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Development and Preliminary Evaluation of a Bilingual Interactive Citizenship Education Concept Module for Pre-Service Primary Teachers

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ABSTRACT

Bilingual resources that integrate national civic content with global citizenship perspectives are essential in pre-service primary teacher education. This study developed and conducted a preliminary evaluation of an Indonesian–English interactive module for the Citizenship Education Concept course. The development process followed the Dick and Carey model, encompassing learner and context analysis, formulation of performance-based objectives, instructional strategy and material development, and formative evaluation. An initial questionnaire administered to 37 students assessed their perceptions of the quality of existing instructional media and their self-reported learner autonomy. After implementation, a post-use survey completed by the same cohort, consisting of 30 closed-ended statements and four open-ended questions, evaluated technical usability, content quality, bilingual presentation, interactive learning, and visual design. As the instruments measured distinct constructs and employed different response scales, data were analyzed separately using descriptive statistics, and written responses were summarised thematically. The initial assessment produced 86.42% of the maximum possible score for the perceived quality of existing instructional media and 77,97% for learner autonomy. The post-use evaluation yielded an overall score of 90,99%, with consistently high ratings for bilingual presentation (91,57%), content quality (91,49%), technical usability (91,35%), interactive learning (90,18%), and visual design (90,16%). Students highlighted the value of navigation, videos, quizzes, visual layout, and the bilingual format, while also identifying areas for technical and pedagogical improvement. The module was deemed relevant to user needs and highly feasible for pre-service primary teacher education. These findings offer preliminary formative evidence of perceived feasibility and provide a foundation for future outcome evaluation.

Keywords: Bilingual Interactive Module, Citizenship Education, Pre-Service Primary Teachers, Dick and Carey, Formative Evaluation

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INTRODUCTION

Courses designed to prepare pre-service primary teachers for civics instruction face two principal challenges. First, students must develop a comprehensive understanding of national institutions, constitutional principles, and citizens' rights and obligations. Second, they need to be prepared to address issues that transcend national borders and increasingly arise in digital contexts. Global Citizenship Education (GCED) is particularly relevant in this context, as it integrates civic knowledge with human rights, critical assessment, participation, and responsibility within an interconnected global society (Dzwonkowska, 2022; Mellado-

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Moreno & Burgos, 2025; Santamaría-Cárdaba et al., 2024; Veugelers, 2021). In this article, GCED is defined as an educational orientation rather than a form of legal citizenship outside the nation-state. Pre-service teachers should be able to explain global issues to learners while maintaining connections to the history, values, and political institutions of the society in which these learners live.

The implementation of Global Citizenship Education (GCED) involves complexities that extend beyond the term's generally positive associations. GCED comprises a range of approaches, including cultural openness, individual engagement, and critical perspectives that address inequality, power dynamics, and collective action (Hameed et al., 2023; Thomas & Banki, 2021; Waghid, 2023). Teacher educators face considerable challenges in translating these principles into effective curriculum, particularly when institutional priorities such as international visibility and employability overshadow democratic learning and social justice (Smith et al., 2024; Witt, 2023). Simply incorporating international examples into existing courses is insufficient for achieving a genuinely global orientation. Effective integration of national and global perspectives necessitates ongoing, focused discussion of specific citizenship issues.

Indonesia offers a relevant context for examining the intersection of national and global citizenship education. Citizenship Education is fundamentally connected to Pancasila, the Constitution of the Republic of Indonesia, national unity, democracy, social justice, and the rights and obligations of citizens. Although this foundation should not be equated with Global Citizenship Education (GCED), the two frameworks are not entirely distinct. Pre-service teachers in Indonesia tend to interpret global citizenship through the perspectives of local history, religious values, and social life informed by Pancasila (Maisara et al., 2026; Sunarso et al., 2024). In parallel, research on digital citizenship emphasizes the importance of addressing misinformation, privacy, online ethics, and responsible participation, which are not fully encompassed by traditional conceptions of national civic identity (Japar et al., 2024; Prasetiyo et al., 2021). The central challenge is to expand the scope of Civics to integrate global and digital dimensions while preserving the local influences that inform students' understanding of citizenship.

