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Development of E-Learning Flipped Classroom Model to Improve Learning Outcomes in the Natural and Social Sciences

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Abstract: This study aims to develop a flipped classroom e-learning model based on Moodle to improve learning outcomes in the Natural and Social Sciences (IPAS) subject for Grade X students at SMK N 1 Praya. The research employed the ADDIE development model, involving stages of analysis (student needs and learning barriers), design (LMS structure, blended strategies), development (digital content, expert validation), implementation (trial in class X Hospitality), and evaluation (formative-summative assessment). The model features pre-class videos, interactive quizzes, e-modules, and online assignments integrated into Moodle. Feasibility was assessed by media, material, and model experts using Likert-scale instruments, scoring 4.0 (feasible) and 4.7 (very feasible). Practicality was evaluated through teacher responses, scoring 4.85 (very practical). Effectiveness was measured via pretest and posttest using the N-Gain formula, showing an average gain of 0.59 (moderate improvement). The model was trialed with 34 students, considering the school's characteristics (vocational focus, limited practice time, and low student engagement). Results indicate that the flipped classroom e-learning model is feasible, practical, and effective in enhancing student outcomes in vocational science learning.

Keywords: E-Learning; Flipped classroom; Learning outcomes; Natural and social sciences; Vocational school

Introduction

Advancements in information and communication technology have transformed the landscape of education (Sylvia et al., 2021). Traditional tools such as chalk, blackboards, and printed textbooks are being replaced by digital platforms that enable more flexible and student-centered learning environments. Sukiman (2012) explains that the role of teachers is shifting from being sole providers of knowledge to facilitators, while students increasingly access educational resources independently through the internet. The internet offers various multimedia formats, including text, images, audio, and video, which can be used to support teaching and learning activities (Hapsari & Pamungkas, 2019). In developed nations, internet integration has reached the stage of the Internet of Things (IoT), allowing for seamless access to learning materials (Yudhanto & Azis, 2019).

Despite the growing number of internet users in Indonesia, which ranks fourth globally with 215.63 million active users (Kominfo, 2023), its use in education remains underdeveloped. Internet access in Indonesia is primarily used for entertainment, online games, and e-commerce (Walidaini & Arifin, 2018), which limits its potential as an educational tool. This underutilization highlights the need for innovative learning methods that incorporate digital tools to improve instructional effectiveness (Haryanto et al., 2024; Shiddiqi & Setiyawan, 2024; Tasyah et al., 2021; Vilmala, 2025). One such method is e-learning, defined as the process of acquiring knowledge through digital platforms such as

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computers and mobile devices (Simanihuruk et al., 2019). E-learning enables access to teaching materials in digital form (Ajiatmojo, 2021) and promotes organized distribution of content through network-based systems (Devi, 2021). When integrated with Learning Management Systems (LMS), such as Moodle, it allows for flexible access, content updates, and storage (Mustari et al., 2024; Satriani & Syamsuddin, 2023), and enhances interactivity through the incorporation of multimedia (Jonatan & Waruwu, 2023; Miftah & Rokhman, 2022).

At SMK N 1 Praya, the Natural and Social Sciences (IPAS) subject combines disciplinary knowledge from science and social studies, with an emphasis on project-based learning. In practice, however, instruction in this subject still relies heavily on one-way lectures and static media such as PowerPoint presentations. Observations conducted on January 13, 2024, revealed that students demonstrated low engagement during lessons and achieved unsatisfactory results, with scores ranging from 55 to 70. These outcomes were attributed to the lack of interactive media and insufficient classroom time for practical exploration of the material. Furthermore, observations on January 20, 2024, indicated that students struggled to understand theoretical concepts due to limited opportunities for practice. According to Sutapa et al. (2019), students require adequate time to develop cognitive and motor skills through repeated and meaningful application. A needs analysis conducted through questionnaires confirmed that 95% of students in Grade X Hospitality preferred online learning environments, but also emphasized the importance of maintaining hands-on learning experiences.

To address these instructional shortcomings, a learning model that supports independent study and facilitates deeper in-class engagement is required. The flipped classroom model has the potential to fulfill these requirements by shifting content delivery to outside the classroom, allowing students to review materials in advance and engage in collaborative activities during face-to-face sessions (Hasmara & Ma'arif, 2023; Mujab, 2023; Shiddiqi, 2024). This model has been shown to improve students' understanding of both theoretical and practical components of learning (Divjak et al., 2022). In this study, the flipped classroom model is implemented through Moodle-based e-learning, which includes structured digital resources such as videos, e-modules, journals, and simulations (Prasetia et al., 2023; R. R. Putri et al., 2022; Sholikhah & Alyani, 2022). These materials are designed to be accessed independently, while in-person meetings focus on exercises, discussions, and problem-solving activities led by the teacher (Ramadhani et al., 2023).

