

Development of a Learning Management System (LMS) Based on Canvas Instructure to Support Students' Critical Thinking Skills

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ABSTRACT

A learning management system (LMS) is a solution for managing learning in the 21st-century education era. Canvas Instructure is an LMS that supports students' critical thinking skills. This study aims to develop a canvas-based LMS structure on Linear Program material to support the critical thinking skills of grade 11 students. The research method was research and development using the ADDIE development model. The LMS was tested on 22 eleventh grade high school students with Linear Program material. The results of the study showed that, LMS validation obtained a percentage of 89.375% based on LMS expert validation and 92.222% from material experts. The average teacher response questionnaire was 94.36% and the average student response questionnaire was 89.37%. The results of students' critical thinking skills obtained a percentage of student completion of 90.91% with an average of 85.82. Therefore, this LMS is considered valid, effective, and practical for use in supporting the critical thinking skills of grade 11 students in the Linear Program.

Keywords: *Canvas Instructure, Critical Thinking, Learning Management System, Linear Program*

Pengembangan *Learning Management System* (LMS) Berbasis *Canvas Instructure* untuk Mendukung Kemampuan Berpikir Kritis Siswa

ABSTRAK

Learning Management System (LMS) menjadi solusi dalam mengelola pembelajaran di era pendidikan abad 21. *Canvas Instructure* merupakan salah satu LMS yang memiliki kelengkapan fitur pembelajaran dalam mendukung kemampuan berpikir kritis siswa. Penelitian ini bertujuan untuk mengembangkan struktur LMS berbasis Canvas pada materi Program Linear untuk menunjang kemampuan berpikir kritis siswa kelas 11. Metode penelitian yang digunakan adalah penelitian dan pengembangan menggunakan model

pengembangan ADDIE. LMS yang diujikan kepada 22 siswa kelas 11 SMA dengan materi Program Linear. Hasil penelitian menunjukkan bahwa, validasi LMS memperoleh persentase sebesar 89,375% berdasarkan validasi ahli LMS dan 92,222% dari ahli materi. Angket respons guru rata-rata sebesar 94,36% dan angket respons siswa dengan rata-rata sebesar 89,37%. Hasil keterampilan berpikir kritis siswa memperoleh persentase ketuntasan siswa sebesar 90,91% dengan rata-rata 85,82. Oleh sebab itu, LMS ini disimpulkan valid, praktis, dan efektif untuk digunakan dalam mendukung kemampuan berpikir kritis siswa kelas 11 pada materi Program Linear.

Kata Kunci: *Canvas Instructure, Berpikir Kritis, Learning Management System, Program Linear.*

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1. Introduction

The development of 21st-century technology demands changes in the world of education, especially in the learning management system (LMS). Currently, it is very important to know information about online learning so that students can self-organize to design an optimal online learning process. Teachers are crucial in managing learning effectively, understanding students' needs, and adopting the latest technology to improve engagement and learning outcomes (Lucas & Vicente, 2023; Sorensen & Dumay, 2024; Suryani, Anwar, Hajidin, & Rofiki, 2020; Timotheou et al., 2023; Suwarman, Rofiki, & Inayah, 2024; Listiawan, Darmawan, Rofiki, & Hayuningrat, 2024). In addition, integrating technology into learning can make learning more effective, interactive, and adaptive (Ramadhan & Kusuma, 2021; Safitri, Haryanto, & Rofiki, 2020).

LMS is a digital platform specifically designed to manage, deliver, and track the online learning process (Mundir & Umiarso, 2022; Nur et.al, 2022; Ouariach, Nejjari, Ouariach, & Khaldi, 2024; Simelane-Mnisi, 2023). In digital education, LMS allows educators to organize materials, facilitate interaction, and assess student progress (Aboagye, Yawson, & Appiah, 2020; Alserhan, Alqahtani, Yahaya, Al-Rahmi, & Abuhassna, 2023; Bradley, 2020; Mathisen & Sørensen, 2024; Su & Chen, 2024). LMS becomes software for online learning processes that use the internet to access media and organize web-based online learning materials (Andriani & Daroin, 2022). Canvas Instructure is a learning management system that supports online learning by providing tools for material delivery and student interaction (Pujasari, 2021). In math learning, this platform is considered effective in helping teachers improve students' skills (Nishitha & Pandey, 2021). Canvas Instructure in learning allows teachers to present learning materials in various formats, including text, images, videos, and other interactive resources. This requires students to process, interpret, and critique the information presented (Permana, Sopan, & Muntasa, 2022).

Students' ability to analyze, evaluate, and solve problems critically and reflectively is the essence of critical thinking. Through critical thinking skills, students can communicate mathematical thinking coherently to teachers and other students. In critical thinking skills, students explain the steps taken to solve problems, justify the solutions found, and communicate logical arguments. Students can also organize and combine mathematical thinking and express

mathematical ideas appropriately (Damarjati & Miatun, 2021; Febriani, et al., 2024). Moreover, the ability to provide correct solutions and accurate results (Maulidah, Syaf, Rachmawati, & Sugilar, 2020).

