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FEASIBILITY OF LMS-BASED E-MODULES IN COMPUTER NETWORK LEARNING USING THE PROBLEM BASED LEARNING MODEL

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ABSTRACT
Vocational education requires interactive digital learning resources that support higher-order thinking skills, particularly in practice-oriented subjects such as computer networks. However, many existing digital tools are not yet integrated with structured pedagogical models. This study aimed to develop and assess the feasibility of a Learning Management System (LMS)-based e-module integrated with the Problem-Based Learning (PBL) model for eleventh-grade computer network learning. Using a research and development design with the ADDIE model, the study focused on the development stage. Participants included material and media experts, informatics teachers, and 72 eleventh-grade students from a public high school, selected through purposive and quota sampling. Data were collected using expert validation sheets and student response questionnaires. The results showed that the developed e-module had very high feasibility for implementation. Material and media experts gave an average score of 3.63, indicating strong content accuracy, instructional organization, and visual design. Student responses also indicated a highly positive average score of 3.52, reflecting good accessibility and engagement, despite minor difficulties with some technical terms. In conclusion, the LMS-based e-module showed very high feasibility and offers a promising framework for supporting structured, problem-based learning in vocational education.

INTRODUCTION

The rapid advancement of information and communication technology has repositioned digital platforms as central components of contemporary education (Haleem et al., 2022). Consequently, Learning Management Systems (LMS) and blended learning environments are increasingly utilized to facilitate flexible instruction and resource

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distribution (Ali et al., 2023). In vocational education, digital materials play a critical role in enhancing interactivity, learner autonomy, and engagement, particularly in practice-oriented subjects such as computer networks (Yan et al., 2024). This trend aligns with the demand for 21st-century skills, which require the integration of technology with effective pedagogical approaches (Almazroa & Alotaibi, 2023).

However, the integration of digital learning does not necessarily ensure the development of higher-order thinking skills (HOTS). Although student-centered curricula emphasize active participation and autonomy (Amiruddin et al., 2023), many e-learning environments lack the collaborative and reflective components needed to foster these skills (Khadka et al., 2025). This issue is particularly evident in computer network learning, where limited conceptual understanding often leads to cognitive and psychomotor challenges (Fathirma'Ruf et al., 2024), and conventional media tend to hinder student engagement (Setyawan et al., 2024). While approaches such as analogy-based multimedia have shown potential in improving conceptual understanding (Mertayasa et al., 2025), a more structured pedagogical framework is still required.

Problem-Based Learning (PBL) offers a relevant framework to address these challenges by engaging students in authentic problem-solving processes. Prior studies indicate that PBL enhances autonomous learning, problem-solving skills, and HOTS among vocational students (Hariani et al., 2023), especially when supported by appropriate learning media (Robby Al-Farisi et al., 2023). In the context of computer network learning, PBL-based media have demonstrated validity, practicality, and effectiveness in improving learning outcomes (Annisa et al., 2024; Al Husaeni et al., 2025), highlighting its relevance for practice-oriented disciplines.

Integrating PBL with LMS-based interactive e-modules provides a promising approach to structuring digital learning. LMS platforms support adaptive and accessible learning environments (Almazroa & Alotaibi, 2023;Kusasi, 2024), while digital modules can enhance analytical thinking and computational skills (Annisa et al., 2024; Hossain, 2023). Previous studies also confirm that combining PBL with interactive media improves critical thinking and problem-solving abilities (Hamidah et al., 2024; Ahdhianto et al., 2024). However, existing research predominantly examines LMS, PBL, and e-modules separately, with limited attention to their integrated design (Simelane-Mnisi & Mthimunye, 2025; Xu et al., 2025; Mursyida et al., 2024; Ruslan et al., 202). Moreover, ensuring the feasibility of such integration requires systematic validation through R&D processes (Hadira et al., 2024).