This study aims to develop a flipped classroom e-learning model to improve student achievement in IPAS learning at SMK N 1 Praya. The research responds directly to the challenges identified during preliminary observations by introducing a structured, interactive, and student-centered approach. The model is developed using the ADDIE instructional design framework, ensuring that every stage—from analysis to evaluation—is based on clearly defined objectives and empirical validation. The contribution of this research lies in offering a complete and replicable instructional model that aligns with digital literacy trends while addressing specific issues observed in vocational school learning environments. The design, validation, and evaluation stages are integrated to ensure that the resulting product is pedagogically sound, technically feasible, and practically useful for both teachers and students.

Method

This research uses the Research and Development (R&D) method with the ADDIE model developed by (Branch, 2009), which includes five systematic stages: Analysis, Design, Development, Implementation, and (Meutia et al., 2021; N. M. Putri & Hamimah, 2023). The research began by mapping problems found in the field and designing solutions which were subsequently developed into a flipped classroom-based e-learning model. The study was carried out from May 13 to June 10, 2024, involving 34 students from Class X, Semester 2, majoring in Hospitality at SMK N 1 Praya. The selection of this group was based on prior observation and needs analysis that identified low engagement and suboptimal learning outcomes in IPAS subjects.

In the analysis stage, researchers conducted a gap analysis to identify discrepancies in cognitive, affective, and psychomotor aspects. The data were gathered using a student needs questionnaire that was constructed with Likert-scale items and validated through expert review. Respondents included 34 students and 2 IPAS teachers. The analysis also included interviews and in-class observations to understand learner behavior, access to technology, and student preferences for digital learning. These data served as the foundation for defining the learning objectives, instructional strategies, and required content.

During the design stage, a flipped classroom-based blended learning structure was developed based on Carman's, (2005) framework. The design included the development of e-learning architecture using Moodle LMS, learning objectives aligned with the curriculum, subject descriptions, educator profiles, and learning materials such as e-modules and video content. Tutorials and user guides were also created to assist teachers and students in navigating the platform. The storyboard and navigation structure of the platform were designed to ensure logical content flow and user accessibility.

The development stage involved transforming the instructional design into a complete Moodle-based e-learning environment. Online classes were created and populated with multimedia learning materials including videos, readings, simulations, and interactive quizzes. Validation was conducted by six experts: two media experts, two material/content experts, and two instructional design experts. Each expert used a structured validation instrument with 15–20 Likert-scaled items assessing aspects such as relevance, clarity, interactivity, technical functionality, and alignment with learning goals. Revisions were made based on expert feedback before proceeding to the implementation stage.

Implementation was carried out as a limited trial with one intact class of 34 students. The flipped classroom model was applied by allowing students to study independently through Moodle before attending classroom sessions. During face-to-face meetings, the teacher functioned as a facilitator, guiding discussions, practice tasks, and assessments, while researchers served as observers. Observations focused on student activity levels, interaction patterns, and engagement with both digital content and peers. Students completed assignments during in-class sessions based on the material previously accessed online.

The evaluation stage included both formative and summative evaluations. Formative assessments were used during development and implementation to improve product quality based on user feedback and expert input. Summative evaluation was conducted using pretest and posttest instruments consisting of 25 multiple-choice questions, developed and reviewed by subject matter experts to ensure content validity. Item analysis was performed to evaluate the difficulty level and discrimination index, and reliability was tested using Cronbach's Alpha, which yielded a coefficient of 0.81, indicating high internal consistency.

This study employed both quantitative and qualitative data. Quantitative data came from validation scores and test results, while qualitative data were gathered from interviews and observations. Data from expert validation and practicality assessments were first converted into interval scores using a Likert scale, then transformed into qualitative categories based on five-scale interpretations (Sukardi, 2021). The effectiveness of the model was measured using the normalized gain (N-gain) formula from Hake (1998) to assess improvement from pretest to posttest. Interview and observation data were analyzed thematically to support the interpretation of quantitative results and to provide insight into user experiences and perceptions of the model's effectiveness.