Based on the results of interviews with mathematics teachers at Senior High School in Malang, it shows that students have difficulty in linear programming material. In fact, linear programming requires students to use critical thinking skills, such as analysis, modelling, and problem-solving involving patterns and relationships between variables. Ironically, this topic often reflects students' low critical thinking skills (Syifa, Hapizah, Susanti, Mulyono, & Hadi, 2022). It can be seen from the students' test results that they show scores under the minimal completeness criteria (KKM) when solving the problems given (Mirayani, Widana, & Purwati, 2021). The constraints that arise include difficulty solving problems, assembling information, and identifying relationships between variables. Students' critical thinking abilities are low due to errors in solving mathematics problems. This is evident from the difficulties in analyzing problems, choosing strategies, and applying logical reasoning. Their errors stem from misconceptions, computational errors, or lack of justification in their solutions. This problem has an impact on low exam scores for students, indicating a lack of understanding and weak problem-solving skills. A lack of critical thinking skills can affect the quality of students' problem-solving, analysis, and evaluation problem-solving. As a result, students struggle to apply critical thinking in mathematical contexts, leading to repeated errors.

Jacob and Sam's theory can be used to measure students' critical thinking abilities. According to Jacob and Sam (2008), their critical thinking theory consists of four indicators. The first indicator, clarification, refers to students' ability to identify problems and accurately record all relevant information from the main problem. Clarification is seen in how students identify and write information about their problems. Assessment is the second indicator of the critical thinking process. It describes students analyzing the relevant information process, finding questions and logical reasons to strengthen the information to conclude. Assessment is seen from the way students provide reasons based on the problems that have been identified. The next indicator is the inference describes students being asked to draw conclusions based on information obtained by collecting and combining information from a problem to generalize. Inference can be seen from the way students make conclusions. Strategies describe how students can solve problems by evaluating each step and finding other possible solutions to solve the problem. Strategy is seen in how students re-evaluate the solutions' results (Sukayasa, Murdiana, Hasbi, & Jaeng, 2022).

In the past four years, there have been many studies related to LMS-based e-learning in mathematics learning, such as using LMS to support student learning motivation (Ramadhan & Kusuma, 2021), use of LMS to support creative thinking skills (Sari et al., 2020), use of LMS to facilitate student learning (Danurahman & Arif, 2021; Kholipah, Arisanty, & Hastuti, 2021), use LMS to support problem-solving skills of students (Afra, Novia, Sasmita, Fauzy, & Rozak, 2023), and use of EdPuzzle as an LMS (Sari et al., 2023). However, research regarding the use of Canvas Instructure as an LMS, especially in supporting students' critical thinking abilities, is still rare. In fact, Canvas Instructure has superior features and interactivity to the needs of teachers and students. Features such as Quizzes & Assignments, Discussions, Rubrics, SpeedGrader, and Analytics & Reports play an important role in fostering critical thinking. Quizzes & Assignments encourage analysis and problem-solving, while Discussions encourage argumentation and logical reasoning. Rubrics provide clear evaluation criteria to guide students' reflections, and SpeedGrader enables timely and detailed feedback to refine their thinking. With these features Canvas Instructure can support students in practicing critical thinking skills (Santiana, Silvani, & Ruslan, 2021). To address the identified research gap, this study aims to develop a Canvas Instructure-based LMS tailored to support students' critical thinking skills.

The outcomes of this research are intended to serve as a reference and practical guidance for teachers in designing mathematics learning experiences that leverage the unique capabilities of a Canvas Instructure-based LMS. This research explores the specific features of Canvas Instructure that facilitate critical thinking and investigates how these features differ from those of other LMS in supporting such skills. By identifying these distinctive aspects, the study seeks to provide valuable insights into the design and implementation of effective, critical-thinking-focused learning strategies.

2. Method

This study employed a research and development (R&D) approach using the ADDIE development model. The ADDIE model was chosen for LMS development because it minimized risks and errors during the process. The ADDIE development model was adapted to meet the specific needs and characteristics of the LMS, aiming to support the critical thinking skills of grade 11 high school students. The stages of the ADDIE development are shown in Figure 1 (Tegeh, Jampel, & Ketut, 2014).