Therefore, this study aims to evaluate the feasibility of an LMS-based e-module integrated with the PBL model in computer network learning. The novelty of this study lies in explicitly aligning the e-module structure with PBL syntax to support a more systematic and pedagogically grounded digital learning environment.

METHOD

This study employed a Research and Development (R&D) design using the ADDIE model, specifically focusing on the development stage to evaluate the feasibility (validity and practicality) of an LMS-based e-module for computer network learning using Problem-Based Learning (PBL). Participants included material and media experts, Informatics teachers, and 72 eleventh-grade students from SMA Negeri 5 Tegal, selected through purposive and quota sampling. The validation process ensured both content accuracy including PBL integration and alignment with learning objectives and media usability within the LMS platform before full classroom implementation.

The research instrument utilized expert validation sheets containing quantitative rating scales and qualitative open-ended questions. Content validation assessed conceptual accuracy, material completeness, PBL syntax integration, and alignment with the Merdeka Curriculum for eleventh-grade students. Meanwhile, media validation evaluated the e-module's interface clarity, navigation, and visual presentation within the LMS platform. The specific aspects and indicators for material expert validation are detailed in Table 1.

Table 1. Aspects and Indicators of Material Expert Validation of the LMS-Based E-Module in Computer Network Learning using the Problem-Based Learning Model

No	Aspect	Indicator	Item No
1	Self Instruction	Clarity of learning objectives	1
		Organization of material	2

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No	Aspect	Indicator	Item No
		Availability of illustrations and images	3, 4
		Availability of examples, exercises, and formative tests	5, 6, 7, 8
		Relevance of material to learning context	9
		Use of language	10, 11, 12
		Availability of assessment instruments	13
		Availability of feedback	14, 15
2	Self Contained	Contains complete material within one unit or sub-competency	16
3	Stand Alone	Not dependent on other modules	17
4	Adaptive	Ease of using the module	18
5	User Friendly	Instructions are easy to understand	21
		Information is easy to understand	22, 23
6	Content Currency	Accuracy of material	24
		Accuracy of facts and data	25
		Accuracy of concepts and definitions	26
		Accuracy of descriptions and visual design	27, 28
7	Benefits	Clarifies material presentation	29
		Increases motivation	30
		Helps students solve computer network problems	31
		Improves competency	32
		Encourages student activeness	33
		Enables self-assessment	34
		Helps identify competency achievement	35

Source: (Hadira et al., 2024; Mursyida et al., 2024)

Aspects and Indicators of Media Expert Validation of the LMS-Based E-Module in Computer Network Learning using the Problem-Based Learning Model are presented in Table 2 below.

Table 2. Aspects and Indicators of Media Expert Validation of the LMS-Based E-Module in Computer Network Learning using the Problem-Based Learning Model

No	Aspect	Indicator	Item No
1	Format	Paper format and column layout	1, 2
		Layout format	3
2	Module Size	Module size	4
3	Module Cover Design	Module cover design	5
4	Attractiveness	Presentation of module cover	6, 7
		Composition of cover elements	8, 9
		Presentation of module content	10,11,12,13
		Packaging of assignments and tests	14, 15
5	Font Type and Size	Use of font types and sizes	16, 17
		Presentation of proportional font types and sizes	18, 19
6	Spacing (White Space)	Blank space	20, 21
		Spacing between text	22,23,24,25
7	Consistency	Font consistency	26, 27
		Spacing consistency	28, 29

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No	Aspect	Indicator	Item No
		Writing consistency	30, 31
8	Presentation	Presentation techniques	32
		Structure and flow between chapters, units, and paragraphs	33,34,35,36
		Presentation support elements	37,38,39,40

Source: (Ahdhianto et al., 2024; Al Husaeni et al., 2025)

The student test instrument includes a module feasibility test based on material, media, and usability aspects. The outline of the student test instrument is shown in Table 3.