Table 1. Scoring Rules

Score	Percentage	Category
1	< 20%	Highly Not Feasible
2	40% - 21%	Not Feasible
3	60% - 41%	Neutral
4	80% - 61%	Feasible
5	100% - 81%	Highly Feasible

Below is the formula used to calculate the average score of the practicality of e-learning products. Quantitative data was converted to qualitative data to determine the assessment category according to Arikunto (2010) as shown in the table 2.

$$Score = \frac{Total\ Score\ obtained}{Number\ of\ Items} \quad (1)$$

Table 2. Conversion to Qualitative Data

Formula	Mean score	Category
X> Xi+ 1.8 x sbi	4.2	Highly Not Feasible
Xi + 0.6 x sbi << X < Xi +1.8 x sbi	X>3.4-4.2	Not Feasible
Xi-1.8 xsbi<X<Xi+0.6x sbi	X>2.6-3.4	Neutral
Xi-1.8 x sbi< X <Xi-0.6 x sbi	X>1.8-2.6	Feasible
X<Xi-1.8 x sbi	X<1.8	Highly Feasible

The implementation of e-learning practicality testing uses a Likert scale (1-5) as follows: 1 = Very Impractical, 2 = Impractical, 3 = Neutral, 4 = Practical, 5 = Very Practical (Sugiyono, 2019). This scale was chosen because it can measure individual assessments quantitatively. The e-learning practicality test assessment guidelines refer to Sugiyono, (2019).

Table 3. Scoring Rules

Score	Percentage	Category
1	< 20%	Very Unpractical
2	40% - 21%	Not practical
3	60% - 41%	Neutral
4	80% - 61%	Practical
5	100% - 81%	Very Practical

Below is the formula used to calculate the average score of the practicality of e-learning products. Quantitative data will be transformed into qualitative data to determine the assessment category (Arikunto, 2010).

$$Score = \frac{Total\ Score\ obtained}{Number\ of\ Items} \quad (2)$$

Table 4. Conversion to Qualitative Data

Score	Percentage	Category
5	X > 4.2	Very Unpractical
4	X > 3.4 – 4.2	Not practical
3	X > 2.6 – 3.4	Neutral
2	X > 1.8 – 2.6	Practical
1	X ≤ 1.8	Very Practical

Effectiveness test data was obtained from pretest and posttest using normalized gain technique (Hake, 1998, p. 65) to measure the difference before and after flipped classroom-based e-learning.

$$g = \frac{S - S_0}{S_{maks} - s_0} \quad (3)$$

Description:
S_1 = Total score on the final test
S_0 = Total score on the initial test
S_{maks} = Maximum score to be achieved

The improvement of learning outcomes of students in grades X and XI of SMK N 1 Praya on e-learning learning with the flipped classroom model was analyzed using the n-gain formula. The results were then classified according to Hake's table, (1998).

Table 5. Classification of Gain Value

Value of n-gain	Level
g ≥ 0.7	High
0.3 ≤ g ≤ 0.7	Medium
g < 0.3	Low

Result and Discussion

The result of this research and development is a flipped classroom e-learning model to improve IPAS learning outcomes. The application used in the development is Learning Management System (LMS) Moodle version 4. The advantages of e-learning products compared to other e-learning are on the activity side in the form of quizzes and flexible assignments using a structured learning model (flipped classroom model).

View of the introduction page. The opening page was designed to align with the attributes and content displayed to students. The opening page is created by integrating text, images, and buttons to access the main page.

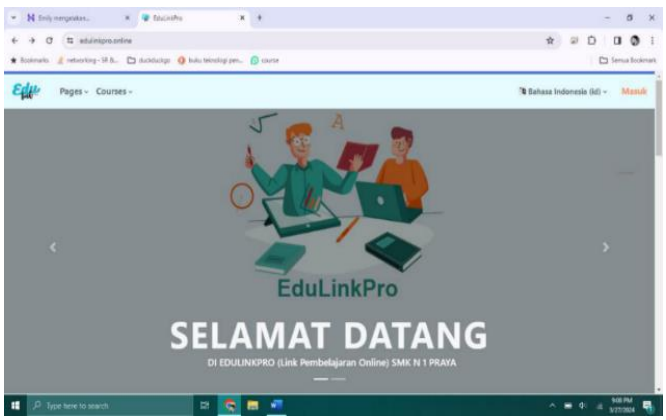

Figure 1. E-learning home page display

Login page display the learning e-learning website is equipped with a page for student or teacher user login.