Curricular challenges in bilingual programs are closely connected to language-related issues. English as a medium of instruction (EMI) is frequently linked to internationalisation and increased access to academic literature. Nevertheless, students often encounter difficulties in comprehending complex disciplinary concepts when instruction occurs in a language they have not fully mastered. Research in Indonesia and other EMI contexts identifies tensions related to institutional policies, language proficiency, lecturer preparedness, and mastery of course content (Coleman et al., 2024; Galloway & Rose, 2021; Pun et al., 2024). Bilingual modules can mitigate these challenges if they extend beyond simply presenting identical content in two languages. Studies on translanguaging—the intentional and flexible use of an individual's linguistic repertoire—indicate that alternating between languages can support explanation, comparison, and the development of disciplinary understanding (Genc et al., 2023; Prilutskaya, 2021; Rodríguez et al., 2021). English expands access to international civic discourse, whereas Indonesian offers a conceptual foundation and a context for critical comparison. Therefore, bilingualism functions as a pedagogical scaffold rather than a

simplified version of EMI.

The adoption of digital formats introduces additional pedagogical considerations. In this study, interactive electronic modules (e-modules) are defined as structured learning resources that integrate text, navigation systems, multimedia, exercises, quizzes, and user controls. However, the presence of these features alone does not guarantee pedagogical interactivity. Research on online learning links learning quality to clear organisation, alignment between objectives and activities, intuitive navigation, meaningful assessments, and adequate technical support (Bond et al., 2021; Konstantinidou & Nisiforou, 2022; Senadheera et al., 2024). Previous studies report mixed findings: digital flexibility may enhance participation, but limited interaction, technical challenges, and poorly designed assessments can reduce student engagement (Akpen et al., 2024; Heil & Ifenthaler, 2023). In the context of citizenship education, interactivity should be assessed by the extent to which students are encouraged to interpret, compare, make decisions, and reflect, rather than by the quantity of multimedia elements included.

Learner autonomy refers to a student's capacity to take conscious responsibility for learning goals, resources, strategies, progress, and reflection. Digital learning resources can support autonomy by providing scheduling flexibility, repeated access, and immediate practice opportunities; however, access alone is insufficient (Fujii, 2024; Pratiwi & Waluyo, 2023). Students benefit from explicit goals, clearly defined learning pathways, timely feedback, and activities that extend beyond passive reading. This requirement is especially significant in teacher education, as frequent use of digital tools does not necessarily reflect the ability to use technology critically for learning and teaching within a specific discipline (Thohir et al., 2021; Yang et al., 2023). Modules designed to foster autonomy should incorporate structured independent learning activities, rather than leaving students to learn without guidance.

Recent scholarship has established a robust foundation in Global Citizenship Education (GCED), multilingual higher education, and digital learning. Nevertheless, these domains frequently evolve in isolation. Research on GCED within teacher education primarily addresses conceptual frameworks, educators' perspectives, and the tensions between critical approaches and market-driven interests. Studies on English-Medium Instruction (EMI) generally focus on language policies and instructional practices, whereas investigations into digital learning emphasise design quality, usability, competencies, and student engagement (Bosio et al., 2024; Coleman et al., 2024; Smith et al., 2024). There has been minimal integration of these areas into a comprehensive learning resource specifically designed for pre-service primary teachers in Indonesia. This gap is both conceptual and practical, as there is insufficient evidence regarding how student needs, Civics education content, global perspectives, bilingual support, and digital interactions can inform one another during resource development and formative evaluation.

The Dick and Carey instructional design systems approach was selected for its comprehensive integration of student needs, performance objectives, assessment, instructional strategies, material development, evaluation, and revision within a unified process (Dick et al., 1985). The model is significant because it demonstrates the relationship between identified needs and subsequent design decisions, rather than requiring strict adherence to sequential stages. Recent research in higher education instructional design emphasises the importance of aligning instructional components and adapting to user contexts

(Senadheera et al., 2024; Thohir et al., 2021). This framework provides a systematic yet adaptable basis for integrating Civics content, global citizenship perspectives, bilingual presentation, and interactive features into a cohesive learning resource.