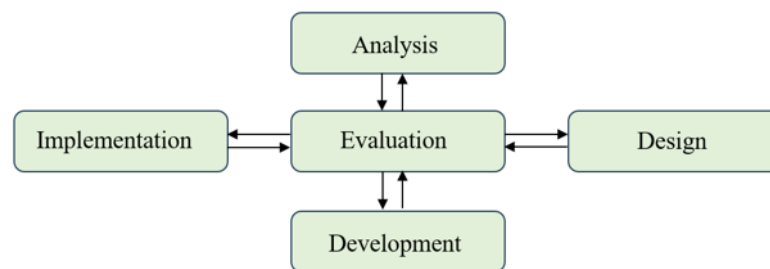


Figure 1. Stages of ADDIE Development Model

In the analysis phase, problems, solutions, and student needs were identified through activities like curriculum mapping and needs analysis. The design phase involved planning and structuring instructional materials, including LMS development, handouts, videos, quizzes, and rubrics. During development, these materials were created and validated for quality. Implementation tests the LMS in small- and large-scale trials to evaluate its effectiveness. Finally, Evaluation assessed the instructional product through summative and formative methods, ensuring continuous improvement.

The study involved LMS experts, material experts, practitioners, teachers, and students. LMS and material experts were doctoral-qualified lecturers, practitioners held at least undergraduate degrees, and teachers were high school math educators with bachelor's degrees. In the implementation stage, 22 students participated: six in a small group trial (two each of low, medium, and high ability) and 16 in a large group trial.

Data collection techniques included interviews, questionnaires, and tests, with instruments validated by experts to ensure quality. Validation focused on LMS interactivity, content design, and system functionality. Interactivity examined ease of access, operation, and file management. Material experts evaluated LMS content, language, and alignment with competencies, while response questionnaires measured usability and relevance.

The validity of the media was calculated based on the answers from the results of the validation sheet. Meanwhile, the practicality of the media was calculated based on answers from the response questionnaire. Data were analyzed using a Likert scale. The assessment scores are categorized into five levels, where a score of 5 indicates Excellent, 4 was considered High, 3 was classified as Medium, 2 was labeled as Low, and 1 was indicated as Poor. Furthermore,

data processing is carried out using the following formula from the results of obtaining the validation sheet and response questionnaire.

$$P = \frac{\sum x}{\sum x_i} \quad (1)$$

Description

P = Percentage
 $\sum x$ = Total number of answers in each item
 $\sum x_i$ = Total ideal score

The validation criteria used in the study are presented in Table 1. This LMS is considered valid if the percentage obtained is $\geq 60\%$, with valid minimum qualifications.

Table 1. Criteria for Validation of Learning Management System

Interval	Validity Criteria
$80\% < x \leq 100\%$	Very Valid
$60\% < x \leq 80\%$	Valid
$40\% < x \leq 60\%$	Valid Enough
$20\% < x \leq 40\%$	Less Valid
$0\% < x \leq 20\%$	Invalid

The practicality criteria used in this study are shown in Table 2. This LMS is considered practical if it has a percentage more significant than 60% with practical minimum qualifications.

Table 2. Criteria for Practicality of Learning Management System

Interval	Practicality Criteria
$80\% < x \leq 100\%$	Very Practical
$60\% < x \leq 80\%$	Practical
$40\% < x \leq 60\%$	Practical Enough
$20\% < x \leq 40\%$	Less Practical
$0\% < x \leq 20\%$	Impractical

The effectiveness of this LMS is calculated based on the result of critical thinking test with the following average formula:

$$P = \frac{\sum x}{n} \quad (3)$$

Description

P = Percentage
 $\sum x_i$ = Total student score
 n = Total students

LMS was said to be effective if the average score of students' critical thinking test is above the minimum completeness criteria (KKM), which is 78, and the percentage of complete students is greater than or equal to 85%. These benchmarks indicated that the LMS successfully facilitates learning by enhancing students' ability to analyze, evaluate, and apply knowledge critically, aligning with the goals of fostering critical thinking in educational contexts. This reflected the LMS's ability to support critical thinking by promoting analysis, problem-solving, and evaluation skills, as evidenced by improved academic performance and learning outcomes.

3 RESULT AND DISCUSSION

3.1 Analysis

Based on the results of interviews with high school teachers, it showed the need for ICT-based media to support students' critical thinking skills in linear program material. The ICT media used provide interactive visualizations, dynamic problem-solving environments, and real-time feedback, so that students can explore mathematical concepts, analyze various scenarios, and assess solutions more effectively. The media is expected to reduce the use of

paper, overcome space and time limitations, and include features such as video, animation, images, and audio (Anam, 2022; Fuadi, 2022). Students often use smartphones during learning, tend to be inactive, and are more interested in devices than teacher instructions (Olin-Scheller, Tanner, Asplund, Kontio, & Wikström, 2021). During the curriculum analysis stage, the researchers identified the material to be studied, focusing on the Linear Program. At this stage, the material was aligned with basic competencies 3.2 and 4.2 in Table 3. Furthermore, competency achievement indicators for each basic competency were determined by considering operational verbs and formulating appropriate learning objectives (Maharani & Retnowati, 2020). Students are more interested in online-based learning than in conventional learning (Mulenga & Marbán, 2020), because of its ease of access (Syauqi, Munadi, & Triyono, 2020). With e-learning, students are more motivated and easily understand the material compared to direct explanation by the teacher (Gherheș, Stoian, Fărcașiu, & Stanici, 2021).