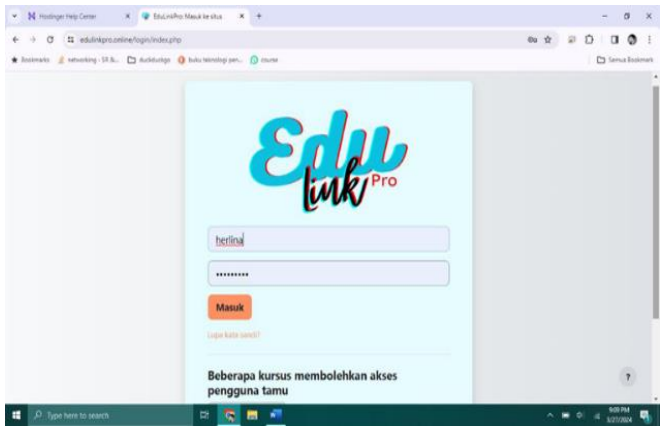

Figure 2. E-learning login page view

Course page display. SMK learning media material page which is one of the sources for students to get information about the material to be studied.

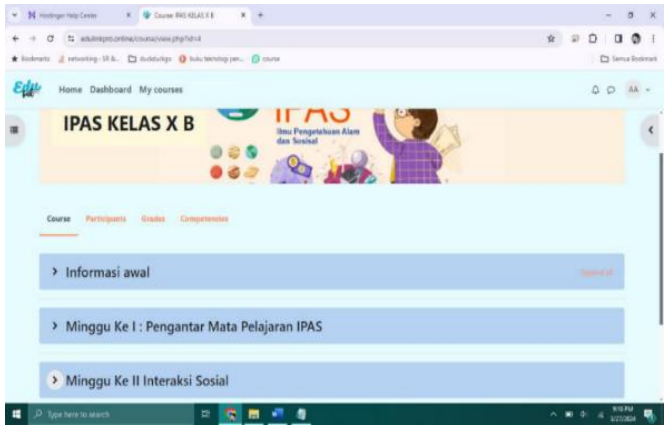

Figure 3. View of the e-learning course page

Display of the teaching material package. Subject matter delivered by the teacher and taught to students as shown in the figure.

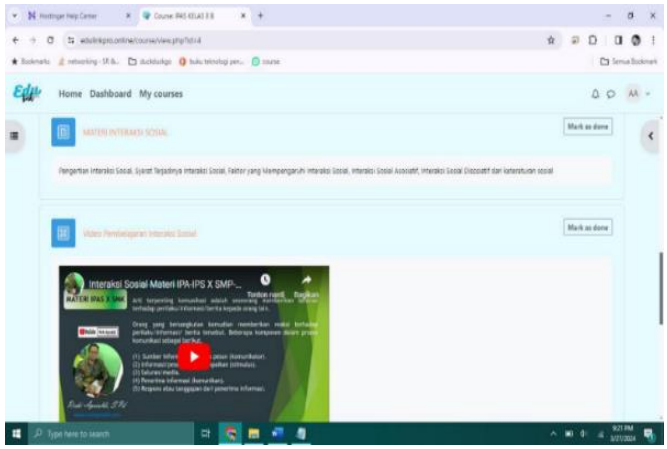

Figure 4. Display of e-learning teaching materials

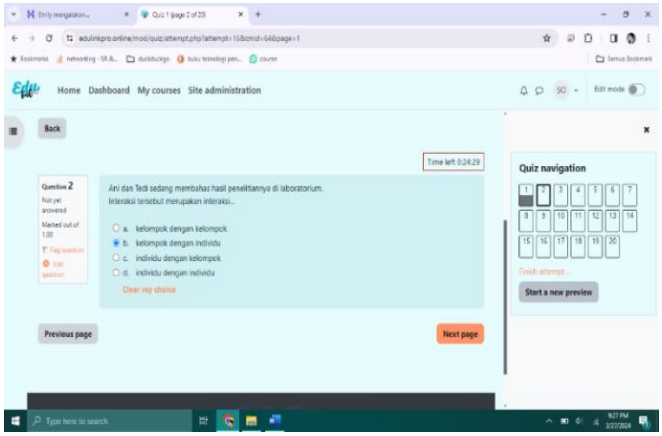

Figure 5. Display of learning outcome assessment

The process of testing the e-learning flipped classroom model that has been developed in this study was first validated by experts. Validation was carried out in two stages, the first is instrument validation to provide the accuracy of the questionnaire and the second is media, material and model validation so that the e-learning flipped classroom model becomes feasible to be implemented to students of SMK N 1 Praya. The results of the validations that have been carried out are as follows.