Guided by this framework, the study developed and conducted a preliminary evaluation of an interactive, Indonesian-English bilingual civics education module for pre-service primary teachers. The development process began with an assessment of students' perceptions of the quality of existing instructional media and their self-reported learner autonomy, which informed the module's design. Following implementation, the module was evaluated based on technical usability, content quality, bilingual presentation, interactive learning, and visual design. The preliminary evaluation demonstrated that the module received highly positive ratings in all areas. However, students' initial profiles indicated a need for more structured support to foster learner autonomy. These findings indicate that the module aligns with user needs and is suitable for further use and refinement in the education of pre-service primary teachers.

METHODS OF RESEARCH

A research and development methodology incorporating initial formative evaluation was utilized. The development process was guided by an adaptation of the Dick and Carey learning design model (Dick et al., 1985), ensuring alignment among student needs, learning objectives, instructional strategies, materials, and evaluation. The adaptation comprised four primary stages: analysis of learning needs and context, formulation of goals and strategies, module development, and implementation with formative evaluation and subsequent revision. As the study concentrated on initial product development and assessment, summative evaluation and effectiveness testing of learning outcomes were not performed.

The study took place during the even semester of the 2025/2026 academic year in a bilingual section of the Citizenship Education Concept course within the Primary School Teacher Education Study Program in a public university in Jakarta. The participant group consisted of 37 second-semester students, all selected through saturated sampling. Both the baseline questionnaire and the post-use survey received responses from all 37 participants. However, individual data were not paired for change analysis because the two instruments assessed different constructs and employed distinct response scales.

The developed product is an interactive Indonesian–English module consisting of seven learning units. The module covers topics including Pancasila values, norms and morals, human rights, Pancasila Democracy, legal awareness, and their application in primary school contexts. Content delivery methods include concept maps, trigger questions, case studies, videos, quizzes, illustrations, a bilingual glossary, and independent reflection activities.

In the initial stage, a needs-assessment questionnaire was administered before module development. The questionnaire contained 20 items: the first 10 assessed students' perceptions of the quality of the existing instructional media used in the course, while the remaining 10 assessed self-reported learner autonomy. The items used a four-point response format ranging from 1 (most positive response) to 4 (least positive response). This format provided a directional assessment of students' initial conditions without a midpoint. The results informed the selection of content, features, language support, and learning activities

incorporated into the module. Learning objectives were formulated using the elements of audience, behavior, condition, and degree, corresponding to participants, expected behaviors, implementation conditions, and achievement levels. Based on these objectives, learning strategies and bilingual materials were developed, and the module was implemented during lecture sessions. After implementation, students completed a post-use evaluation survey consisting of 30 closed-ended statements and four open-ended questions. The closed-ended items used a five-point response format ranging from 1 (most positive response) to 5 (least positive response). Unlike the initial questionnaire, this format included a midpoint to accommodate neutral or mixed evaluations after students had directly used the module. The closed-ended items addressed technical usability (6 items), content quality (8 items), bilingual presentation (5 items), interactive learning (6 items), and visual design (5 items). The open-ended questions explored preferred features, usage challenges, content requiring further explanation, and suggestions for module refinement.

Content validity was evaluated through expert judgment involving two reviewers, one specializing in Pancasila and Citizenship Education and the other in educational technology. The reviewers assessed the relevance, clarity, and alignment of the items with the intended constructs and the context of the study. Their ratings yielded an overall Aiken's V coefficient of 0.89, providing evidence of satisfactory content validity. The experts' comments and recommendations were also considered in finalizing the questionnaire items.