Table 3. Basic Competencies

Basic Competencies	
3.2 Explain two-variable linear program and its solving methods by using contextual problems	4.2 Solve contextual problems related to two-variable linear programs

3.2 Design

In the design stage, researchers used Canvas Instructure as an LMS equipped with a presence feature, quiz, student worksheets, syllabus, assessment rubric, and learning video. Student worksheets are attractively designed using Canva and Flipbook Maker to increase learning motivation (Harwati & Rokhmat, 2021). Learning videos are made using Cap Cut and Canvas. The syllabus is displayed in e-learning and includes core competency (*kompetensi inti*), basic competencies (*kompetensi dasar*), subject matter, and learning indicators (Sobirovna & Hakima, 2024; Suartama, Mahadewi, Divayana, & Yunus, 2022). Meanwhile, assessment rubrics are obtained from the Canvas Instructure feature. The quiz questions were arranged to support students' critical thinking skills (Setiana, Purwoko, & Sugiman, 2021). The quizzes are structured by combining higher-order thinking skills and Jacob and Sam indicators. The questions are structured progressively, starting with basic understanding to test students' ability to clarify concepts. Next, students are given questions that require them to assess evidence and draw conclusions based on the information provided. In this design stage, the researchers first draft the features, which were discussed with the supervisor.

LMS user satisfaction lies in the design features. There is high satisfaction with the basic features of the LMS and low with the design features. This shows that the LMS design aspect is essential. Design features in the LMS context include everything related to the user interface and user experience and flexibility in adapting the LMS to the specific needs of the user or institution (Al-Sharhan, Al-Hunaiyyan, Alhajri, & Al-Huwail, 2020; Muhardi, Gunawan, Irawan, & Devis, 2020). Users take advantage of the LMS design features in Canvas for more effective online learning in designing and implementing instructions (Santiana et al., 2021).

3.3. Development

In the development stage, LMS product development is carried out. The development stage involved creating the LMS and validating LMS experts, material experts, and practitioners (Saputro, Saerozi, Siswanta, Siswanto, & Susilowati, 2020). The LMS was developed using Canvas Instructure and filled with various features.

3.3.1. Home

This feature is filled with a welcome to students and instructions for using the LMS. The home feature will appear for the first time when students open the LMS that has been developed.

This home feature is the same as the dashboard or start page feature (Ni'mah, 2021). The display of the home feature is shown in Figure 2.



Figure 2. Home feature display

3.3.2. Announcements

The announcements feature was filled with announcements related to the Google Meet link, which was used for two meetings. Google Meet was chosen as an online meeting platform in video form that allows meetings with high-quality audio and video features, as well as collaboration via various devices (Al-Marouf, Salloum, Hassanien, & Shaalan, 2020; Upchurch, 2022). The announcement feature on the student LMS looks like Figure 3.



Figure 3. Display of the announcement feature

3.3.3. Quizzes

The quizzes feature is filled with two quizzes and an evaluation. The quiz questions consist of two short fill-in questions and two essay questions, while the assessment is filled with three description questions. Students can use the equation feature in Canvas Instructure to answer the short fill-in questions and upload a .jpg/.pdf file for the description questions. Quizzes can only be accessed after the teacher provides an access code before they begin. This quiz is necessary to support students' critical thinking abilities (Supriyatno, Susilawati, & Ahdi, 2020). To ensure the quiz measures critical thinking, questions are designed based on Jacob's (2008) critical thinking indicators. Short fill-in-the-blank questions assess clarification by requiring precise conceptual understanding. Meanwhile, descriptive questions require students to explain what is known, what is asked, their thought processes, provide justification for the answers given, and evaluate alternative solutions. The display of the quizzes feature on the student LMS is shown in Figure 4.

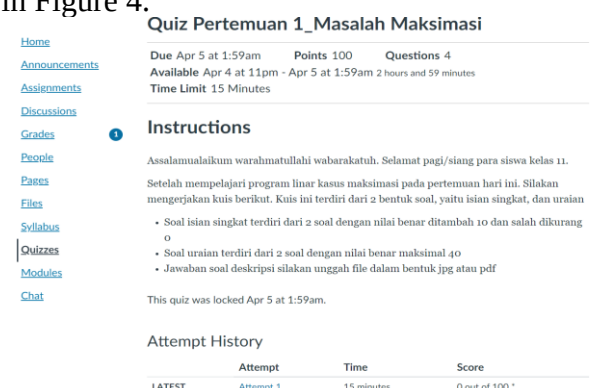


Figure 4. Display of the quizzes feature

3.3.4. Modules

In this feature, the researchers fill in electronic handouts related to linear program material. In addition to e-handouts, modules are filled with two learning videos: videos related to material explanations, videos of sample problems, and a discussion of linear program material. Each learning video lasts less than 6 minutes (Huang et al., 2020). The handouts and videos were specifically developed to support students' critical thinking skills. The handouts provide structured yet open-ended explanations to encourage students to analyze key concepts, identify relationships, and apply problem-solving strategies. Meanwhile, the learning video was designed to encourage deeper engagement by presenting real-world applications of linear programming and guiding students through a step-by-step problem-solving process. The display of the module feature on the student LMS is shown in Figure 5.