Table 3. Student Instrument Grid

No	Aspect	Indicator	Item No
1		Clarity of learning objectives	1
		Availability of examples, assignments, and formative tests	2, 3, 4, 5
		Relevance of material to learning context	6
	Material	Use of language	7, 8, 9
		User friendly (Instructions are easy to understand)	10
		User friendly (Information is easy to understand)	11
		User friendly (Terms are easy to understand)	12
2		Presentation of module cover	13, 14
		Composition of module cover elements	15
	Media	Presentation techniques	16, 17
		Presentation of module content (attractiveness)	18,19,20,21
		Use of font types and sizes	22, 23
3		Clarifies material presentation	24, 25
		Increases motivation	26, 27
		Overcomes space and time limitations	28
	Benefits	Improves competency	29, 30
		Guides students in problem solving	31, 32
		Encourages student activeness	33, 34
		Helps complete assigned tasks	35

Source: (Shen et al., 2024; Hariani et al., 2023)

The data was analyzed using quantitative descriptive techniques by calculating the average score (mean) for each indicator and overall to determine the level of product feasibility. The analysis results were then interpreted based on eligibility criteria arranged according to a Likert scale range of 1–4. The category interval was determined by dividing the difference between the maximum and minimum scores into four categories, resulting in the classification presented in Table 4.

Tabel 4. Eligibility Criteria Based on Average Score

Score Range	Eligibility Category
3,26 – 4,00	Very High
2,51 – 3,25	High
1,76 – 2,50	Moderate
1,00 – 1,75	Low

Source: (Sugiyono, 2022)

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This study adhered to ethical research principles by ensuring voluntary participation of the expert validators. Informed consent was obtained prior to data collection, and the confidentiality of the validators' identities and responses was maintained. The data were used solely for research purposes and reported objectively to ensure the integrity and credibility of the findings.

RESULT AND DISCUSSION

Result

Material Expert Validation

The validation results provide a comprehensive overview of the quality of the LMS-based e-module content before implementation in learning. A summary of the feasibility assessment results by subject matter experts is presented in Table 5 below.

Table 5. Summary of the Results of the Feasibility Assessment of LMS-based e-modules by Material Experts

No	Statement	Validator		Average	Category
		1	2		
1	Learning objectives are clearly and measurably stated	4	4	4.00	Very High
2	Material is systematically and sequentially organized	4	3	3.50	Very High
3	Illustrations help in understanding the material	3	3	3.00	High
4	Images are relevant to the material	4	3	3.50	Very High
5	Examples are appropriate to the material	4	4	4.00	Very High
6	Exercises help understanding	4	3	3.50	Very High
7	Test items are varied	3	3	3.00	High
8	Tests align with learning objectives	4	4	4.00	Very High
9	Material is related to the learning context	3	3	3.00	High
10	Language is easy to understand	4	4	4.00	Very High
11	Sentences are effective	4	3	3.50	Very High
12	Terms follow scientific conventions	4	4	4.00	Very High
13	Assessment instruments are available	3	3	3.00	High
14	Feedback is available	4	3	3.50	Very High
15	Feedback helps identify mistakes	4	4	4.00	Very High
16	Material is presented comprehensively	4	4	4.00	Very High
17	Module does not depend on other materials	3	3	3.00	High
18	Module is easy to use	4	3	3.50	Very High
19	Instructions are easy to understand	4	4	4.00	Very High
20	Instructions are clear and not confusing	4	3	3.50	Very High
21	Instructional language is communicative	4	4	4.00	Very High
22	Information is easy to understand	4	3	3.50	Very High
23	Information is clearly presented	4	4	4.00	Very High
24	Material follows scientific principles	4	4	4.00	Very High
25	Facts and data are accurate	4	3	3.50	Very High
26	Concepts and definitions are correct	4	4	4.00	Very High
27	Learning design aligns with objectives	3	3	3.00	High
28	Material structure is logical	4	3	3.50	Very High
29	Enhances clarity of material presentation	4	4	4.00	Very High
30	Increases learning motivation	4	3	3.50	Very High
31	Helps in problem solving	4	4	4.00	Very High
32	Improves student competency	4	3	3.50	Very High
33	Encourages student activeness	4	4	4.00	Very High
34	Enables students to assess their own ability	3	3	3.00	High