Data collection was conducted online, with the initial questionnaire administered before module use and the post-use evaluation survey administered following implementation. Scores were therefore reverse-coded using 5 minus the raw score for the four-point initial questionnaire and 6 minus the raw score for the five-point post-use survey. Following this transformation, higher scores indicated more positive perceptions. Because the questionnaires served different purposes, assessed different constructs, and employed different response formats, their results were analyzed separately and were not treated as equivalent pre-test and post-test measures.

Descriptive analysis included the number of responses, mean, standard deviation, and percentage of the maximum possible score. Internal consistency was examined using Cronbach's alpha, whereas content validity was established separately through expert judgment and Aiken's V. Responses to the four open-ended questions were analyzed thematically. One researcher conducted repeated readings of all responses, generated the initial codes, and grouped related codes into provisional themes. A second researcher reviewed the coding structure, the allocation of responses to the themes, and the resulting thematic interpretations. Differences in interpretation were discussed until agreement was reached, after which the themes were finalized. This review process was used to strengthen the credibility and consistency of the qualitative analysis.

The study involved a minimal-risk formative evaluation of an instructional module conducted within regular course activities. Formal review by an institutional ethics committee was not required for this type of educational evaluation. Participation was voluntary, written informed consent was obtained from all participants, and participant responses were treated confidentially and reported without personally identifying information.

RESULTS AND DISCUSSION

This section presents the results of the module's development and initial evaluation, utilizing three sources of evidence: a profile of student needs, quantitative assessments after module use, and qualitative feedback. These data sources were analyzed collectively to assess the alignment among identified needs, design decisions, and user experience. The findings offer formative evidence concerning the module's relevance and feasibility.

Initial Student Profile and Implications for Module Development

An initial questionnaire was administered to 37 students to assess their perceptions of the quality of the existing instructional media and their self-reported learner autonomy. Following reverse-scoring, higher scores indicated more positive perceptions. The perceived quality of existing instructional media received a score of 86.42%, whereas learner autonomy received a score of 77.97%, as presented in Table 1.

Table 1 Profile of Instructional Quality and Learner Autonomy

Aspect	Items	M	SD	Percentage of maximum score	α
Instructional quality	10	3.46	0.55	86.42%	0.958
Learner autonomy	10	3.12	0.43	77.97%	0.853

Note: N = 37; score range = 1–4; M = mean; SD = standard deviation.

The 8.45 percentage-point difference between the two aspects does not represent a change or causal relationship because the aspects measure distinct constructs. The findings indicate that positive perceptions of the existing instructional media do not necessarily correspond with an equally strong capacity to manage the learning process independently. The literature supporting this study defines learner autonomy as the capacity to set goals, select strategies, monitor progress, and reflect on outcomes, rather than simply engaging in unsupervised learning (Fujii, 2024; Pratiwi & Waluyo, 2023). Therefore, flexible access should be accompanied by clear learning pathways, feedback, and activities that support students in making incremental decisions.

This interpretation challenges the assumption that student familiarity with technology always signifies readiness for independent learning. Research on digital competence in higher education demonstrates that the ability to use devices does not necessarily correspond with the ability to utilize technology critically for disciplinary purposes (Thohir et al., 2021; Yang et al., 2023). As a result, the modules were intentionally designed to provide more than just material repositories, ensuring that the direction of learning is not left entirely to the student. Each unit includes a learning map, performance-based objectives, guiding questions, contextual case studies, bilingual (Indonesian–English) materials, videos, quizzes, a glossary, and reflective activities.

This decision demonstrates the application of the Dick and Carey model as a mechanism for ensuring traceability between needs and features, rather than as a simple procedural sequence. In this framework, the need for both structure and autonomy is addressed through guided navigation, scaffolded exercises, and opportunities to review and reflect on the material. This approach aligns with the perspective that instructional design in higher education must maintain coherence among learner needs, objectives, activities, and assessments, while remaining adaptable to the specific context of use (Senadheera et al., 2024;

Thohir et al., 2021). However, the initial self-reported profile represents only student perceptions and does not directly measure actual independent learning behaviors.