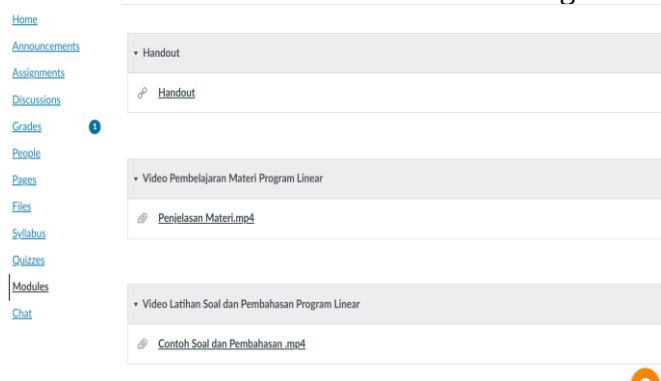


Figure 5. Display of modules feature

3.3.5. Discussions and Chat

These two features are used for students to discuss related learning materials. In the discussion feature, the teacher prepared student worksheets as group discussion material for students. Meanwhile, in the chat forum, students are asked to discuss linear program material in real time. Discussion and chat features are very important for teachers and students to interact with each other (Simanullang & Rajagukguk, 2020). The display of the discussion feature is shown in Figure 6.

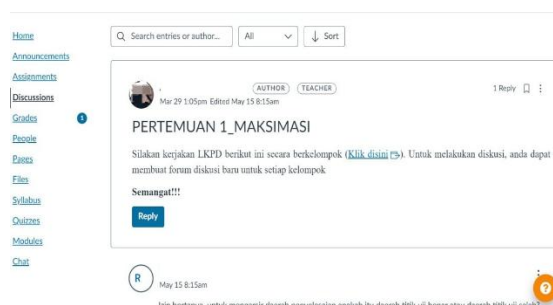
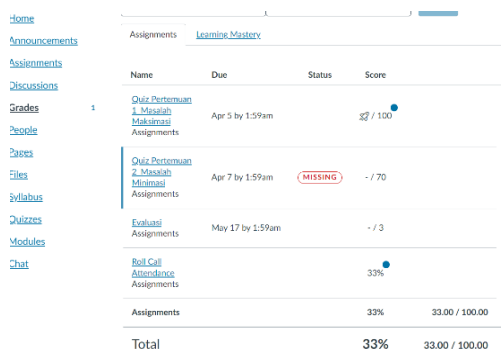


Figure 6. Display of the discussion feature

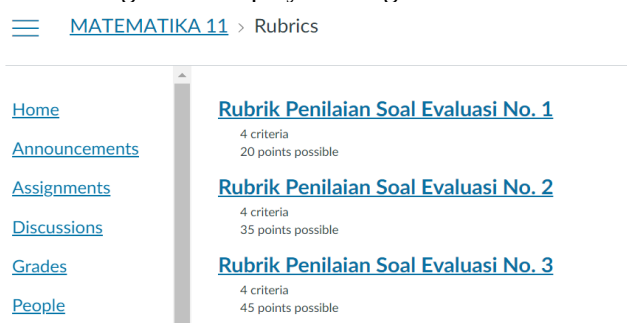
3.3.6. Grades and Rubric

Grades are a feature of the Canvas Instructure LMS that students can use to see their learning results (Burrack & Thompson, 2021). Meanwhile, rubrics are a feature that cannot be accessed by students and can only be accessed by teachers who are used to see assessment indicators for student evaluation test results (Muktiarni, Ana, Sern, & Saripudin, 2020). The grades feature is presented in Figure 7 whereas the rubrics feature is shown in Figure 8.



Name	Due	Status	Score
Quiz Performance 1 Masalah Matematika Assignments	Apr 5 by 1:59am		32 / 100
Quiz Performance 2 Masalah Matematika Assignments	Apr 7 by 1:59am	MISSING	- / 70
Evaluasi Assignments	May 17 by 1:59am		- / 3
Roll Call Attendance Assignments			33%
Assignments			33% 33.00 / 100.00
Total			33% 33.00 / 100.00

Figure 7. Display of the grades feature



Rubric Title	Criteria	Points Possible
Rubrik Penilaian Soal Evaluasi No. 1	4 criteria	20 points possible
Rubrik Penilaian Soal Evaluasi No. 2	4 criteria	35 points possible
Rubrik Penilaian Soal Evaluasi No. 3	4 criteria	45 points possible

Figure 8. Display of rubrics feature

Based on the suggestions of validators and learning practitioners, revisions to the developed LMS are shown in Table 4, and the material expert validation results in Table 5.

