic contexts such as TOEFL. However, the increasing use of artificial intelligence (AI) in grammar learning risks encouraging surface-level accuracy without deep cognitive engagement. This study aimed to develop a Higher-Order Thinking Skills (HOTS)-based grammar learning module focusing on clause mastery by integrating Problem-Based Learning (PBL) within the ADDIE instructional design model. Using a Research and Development (R&D) approach, the study followed five stages: analysis, design, development, implementation, and evaluation. Data were collected through expert validation and student questionnaires and analyzed using descriptive quantitative and qualitative methods. The material expert evaluation showed a feasibility score of 84.6% (highly feasible), while student responses indicated a feasibility level of 78.8% (feasible). Students perceived the module as effective in enhancing analytical and evaluative thinking. The findings suggest that the HOTS-based grammar module is pedagogically feasible and supports deeper cognitive engagement in grammar learning, provided it is implemented with coherent instructional strategies and appropriate assessment alignment in AI-supported learning environments.

Introduction

In learning English as EFL, mastering grammar is essential because it provides the framework for clear communication. Without it, sentences may be ambiguous or incorrect, hindering understanding. Oxford Dictionary defines grammar as the principles underlying sentence construction. It explains why grammar is often described as the "mathematics of the English language" due to its structured and rule-based nature (Romadhon et al., 2020). Mastery of grammar, particularly clause structures, requires not only procedural knowledge but also the ability to analyze, evaluate, and apply rules appropriately in academic and test-oriented contexts such as TOEFL .

The rapid advancement of artificial intelligence (AI) has significantly transformed grammar learning practices in higher education. AI-powered tools are now capable of generating grammatically accurate sentences, correcting errors, and providing instant feedback (Crompton & Burke, 2025). While these tools offer efficiency and accessibility, they also introduce pedagogical challenges. Students may achieve correct grammatical output without engaging in meaningful reasoning or understanding underlying structures. This condition raises concerns that grammar learning may become a surface-level activity, emphasizing outcomes over cognitive processes (Zhai, et.al, 2024).

Such challenges are further exacerbated by instructional practices that continue to prioritize lower-order cognitive skills, including memorization and routine exercises. In many grammar classrooms, learning materials are designed to transmit rules rather than to engage students in critical analysis or contextual evaluation of grammatical usage. Consequently, students often struggle to justify grammatical choices, detect errors in authentic texts, or apply grammar flexibly beyond controlled exercises. These limitations become increasingly evident in AI-rich learning environments where answers are readily available but critical thinking is not systematically cultivated.

Higher-Order Thinking Skills (HOTS) have therefore become a pedagogical necessity in contemporary language education. HOTS involve advanced cognitive processes such as analysis, evaluation, and creation, which are essential for meaningful learning and long-term retention (Gunawan, 2003; Kemendikbud, 2023; Weis, 2003). In grammar instruction, a HOTS-oriented approach encourages learners to analyze sentence structures, evaluate grammatical accuracy within context, and create appropriate language output. However, despite the recognized importance of HOTS, many existing grammar learning modules fail to embed these skills in a structured and systematic manner (Freeman, et al, 2014).

Problem-Based Learning (PBL) offers a learning framework that aligns naturally with the development of Higher-Order Thinking Skills (HOTS) by engaging students in authentic and cognitively demanding problems. Through PBL, students are required to explore contextual issues, analyze alternative solutions, and justify linguistic decisions. Nevertheless, the effectiveness of PBL is highly dependent on the quality of instructional design. Without carefully developed learning modules, PBL implementation often remains fragmented and fails to produce sustained improvements in higher-order thinking skills (Dabbagh, 2019). To address this instructional gap, a systematic instructional design approach is required. The ADDIE model—consisting of Analysis, Design, Development, Implementation, and Evaluation—provides a comprehensive framework for developing effective learning modules. Through the analysis phase, learners' needs, learning context, and challenges related to AI-assisted grammar learning can be identified. The design and development phases enable the integration of HOTS indicators into grammar tasks, ensuring that learning activities require analysis, evaluation, and creation within a Problem-Based Learning structure. The implementation phase allows the module to be applied in authentic classroom settings, while the evaluation phase ensures its quality, effectiveness, and feasibility.