Quantitative Evaluation Patterns After Implementation

Post-usage evaluation demonstrated positive ratings in all aspects of the module. The overall score was 90.99%, with individual aspect scores ranging from 90.16% to 91.57%, as shown in Table 2. According to the instrument's criteria, these findings reflect a very high level of suitability as perceived by users.

Table 2 Evaluation of Bilingual Interactive Module Usage

Aspect	Items	M	SD	Percentage of maximum score	α
Technical usability	6	4.57	0.65	91.35%	0.953
Content quality	8	4.57	0.56	91.49%	0.959
Bilingual presentation	5	4.58	0.72	91.57%	0.965
Interactive learning	6	4.51	0.68	90.18%	0.971
Visual design	5	4.51	0.76	90.16%	0.963
Overall	30	4.55	0.64	90.99%	0.990

Note: N = 37; score range = 1–5; M = mean; SD = standard deviation.

The standard deviations for bilingual presentation (0.72) and visual design (0.76) were higher than that for content quality (0.56), indicating greater variation in students' perceptions of language and visual presentation.. However, the difference between the highest- and lowest-rated aspects was only 1,41 percentage points, insufficient to warrant a substantive quality ranking. A more significant pattern is the consistent positive assessment across all five aspects, indicating that language, content, technical functionality, activities, and visuals were not perceived as isolated components.

Assessments of the bilingual presentation must be viewed within the context of the challenges associated with learning through English. Research on English-medium instruction indicates that access to international literature can entail a conceptual burden when language proficiency, lecturer readiness, and disciplinary demands are not fully aligned (Coleman et al., 2024; Galloway & Rose, 2021; Pun et al., 2024). In this module, the Indonesian–English presentation allows Indonesian to provide a conceptual foundation, while English opens access to international civic terminology and perspectives. This function aligns with the principle of translanguaging, the strategic use of two languages to construct meaning, compare concepts, and support disciplinary understanding (Genc et al., 2023; Prilutskaya, 2021; Rodríguez et al., 2021). However, the perception scores do not prove that the bilingual presentation enhances conceptual mastery or academic English proficiency.

At the item level, the highest scores were assigned to the clarity of content related to human rights, Pancasila Democracy, and legal awareness (93,51%). Clarity of usage instructions, alignment with course learning outcomes, clarity of basic Civics concepts, and the bilingual format's support for understanding each received scores of 92,97%. These results indicate that students are more likely to recognize the quality of a module when features provide direct, visible functions, such as content explanations, navigation guidance, or language equivalents. In contrast, the lowest scores were recorded for the ability of "trigger questions" to foster critical thinking (88,11%), followed by motivation to deepen understanding of Civics and the readability of text or fonts, both at 88,65%. Although all three

aspects were rated positively, this pattern underscores a distinction between operational interactivity and cognitive interactivity. Features such as videos, quizzes, and navigation may enhance user-friendliness but do not necessarily prompt students to compare positions, evaluate evidence, or construct civic arguments. The digital design literature further cautions that the presence of multimedia and flexible access do not automatically lead to meaningful engagement unless activities and assessments require conceptual processing (Akpen et al., 2024; Heil & Ifenthaler, 2023). Consequently, future development should prioritize improving the quality of tasks and questions rather than increasing the quantity of media.

The standard deviations for bilingual presentation (0,72) and visual design (0,76) exceeded that for content quality (0,56), indicating greater variability in experiences related to language and visual layout, despite high mean scores. Variations in devices, network conditions, visual preferences, or language proficiency may account for these differences, although these factors were not directly examined. The very high Cronbach's alpha also warrants cautious interpretation; high internal consistency does not necessarily indicate that an instrument comprehensively measures a single construct, as values approaching 1 may reflect item similarity or redundancy (McNeish, 2018). Factor structure analysis and instrument testing with a larger sample are required before these five aspects can be considered established dimensions.

User Experience and Revision Priority

Written responses elucidate the underlying reasons for quantitative scores and reveal issues not evident in aggregate data. Thematic analysis in Table 3 identified four categories of experience: navigation and multimodality, bilingual presentation, access and readability, and depth of content and assessment. These themes served a diagnostic purpose and were not interpreted as frequencies representative of the entire group of participants.