Table 4. LMS Expert Validation

Validator	Aspects			Percentage
	Media Interactivity	Content	System	
LMS Expert	88%	82.86%	85%	85%
Practitioner	92%	94.29%	95%	93,75%
Average	90%	88.57%	90%	89.38%

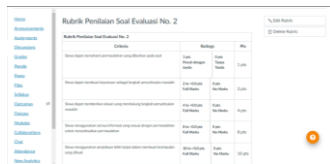
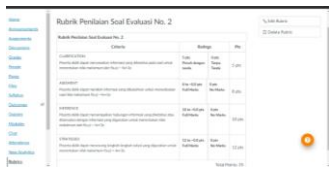
Table 5. Material Expert Validation

Validator	Aspects			Percentage
	Contents	Language	Problem (Task)	
Material Expert	92%	86.67%	80%	87.78%
Practitioner	96%	100%	96%	96.67%
Average	94%	93.33%	88%	92.22%

Based on the results of the LMS validation test, a percentage of 89.375% was obtained from the LMS expert validator and 92.22% from the material expert validator; this proved that the use of this Canvas Instructure-based LMS could support the critical thinking skills of grade XI students on Linear Program material. This LMS could be said to have been very valid with the suitability of validity indicators. The validation sheet that had been tested received a percentage of 89.38% from the LMS expert validator and 92.222% from the material expert validator, with very valid criteria for use by students. This meant that in this case, the LMS was very valid in supporting the critical thinking skills of grade XI students on Linear Program material. E-learning supported students' critical thinking skills compared to conventional-based learning (Dewi, Suarsana, & Juniantari, 2020). In the 21st-century, learning requires new learning innovations that are more interactive. LMS is a solution for developing 21st- century learning innovations to support students' critical thinking skills (Verawati, 2020). LMS-based learning will have a much more significant impact on increasing critical thinking skills. Through LMS, students can optimize interaction and critical problem-solving (Hikmawati, Sahidu, & Kosim, 2021; Liu et al., 2022).

After taking an e-learning assessment by LMS experts and material experts, researchers made revisions from the results experts' suggestions and comments before testing the students. The revised results of the Canvas Instructure LMS development are shown in Table 6.

Table 6. LMS Canvas Instructure Revision

Initial Design	Advice	Revised
	The initial <i>homepage</i> image was replaced with a live class atmosphere and completed with the supervisor's writing.	
	Given an explanation of the learning model, student activities, and steps of learning activities	
	The scoring rubric is adjusted to the critical thinking indicators of Jacob and Sam (2008)	
	Considering the variety of questions changed from multiple choice questions to short fill-in questions	

3.4 Implementation

In the implementation stage, the LMS was tested on students of grade XI SMA, with 22 students. The LMS trial was conducted synchronously online using Google Meet as shown in Figure 9.

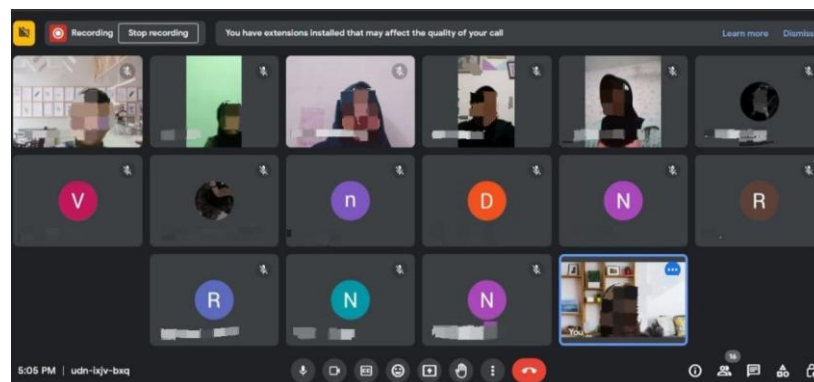


Figure 9. LMS Implementation Via Google Meet

Implementation began by sharing links to Google Meet for online meetings. Then, students were asked to explain the activities that had been carried out in the session. The researchers then briefly explained the material related to the Learning Management System (LMS). Next, students were asked to log in to the LMS provided, work on the test questions

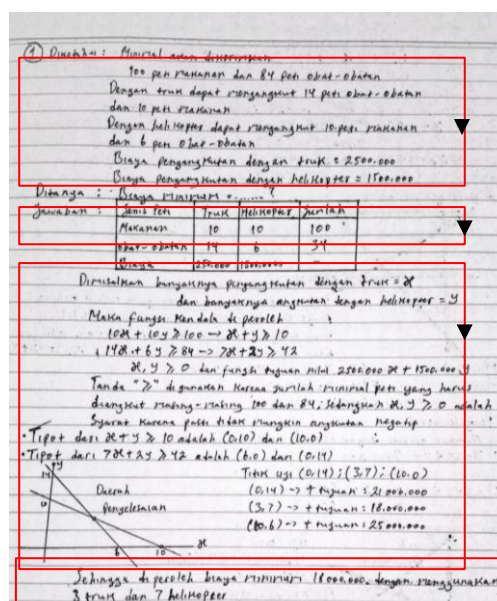
contained within it, and upload the results directly into the LMS. Students were also given directions to explore various features in the Canvas Instructure LMS. Following that, students were asked to respond via a questionnaire related to their Canvas Instructure LMS experience. The session ended with closing remarks and thanks for their willingness to try Canvas Instructure.