This study proposes the development of a grammar learning module based on Higher-Order Thinking Skills using the ADDIE model. The module specifically focuses on clause mastery in TOEFL-oriented grammar learning and is designed to promote critical engagement with grammatical structures rather than procedural accuracy alone. By embedding HOTS-oriented tasks into each phase of Problem-Based Learning and systematically developing the module through the ADDIE framework, this study positions grammar learning as a higher-order cognitive process. Furthermore, the module encourages students to critically evaluate AI-generated grammatical feedback, thereby fostering

reflective and independent learning. This approach offers a pedagogically sound response to the challenges of grammar instruction in AI-driven educational environments.

Methodology

This study employed a Research and Development (R&D) approach using the ADDIE model which consists of five stages: analysis, design, development, implementation, and evaluation. The analysis stage focused on identifying students' needs and existing problems in grammar learning. Based on this analysis, the design stage involved developing a syllabus that defined learning objectives, indicators, and grammar content integrated with Higher-Order Thinking Skills (HOTS). In the development stage, the module content was constructed by adapting authentic grammar materials from various authoritative sources while maintaining conceptual accuracy. The developed digital module was then implemented through a limited trial involving students of the English Education program and was validated by material and media experts to assess its feasibility. The evaluation stage was conducted by revising the module based on expert feedback and students' responses to ensure its effectiveness and usability. Data were collected using closed- and open-ended questionnaires and analyzed using descriptive quantitative and qualitative techniques. Quantitative data were analyzed through percentage-based feasibility criteria, while qualitative data were examined using data reduction, data display, and conclusion drawing, following the Miles and Huberman model. The results of the analysis were used as the basis for revising and finalizing the HOTS-based grammar module.

Table1. Likert Scale Categories

Evaluation Category	Feasibility Percentage
Feasible	76–100%
Moderately Feasible	50–75%
Less Feasible	26–50%
Not Feasible	< 26%

Source: Sugiyono (2010)

The collected data were analyzed by summing the obtained scores, comparing them with the expected scores, and converting the results into percentages (Sugiyono, 2010), as shown in the following formula:

$$\text{Feasibility Percentage (\%)} = (\text{Total Observed Score} / \text{Total Expected Score}) \times 100\%$$

Result

This study was conducted in IKIP PGRI Bojonegoro and involved second-semester students of the English Education Department as research participants. The research began with a needs analysis stage, which aimed to identify students' initial grammar competence and specific learning difficulties. The analysis revealed that students' understanding of grammar—particularly clause structures—was relatively low. This condition was empirically supported by quiz results administered prior to the development process, where only a limited number of students achieved satisfactory scores, while the majority demonstrated difficulties in identifying, analyzing, and applying clauses accurately. These findings indicated a significant discrepancy between the expected learning outcomes and students' actual grammar performance, thereby justifying the need for developing an instructional module that emphasizes Higher-Order Thinking Skills (HOTS).

Based on the needs analysis, the design stage focused on selecting, organizing, and structuring clause materials that aligned with students' proficiency levels and learning needs. The materials were

adapted from established and widely used grammar textbooks to ensure theoretical validity. To promote higher-order cognitive engagement, the materials were systematically categorized according to Bloom's revised taxonomy at the Analyzing (C4), Evaluating (C5), and Creating (C6) levels. This categorization was intended to shift grammar learning from rule memorization toward deeper cognitive processes, such as analyzing sentence structures, evaluating grammatical appropriateness in context, and constructing original sentences or explanations. Through this approach, students were expected to actively explore grammatical concepts, justify their reasoning, and develop independent understanding.