Table 3 User Experience Themes and Implications for Module Refinement

Theme	Selected Evidence	Implication for Module Refinement
Navigation and multimodality	The table of contents enables "direct navigation to the desired content page" (P31). Additionally, videos and quizzes support comprehension of the material	Maintaining straightforward navigation and using only media that support learning objectives
Bilingual support	The horizontal bilingual layout is reported to facilitate reading (P24). However, the glossary requires further clarification (P36)	Ensuring consistent terminology and strengthening the glossary
Access and readability	"If the network is unstable, pages do not load smoothly" (P20). Additional issues include loading delays, excessive page transitions, and small text size	Compressing files, testing across devices, clarifying links, and providing a search function
Depth and assessment	Students requested additional contextual examples. Three students (8.1%) reported that open-ended responses conveying the intended meaning were marked as incorrect or received no credit. One report concerned Unit 6, while the other two did not identify a particular unit	Add authentic contextual cases and revise the scoring mechanism for open-ended items through rubric-based assessment, manual review, or ungraded reflection

Positive feedback on the table of contents, videos, quizzes, and visual layout supports the quantitative findings on technical usability and interactivity. In contrast, complaints about loading times, page transitions, and readability demonstrate that ease of use is closely connected to students' access conditions. Research on online learning identifies navigation, technical support, and accessibility as essential elements of pedagogical quality, rather than solely interface concerns (Akpen et al., 2024; Bond et al., 2021; Heil & Ifenthaler, 2023). Media-rich modules that are challenging to use on unstable networks may intensify, rather than reduce, learning barriers.

Feedback on the bilingual format indicates that its pedagogical value extends beyond simply duplicating text in two languages. Although side-by-side presentation supports navigation between terms, explanations, and contexts, requests for more comprehensive glossaries reveal that direct linguistic equivalents may not adequately clarify conceptual differences. According to translanguaging theory, language switching should allow students to explore and construct meaning, rather than rely on literal translations (Genc et al., 2023; Prilutskaya, 2021). Therefore, glossary revisions should include definitions, usage contexts, and examples illustrating the application of citizenship terms in both languages. Three of the 37 students (8.1%) explicitly reported problems with the automated scoring of open-ended quiz responses. They indicated that answers conveying the intended meaning were marked as incorrect or received no credit when their wording did not exactly match the expected response. One student associated the problem with a quiz in Unit 6, whereas the other two did not identify a specific unit. No comparable issue was reported for multiple-choice questions. Although these reports involved a small proportion of participants, they indicate that exact-match automated scoring is unsuitable for evaluating varied forms of civic reasoning. Open-ended items should therefore be assessed using analytic rubrics, manual review, or ungraded reflective responses, while automated scoring can be retained for objective questions.

Conceptual Contribution, Limits of Interpretation, and Future Research

The primary contribution of this study lies not only in the high user evaluation scores but also in the demonstrable connections among need profiles, design decisions, usage experiences, and subsequent revisions. The Dick and Carey model offers a structured framework for linking learner analysis with objectives, strategies, materials, evaluation, and refinement (Dick et al., 1985). In this study, the model was applied adaptively: initial findings regarding learner autonomy were operationalized through guided navigation, exercises, reflection, and feedback. This supports the argument that the value of a design model is determined less by strict adherence to its stages and more by the transparency of the rationale guiding each development decision.

The module integrates Civics content, rooted in Pancasila, with concepts of human rights, democracy, legal awareness, and global citizenship perspectives. However, such integration should not be conflated with the actual development of global citizenship competence. The literature demonstrates that global citizenship education encompasses a range of orientations, from cultural openness to critical engagement with issues of inequality, power, and collective responsibility (Hameed et al., 2023; Thomas & Banki, 2021; Waghid, 2023). High user ratings reflect student acceptance of the material's presentation, but do not provide evidence of students' ability to critically analyze global issues or relate them to the

Pancasila context.