However, before the trial was conducted for students to get a practical LMS regarding teacher assessment, high school teachers assessed the practicality of Canvas Instructure e-learning. The results of the practicality assessment involving three mathematics teachers were obtained according to Table 7.

Table 7. Teachers' Response Questionnaire

User	Aspects			Average
	Content Quality	Technical Usage	Instructional	
Teacher 1	95 %	95 %	96 %	95.39 %
Teacher 2	90 %	95 %	96 %	93.85 %
Teacher 3	90 %	100%	92%	93.85 %
Average	91.67 %	96.67 %	94.67 %	94.36 %

In the practicality test itself, the media was said to be practical, with a percentage of 94.36% from teachers and 89.37% from students. From the results of the practicality test, it could be concluded that this Canvas Instructure-based LMS was practical. Students were eager to solve critical thinking skills questions through the Canvas Instructure-based LMS. This meant that, in this case, the LMS was practical in supporting the critical thinking skills of grade 11 students on Linear Program material. This is in line with the research (Miranda & Purnamaningsih, 2022), which explained that the percentage of students with critical thinking skills is 75%, and a rate of 7.5% of students with very critical abilities. This happens because of learning through LMS-based e-learning. Researchers also mentioned that e-learning was simpler and more practical than conventional learning models. E-learning was very practical in influencing critical thinking skills through texts, quizzes, videos, presentations, and resources such as chat rooms, message boards, and attendance that could be accessed online (Sanuaka, Warpala, & Tegeh, 2022). This also supports the idea that e-learning is valid in supporting learning because students can find concepts and have a more extended memory of solving the problems faced (Khamparia & Pandey, 2020; Setiaji, Wulandari, & Hadisuddin, 2022).



Clarification

Assessment

Strategy

Inference

Figure 10. An example of student' answer

Students were asked to work on the distributed critical thinking tests at the trial stage. Based on the test results, the percentage of student completeness was 90.91%, with an average of 85.82. From the results of the questions distributed to students measuring critical thinking skills according to the indicators of Jacob & Sam (2008). Figure 10 is one of the student's answers that meets all aspects of critical thinking indicators. Students fulfill indicators of critical thinking skills. Clarification described how students could identify problems and correctly write down all the information from the main problem. Clarification could be seen in how students identified and wrote information about the problem. In the assessment aspect, students could analyze relevant information processes and find questions and logical reasons to strengthen the information in order to conclude. Assessment was evident from the way students provided reasons based on the problems that had been identified. In inference, students drew conclusions based on information obtained by collecting and combining information from a problem to generalize. Students could also describe how they solved problems by evaluating each step and finding other possible solutions to solve the problem strategically.

These results indicate that the LMS effectively supports students' critical thinking skills on Linear Program material. E-learning promotes critical thinking skills in high school students, especially in class XI (Wahyuaji & Suparman, 2018). The use of e-learning in the learning environment can optimize critical thinking skills. E-learning is a learning innovation in an online learning environment that can combine synchronous and asynchronous learning. This makes students' exploration abilities better and faster so that students can more quickly master the material provided (Ilić, Mikić, Kopanja, & Vesin, 2023; Permana et al., 2022; Puška, Ejubović, Đalić, & Puška, 2021). Utilization of e-learning to support critical thinking skills. In helping students' critical thinking skills using Canvas Instructure e-learning, Jacob and Sam's theory is used and presented in discussion forums, learner worksheets, videos, and handouts available (Miranda & Purnamaningsih, 2022). The virtual learning environment of Canvas Instructure can support critical thinking skills because the use of e-learning can increase students' courage in expressing opinions through forums in e-learning. Additionally, using e-learning in learning activities optimizes critical thinking skills. Students can complete discussion sessions to produce mutually agreed conclusions (Loureiro & Gomes, 2023; Qi, Sun, & Yue, 2023; Rachmawati, Nindiasari, & Syamsuri, 2020; Sharma, Singh, Prasad, & Hussein, 2024).