During the development stage, the designed materials were expanded into a complete HOTS-based grammar module by integrating structured explanations, examples, and HOTS-oriented tasks. Each cognitive level was accompanied by carefully designed questions and exercises. For instance, evaluative tasks required students to compare multiple sentence constructions and determine the most appropriate tense or clause usage while providing logical justification for their choices. The materials were adopted and adapted from multiple authentic grammar sources to maintain conceptual accuracy and expose students to varied grammatical representations. This multi-source adaptation was intended to enrich learning experiences and strengthen students' grammar mastery through exposure to diverse examples and contexts.

Table 2. Analysis of Subject-Matter Expert Evaluation Data

Assessed Aspect	Indicator	Score
Material Relevance Aspect	Alignment of the material with Course Learning Outcomes (CLOs)	4
	Alignment of the material with learning indicators	3
	Alignment of the material with learning objectives	4
	Conceptual accuracy of the material from a scientific perspective	3
Material Organization Aspect	Clarity of material presentation	4
	Systematic organization of the material	4
	Attractiveness of the material	2
	Completeness of the material	3
	Appropriateness of difficulty level	3
	Clarity of examples	4
	Ease of understanding the material flow	3
Independent Practice Aspect	Variety of independent practice exercises	4
	Difficulty level of the exercises	3
Total Score		44

Prior to classroom implementation, the developed module underwent expert validation to assess its feasibility and quality. The material expert evaluation resulted in a total score of 44 out of 52, equivalent to a feasibility percentage of 84.6%, indicating that the module was highly feasible for instructional use. The evaluation demonstrated strong performance across several aspects, including material relevance to learning outcomes, instructional quality, and conceptual accuracy. However, the aspect of material attractiveness received a comparatively lower score. The expert noted that the module was predominantly text-based and lacked visual elements such as images or illustrations,

which could potentially reduce student engagement. As a result, the expert recommended incorporating relevant visual supports to enhance readability and learner interest.

Following expert validation, the implementation stage was carried out through a user trial involving 30 students. The students were instructed to read the module, engage with the learning materials, and complete the HOTS-based exercises provided. Afterward, they responded to a feasibility questionnaire designed to capture their perceptions of the module's clarity, depth, attractiveness, and cognitive impact. The total score obtained from student responses was 473, corresponding to an overall feasibility percentage of 78.8%, which falls within the feasible category.

Table 3. Feasibility Results Based on Student Responses

No.	Evaluation Aspects	Score Obtained
1	Attractiveness and ease of use of the module	80
2	Clarity of material presentation	112
3	Clarity of the practice examples provided	78
4	Depth of content	88
5	Enhancement of thinking skills	115
Total Score		473

The highest score was observed in the aspect of enhancing thinking skills, indicating that students perceived the HOTS-oriented tasks as effective in stimulating deeper thinking and analytical engagement. Additionally, high scores were obtained for the clarity of material presentation, suggesting that students found the explanations and examples easy to understand. Interestingly, this finding contrasts with the material expert's concern regarding visual appeal, indicating that while visual enhancement is desirable, clarity of content played a more critical role from the students' perspective.

The final stage, evaluation, involved revising the module based on feedback from both experts and students. Comments, suggestions, and identified weaknesses were systematically reviewed and used as the basis for improving content presentation, instructional clarity, and overall usability. As a result, the revised HOTS-based grammar module was refined and finalized, making it ready for use in grammar instruction, particularly in teaching clauses.

Discussion

The development of instructional materials grounded in Higher-Order Thinking Skills (HOTS) is often assumed to directly enhance students' cognitive competence. In the context of the AI-supported learning era, this assumption becomes even more complex and requires careful examination (Abraham, et.al, 2021). While the findings of this study indicate that the HOTS-based grammar module was perceived as feasible and cognitively engaging, material design alone cannot guarantee improvement in higher-order thinking (Shakhmalova & Zotova, 2023). In an environment where AI tools can instantly generate grammatical explanations and corrections, HOTS-based materials should be understood not as a replacement for instruction but as an enabling framework that encourages students to critically evaluate, interpret, and justify grammatical choices rather than passively accept AI-generated outputs. Their effectiveness therefore depends on alignment with instructional strategies, lecturer facilitation, and students' cognitive readiness.