The relationship between national and global perspectives should be conceptualized as a dialogic process. Research in the Indonesian context indicates that pre-service teachers interpret global citizenship through the lenses of local history, religion, and social life grounded in Pancasila (Maisara et al., 2026; Sunarso et al., 2024). Consequently, future module development should include additional cases that require students to compare national and international frameworks, evaluate the tensions between them, and justify their adopted positions. Although the module can support such learning, actual outcomes must be assessed through performance-based tasks.

The alignment between high quantitative scores and positive comments supports the module's formative viability. However, because both forms of feedback originate from the same group of participants and rely on self-reporting, they should not be considered independent sources of evidence. Critical feedback on navigation, readability, the glossary, examples, and quiz assessments is especially valuable, as it highlights limitations that aggregate scores may obscure.

This study was limited to a single class of 37 students and did not include learning-outcome measurements, a control group, or behavioral usage data. Because the initial questionnaire and post-usage evaluation measured different constructs and used different response scales, they could not be analyzed as equivalent pre- and post-tests. Future research should incorporate paired participants, equivalent learning-outcome instruments, case-analysis tasks, in-module activity data, and a control group. Evaluations across multiple institutions are also necessary to determine whether the module's utility is consistent across variations in language proficiency, digital infrastructure, and broader curricular contexts

CONCLUSIONS

The Indonesian–English Citizenship Education module for pre-service primary teachers was developed through an adaptive application of the Dick and Carey model. The initial assessment of 37 students indicated positive perceptions of the quality of the existing instructional media (86.42%), while self-reported learner autonomy received a comparatively lower score (77.97%). These findings informed the inclusion of structured navigation, bilingual content, videos, quizzes, contextual case studies, a glossary, and reflective activities. The post-use evaluation yielded an overall user-perceived feasibility score of 90.99%, with consistently high ratings across technical usability, content quality, bilingual presentation, interactive learning, and visual design. Written feedback identified priorities related to network access, loading time, text readability, search functionality, glossary coverage, contextual examples, and the assessment of open-ended responses. The study provides a traceable account of how learner needs informed design decisions and how user evidence guided module refinement. However, the study was limited to one class of 37 students, relied primarily on self-reported perceptions, and used initial and post-use instruments that measured different constructs on different response scales; therefore, the findings do not demonstrate learning gains or causal effectiveness. Future research should evaluate the refined module using equivalent learning-outcome measures, performance-based tasks, paired-participant data, comparison groups, behavioral usage data, and participants from multiple institutions.

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The authors declare that they used Grammarly for language editing. Despite using AI, the authors affirm that they are the sole authors of this article and are fully responsible for its content, as outlined in the COPE recommendations.

PARTICIPANT CONSENT

This research was conducted based on informed consent from all participants. Participants received an explanation of the purpose, procedures, potential risks and benefits of the research, as well as their right to withdraw at any time without consequence. Participation was voluntary, and written informed consent was obtained from all participants.

CONFLICT OF INTEREST

The authors have no conflict of interest.

AUTHOR CONTRIBUTIONS

V.P.S. conceptualized the study, designed the methodology, led module development and research implementation, analyzed the data, and prepared the original manuscript draft. N.N. contributed to methodological design, theoretical development, interpretation of findings, and critical manuscript revision. L.F. contributed to module content development, literature synthesis, interpretation of findings, and manuscript revision. W.W. contributed to module implementation, data collection and organization, analysis, and manuscript revision. D.N.J. contributed to quantitative and qualitative data analysis, discussion of findings, and critical manuscript revision. M.H.A. contributed to literature synthesis, interpretation of results, and critical review and editing of the manuscript. All authors confirm that they have read and approved the final version of the manuscript and accept responsibility for its content. The percentage contributions to conceptualization, drafting, and revision of this paper are as follows: V.P.S.: 40%, N.N.: 15%, L.F.: 15%, W.W.: 10%, D.N.J.: 10%, and M.H.A.: 10%.

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