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No	Statement	Validator 1	Validator 2	Average	Category
35	Helps identify competency achievement	4	4	4.00	Very High
	Total Average			3,63	Very High

Table 5 shows that the LMS-based e-module obtained an overall mean score of 3.63 (very high), indicating strong content feasibility before classroom implementation. Most indicators were rated very high, particularly learning objectives, material organization, language clarity, examples, feedback, and conceptual accuracy. These results suggest that the module already has a solid instructional foundation and is suitable for use in vocational computer network learning.

However, several indicators were rated high, namely the use of illustrations, test item variety, contextual relevance of the material, availability of assessment instruments, module independence from other materials, alignment of learning design with objectives, and opportunities for self-assessment. These scores indicate areas that still require revision. In practical terms, the module should be strengthened by adding more contextual examples and visuals, diversifying practice questions, making assessment features more explicit, and improving self-assessment components so that learners can work more independently without relying on external resources.

Media Expert Validation

Overall, the results of this validation provide a comprehensive picture of the level of media suitability which is then presented in detail in Table 6 which contains a recapitulation of suitability by media experts.

Table 6. Summary of the Results of the Feasibility Assessment of LMS-based e-modules by Media Experts

No	Statement	Validator 1	Validator 2	Average	Category
1	The paper format used in the module meets the standard.	4	4	4.00	Very High
2	The column format in the module is neatly arranged and easy to read.	4	3	3.50	Very High
3	The module layout is proportionally organized.	3	3	3.00	High
4	The module size is appropriate for student use.	4	4	4.00	Very High
5	The module cover design is attractive and representative.	4	3	3.50	Very High
6	The visual presentation on the cover is able to attract attention.	4	4	4.00	Very High
7	The module cover reflects the content of the material.	3	3	3.00	High
8	The color composition on the cover is harmonious.	4	4	4.00	Very High
9	The placement of elements on the cover is balanced.	4	3	3.50	Very High
10	The presentation of the module content is visually appealing.	4	4	4.00	Very High
11	The module content display is not monotonous.	3	3	3.00	High
12	The use of illustrations supports the content display.	4	4	4.00	Very High
13	The presentation of material in the module is easy to follow.	4	3	3.50	Very High
14	The presentation of tasks in the module is engaging.	4	4	4.00	Very High
15	The presentation of tests in the module is clear and systematic.	3	3	3.00	High
16	The typeface used is easy to read.	4	4	4.00	Very High
17	The font size is appropriate for students' needs.	4	3	3.50	Very High
18	Font variation is used proportionally.	4	4	4.00	Very High
19	Font emphasis (bold/italic) is used appropriately.	3	3	3.00	High
20	The use of white space makes the layout not too dense.	4	4	4.00	Very High
21	Spacing between elements is proportionate.	4	3	3.50	Very High
22	Line spacing makes the text easy to read.	4	4	4.00	Very High
23	Paragraph spacing is neatly arranged.	3	3	3.00	High
24	Spacing between headings and content is clear.	4	4	4.00	Very High