Previous studies have demonstrated that higher-order thinking skills can be systematically developed through consistent and well-structured learning activities (Ariandari, 2015; Nurhasanah &

Yarmi, 2018). These findings support the present results, particularly the high student ratings regarding the module's ability to enhance thinking skills (Khoiriyah, et. Al, 2015). However, in the AI era, the presence of challenging tasks alone is insufficient (McCoy, et.al, 2024). Tasks must be intentionally designed to require reasoning, comparison, and judgment, especially in situations where AI provides multiple plausible grammatical solutions. Without clear cognitive direction, task difficulty may increase cognitive load without promoting meaningful learning or independent thinking (Felin & Holweg, 2024).

Effective HOTS-oriented grammar learning in the AI era requires activities that actively engage students in analysis, evaluation, and creation (Sari et al., 2020; Widihastuti & Suyata, 2014). The integration of C4–C6 level tasks in this study encouraged students to justify tense selection, evaluate sentence appropriateness, and construct explanations—skills that are increasingly critical when learners interact with AI-generated language (Luo, hu, & Zhong, 2024). Importantly, meaningful engagement should not be conflated with technological interactivity. The core value of HOTS lies not in digital features but in tasks that present ambiguity, open-ended problems, and the need for defensible reasoning—capacities that AI cannot fully replace and that learners must develop to remain intellectually autonomous(Godsk, & Møller, 2025).

Moreover, the implementation of HOTS in the AI-supported learning context highlights the importance of instructional coherence. If HOTS principles are embedded only in learning materials while assessment practices continue to prioritize recall or mechanical accuracy, students are likely to rely on AI tools to meet surface-level requirements. This misalignment undermines the intended cognitive goals of HOTS-based instruction. Therefore, effective integration of HOTS in grammar learning must be holistic, encompassing curriculum objectives, teaching methods, learning media, and assessment systems that value reasoning processes over final answers (Latif & Wasim, 2024).

Finally, although the complexity of contemporary learning environments and the widespread use of AI tools underscore the urgency of developing higher-order thinking skills, it is essential to avoid positioning HOTS as a standalone solution. Foundational grammatical knowledge and lower-order cognitive skills remain critical, particularly as a basis for evaluating AI-generated language. Without a solid conceptual foundation, HOTS tasks may overwhelm learners or encourage uncritical dependence on AI outputs. Consequently, the integration of HOTS in grammar instruction should be gradual, scaffolded, and proportional, ensuring that students build higher-order reasoning upon secure foundational understanding.

In conclusion, the findings suggest that the HOTS-based grammar module holds strategic value in preparing students for grammar learning in the AI era. However, its effectiveness depends on coherent instructional design, lecturer readiness to facilitate critical engagement, and assessment practices that reward reasoning and justification. When these elements operate synergistically, grammar instruction can transcend rule memorization and AI-assisted correction, fostering learners' analytical, evaluative, and adaptive thinking skills that are essential for navigating AI-mediated language learning environments.

Conclusion

This study concludes that the HOTS-based grammar learning module developed using the ADDIE model and integrated with Problem-Based Learning (PBL) is feasible for use in grammar instruction, particularly for clause mastery in TOEFL-oriented contexts. The results of expert validation and student responses indicate that the module demonstrates strong material quality, clear presentation, and the capacity to engage learners in higher-order cognitive processes, including analysis, evaluation, and creation. The module supports students in developing conceptual

understanding of grammar while encouraging them to justify grammatical choices and critically evaluate language use, including AI-generated grammatical feedback.

However, the findings also highlight that the development of Higher-Order Thinking Skills cannot rely solely on instructional materials. The effectiveness of the module is highly dependent on coherent instructional design, lecturers' facilitation of critical engagement, and assessment practices that emphasize reasoning processes rather than mere grammatical accuracy. Therefore, while the HOTS-based grammar module offers a pedagogically relevant response to grammar learning challenges in AI-supported educational environments, its successful implementation requires alignment among learning objectives, teaching strategies, and evaluation systems.

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