3.5 Evaluation

Evaluation was the final stage carried out after the implementation stage. At this stage, the LMS that had been developed and tested was analyzed to make final revisions to the Canvas Instructure LMS product. Activities carried out at this stage included evaluations that aimed to assess the effectiveness of the Canvas Instructure LMS. LMS has a vital role in the modern learning context. It provides a digital platform that allows flexible access to learning materials. This allows learning to be accessed anytime and anywhere, increasing accessibility and flexibility. Moreover, LMS facilitates interaction between students and instructors through various features, such as discussion forums or chat features (Mpungose & Khoza, 2022). LMS can significantly optimize student learning. The results of Suwarman et al.'s (2024) research show that the optimization of student learning outcomes with the help of LMS reached a level of 69.49%. This confirms that LMS has an essential role in increasing the effectiveness of student learning. This system gives students better access to learning materials, exercises, and interactions with teachers and fellow students, thereby encouraging better learning outcomes.

Canvas Instructure is one of the LMS platforms with several advantages, such as providing an interactive learning environment and allowing users to participate actively in the learning process (Santiana et al., 2021). Canvas Instructure has been considered capable of

supporting students' critical thinking skills with its various features and functionality. Students can use this LMS to engage in challenging and thought-provoking learning experiences. One of the key features that support the development of critical thinking skills is Canvas' ability to provide an interactive learning environment. With discussion forums, online assignments, and various evaluation tools, students are exposed to situations requiring in-depth analysis, evaluation, and problem-solving. In addition, easy access to diverse learning resources also helps students hone their ability to analyze information and develop critical arguments. The use of technology in the learning process through Canvas also allows students to become more independent in learning (Marachi & Quill, 2020).

Canvas Instructure offers various features that support the development of students' critical thinking skills, in accordance with Jacob and Sam's (2008) theory. Features such as discussion rooms, online assignments, and evaluation tools help students to identify problems, analyze information, draw conclusions, and evaluate problem-solving strategies. Through the quiz feature, students are required to clarify the problem clearly and provide logical reasoning in answering questions, which reflects the indicators of clarification and judgment. Furthermore, students are required to draw conclusions based on the available information and evaluate the solutions provided, in accordance with the inference and strategy indicators. The discussion and chat features also support students' ability to clarify the problem being discussed, analyze the information shared, and draw conclusions from the discussion results. In addition, through this discussion, students can evaluate alternative solutions in problem solving, which reflects the strategy indicator. The discussion and collaboration platform in Canvas allowed students to make inferences based on the information gathered. Meanwhile, the instructor feedback feature will enable students to evaluate their strategies for finding solutions (Sukayasa et al., 2022). The module features in Canvas Instructure facilitate students to clarify key concepts, analyze the information provided, draw conclusions from existing examples, and evaluate various problem-solving strategies. According to Astuti (2024) who stated that assignments and discussion forums encourage students to analyze, evaluate, and synthesize information. The availability of various learning materials and resources in the LMS can also motivate students to examine different points of view, encouraging them to engage in critical thinking about complex issues.

The advantage of this LMS-based e-learning is the interactive learning environment. A Learning Management System (LMS) is a system that supports blended learning, as well as direct and online learning. This LMS is assessed for the effectiveness of implementing LMS in blended learning to increase students' high-level thinking skills (Taufiqurrochman, Muslimin, Rofiki, & Abah, 2020). The use of Canvas Instructure is beneficial, profitable, and effective in helping anytime and from anywhere (Ananda & Fauziah, 2022). The use of Canvas Instructure will help improve their reading comprehension as well as their writing and speaking skills. In addition, the data shows that students have favorable attitudes about using e-learning through Canvas Instructure.

Nonetheless, Canvas Instructure had disadvantages, such as difficulty accessing the password. There was often an error during the password input process, causing cloud learning to be not conducive. Canvas Instructure also offered services without additional add-ons and significant costs. Thus, Canvas Instructure provided more efficient and economical benefits for teachers in managing online learning. Canvas Instructure was more affordable for educational institutions or organizations that wanted to adopt it (Bulut, 2023).

4 Conclusion

To conclude, Canvas Instructure-based LMS has proven valid in supporting students' critical thinking skills in linear program material. Evidenced by the results of LMS expert validation, Canvas Instructure obtained a percentage of assessment with an average of 89.375%, which is included in the very feasible category. The results of the material expert validation regarding the content contained in the LMS amounted to 92.222%. This shows that the content in the LMS is included in the worthy category. The percentage results of the teacher response questionnaire were an average of 94.36%, and the student response questionnaire was an average of 89.37%. Canvas Instructure LMS can be concluded to be practical for use as learning media in a very practical category. Meanwhile, the result of students' evaluation test has a percentage of student completeness of 90.91%, with an average of 85.82. The LMS effectively supports students' critical thinking skills on linear program material. To further optimize its use, it is suggested that the LMS be implemented across various subjects and educational contexts to broaden its impact. Continuous updates and improvements, based on feedback from teachers and students, should be prioritized to maintain its relevance and effectiveness. Integrating additional tools or technologies, such as gamification or analytics, could enhance interactivity and engagement.

5 References

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