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No	Statement	Validator 1	Validator 2	Average	Category
25	The text arrangement is not too crowded.	4	3	3.50	Very High
26	Consistency in the use of font types is maintained.	4	4	4.00	Very High
27	Consistency in font size is appropriate.	3	3	3.00	High
28	Consistency in spacing across pages is maintained.	4	4	4.00	Very High
29	Consistency in layout across pages is good.	4	3	3.50	Very High
30	Consistency in page numbering is accurate.	4	4	4.00	Very High
31	Consistency in writing headings and subheadings is appropriate.	3	3	3.00	High
32	The material presentation techniques are engaging.	4	4	4.00	Very High
33	The flow between chapters is systematically organized.	4	3	3.50	Very High
34	The connection between learning units is clear.	4	4	4.00	Very High
35	The flow between paragraphs is easy to understand.	3	3	3.00	High
36	Transitions between sections of the material are smooth.	4	4	4.00	Very High
37	The use of images supports the presentation.	4	3	3.50	Very High
38	Tables or graphs are presented clearly.	4	4	4.00	Very High
39	Visual elements help in understanding the material.	3	3	3.00	High
40	Other supporting media are relevant to the content.	4	4	4.00	Very High
	Total Average			3,63	Very High

The media expert evaluation indicates that the LMS-based e-module achieved an overall mean score of 3.63 (very high), confirming strong feasibility in terms of layout, readability, visual design, and presentation structure. Most indicators were rated Very High, showing that the module is generally attractive, user-friendly, and well organized for vocational learning.

Nevertheless, several indicators were rated high, particularly those related to layout proportion, cover-content alignment, variation in content display, clarity of task and test presentation, font consistency, paragraph spacing, heading consistency, flow between paragraphs, and the support of visual elements. These results suggest that the product still requires revision in its visual and structural design, especially to improve layout balance, strengthen coherence between cover and content, and make the presentation of learning materials more dynamic and easier to follow. In practical terms, the revisions should focus on improving graphic consistency and formatting so that the module becomes more readable, more engaging, and more pedagogically effective.

Student Responses to LMS-Based E-Modules

Student responses to the developed LMS-based e-module were used to assess the product's acceptability in learning. This assessment was based on students' direct experiences after using the learning materials, including aspects of ease of use, material clarity, and visual appeal. The results provide an overview of the quality of the learning materials from a user perspective, which is presented in Table 7 a summary of student responses.

Table 7. Summary of Student Response Results regarding the Feasibility of LMS-based e-modules

No	Statement	Average	Category
1	The learning objectives in the module are presented clearly.	4.00	Very High
2	The examples provided help me understand the material.	3.50	Very High
3	The tasks in the module help me learn.	3.60	Very High
4	The formative tests help me assess my understanding.	3.40	Very High
5	The practice questions in the module are easy to understand.	3.00	High
6	The material presented is aligned with the learning I experience.	3.20	High
7	The language used in the module is easy to understand.	3.80	Very High
8	The sentences in the module are clear and not confusing.	3.70	Very High
9	The terms used are easy for me to understand.	3.10	High
10	The instructions in the module are easy to follow.	3.90	Very High

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No	Statement	Average	Category
11	The information presented is easy to understand.	3.50	Very High
12	The explanation of terms in the module helps my understanding.	3.00	High
13	The module cover design attracts my attention.	4.00	Very High
14	The module cover makes me interested in learning.	3.60	Very High
15	The composition of images and text on the cover is balanced.	3.40	Very High
16	The way the material is presented in the module is engaging.	3.80	Very High
17	The presentation of the material prevents me from getting bored quickly.	3.20	High
18	The visual appearance of the module content is appealing.	3.70	Very High
19	The use of images helps me understand the material.	3.50	Very High
20	The illustrations in the module are interesting and relevant.	3.60	Very High
21	The module display makes me comfortable while learning.	3.10	High
22	The font type in the module is easy to read.	4.00	Very High
23	The font size in the module is appropriate and comfortable to read.	3.50	Very High
24	The module helps me understand the material more clearly.	3.80	Very High
25	The presentation of material in the module makes it easier for me to learn.	3.60	Very High
26	The module increases my motivation to learn.	3.40	Very High
27	The module makes me more interested in learning.	3.20	High
28	The module can be used anytime and anywhere.	3.50	Very High
29	The module helps improve my abilities.	3.70	Very High
30	I understand the material better after using the module.	3.80	Very High
31	The module helps me solve problems in learning.	3.40	Very High
32	The module provides clear steps for problem-solving.	3.20	High
33	The module encourages me to be more active in learning.	3.60	Very High
34	The module makes me participate more often in learning activities.	3.10	High
35	The module helps me complete the tasks given by the teacher.	3.70	Very High
	Total Average	3.52	Very High

Student responses indicate that the LMS-based e-module was positively received, with an overall mean score of 3.52 (very high). This shows that the module is generally accessible, engaging, and helpful for supporting learning in computer network subjects. The highest ratings were found in items related to clear learning objectives, attractive cover design, readable font use, and the module's ability to improve understanding and learning tasks, suggesting that the product already works well as a learning resource.

However, several items were rated high, particularly those concerning technical terminology, alignment with students' learning experience, boredom reduction, comfort during learning, motivational appeal, clarity of problem-solving steps, and classroom participation. These findings indicate that the module still needs refinement in language simplicity, contextual relevance, and interactive scaffolding. In practical terms, revision should focus on simplifying difficult terms, strengthening examples and explanations, and adding more engaging problem-solving guidance so the module can better sustain student attention and support independent learning.

Discussion

Comprehensive testing confirms that the LMS-based e-module using Problem-Based Learning (PBL) is highly feasible, with material, media, and student responses all achieving highly satisfactory ratings. Pedagogically, it excels in clarifying objectives and facilitating problem-solving, validating PBL's effectiveness in enhancing vocational students' higher-order thinking skills (HOTS) (Hariani et al., 2023); (Annisa et al., 2024). However, a minor dependency on external references suggests the need to enrich internal content to fully support independent student investigations.

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From a media perspective, LMS integration provides excellent visual ergonomics, proven by high ratings for navigational flow, readability, and visual appeal. This adaptive structure goes beyond linear content distribution (Al-(Al-Qora'n et al., 2025; Gavrus et al., 2025). Nevertheless, experts noted that layout proportions and visual elements require functional optimization. Since network concepts are abstract (Setyawan et al., 2024), integrating concrete, analogy-based interactive visuals is essential to ease students' cognitive processes (Mertayasa et al., 2025).

Student responses highlight the module's practical effectiveness, particularly praising its engaging interface and clear instructions, which successfully build the enthusiasm necessary for autonomous learning (Yan et al., 2024). However, students reported challenges in grasping technical terms and practice questions. Because unfamiliarity with network nomenclature often hinders analytical development (Fathirma'Ruf et al., 2024), educators must provide cognitive scaffolding and an interactive technical glossary within the LMS to reduce cognitive load.

Conceptually, this research advances educational technology literature by explicitly mapping the e-module's LMS architecture to PBL's syntax, moving beyond mere evaluations of end-user satisfaction (Simelane-Mnisi & Mthimunye, 2025); (Almazroa & Alotaibi, 2023). While establishing solid practical feasibility, a key limitation is the absence of experimental learning outcome measurements. Future research should employ quasi-experimental designs to objectively measure HOTS improvements and explore integrating adaptive learning analytics for a truly personalized ecosystem.

CONCLUSION

This study establishes that the LMS-based e-module integrated with the Problem-Based Learning (PBL) model has a very high level of feasibility for computer network learning. The principal contribution of this research lies in the explicit alignment of LMS features with the structured syntax of PBL, offering a coherent design framework for developing pedagogically grounded digital learning media in vocational education. This approach repositions the LMS from a content delivery tool into a structured and interactive learning environment that supports problem-based learning processes.

Nevertheless, this study is limited to the development and feasibility evaluation stage and does not address the effectiveness of the e-module in improving learning outcomes or Higher-Order Thinking Skills (HOTS). In addition, the findings are derived from a limited sample within a single institutional context, which may constrain their generalizability. Therefore, further research employing experimental or quasi-experimental designs with broader and more diverse participants is necessary to examine the effectiveness and scalability of the proposed model.

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