Data Description of E-Learning Media Validation Results

The flipped classroom e-learning model is facilitated by moodle-based e-learning media that has been developed. Thus, it is necessary to carry out media validation by experts to determine the quality of the media before it is implemented to students. The results of the e-learning media validation are as follows.

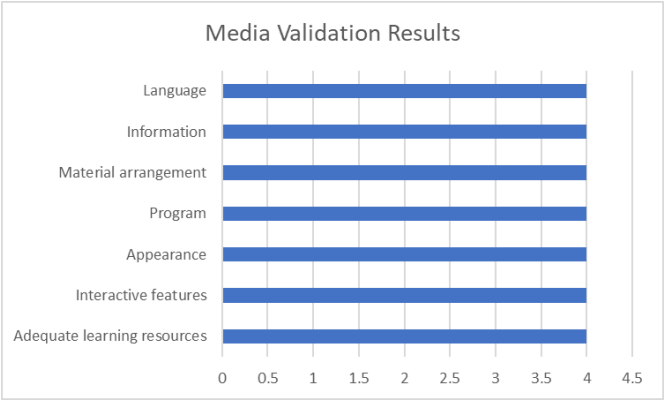

Figure 6. Learning e-learning media validation results

The score obtained in media validation is 100 with an average of 4.0 which is included in the "Appropriate" quality category. In this assessment, there are revisions and suggestions from media experts which are discussed in the product revision section.

Data description of IPAS material validation results

The score obtained in the material validation obtained 71 results with an average of 4.7 which is included in the "Very Feasible" quality category. In this assessment, there are revisions and suggestions from media experts which are discussed in the product revision section.

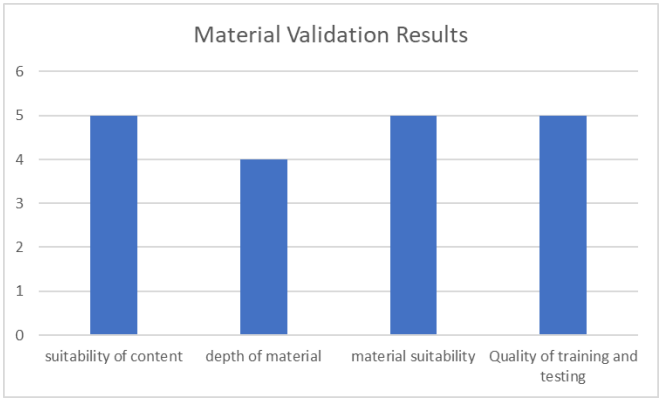

Figure 7. IPAS material expert validation results

Practicality Test Results

The average results obtained from the e-learning product practicality test conducted by teachers will then be transformed from a Likert scale into qualitative data. The average obtained from the product practicality test results is 4.85. Conversion to qualitative data using a scale of five shows that the score of 4.85 is categorized as 'Very Practical'.

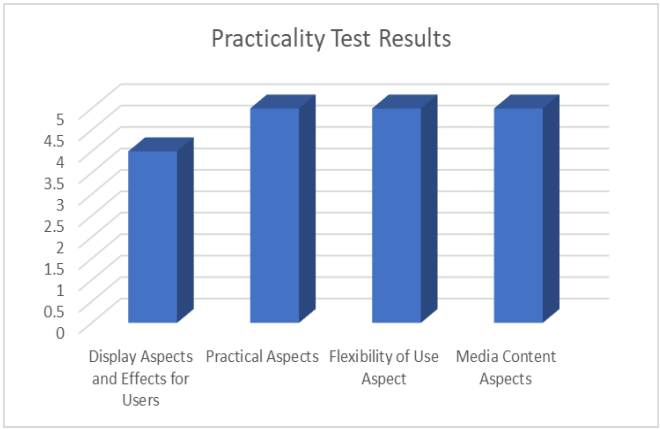

Figure 8. Practicality test results

Effectiveness Test Results with the N Gain Formula

After validation by experts, the flipped classroom e-learning model was improved according to the suggestions and assessments given by the experts. The flipped classroom e-learning model was applied to class X students of SMK N 1 Praya majoring in Hospitality in the IPAS subject. The trial of the flipped classroom e-learning model that has been developed to see the effectiveness of e-learning on the learning process in

IPAS subjects. This stage begins with carrying out a series of pre-tests to see the initial knowledge and ability of students to the material to be learned which is then given a post-test after the application of the flipped classroom e-learning model.

The results of the pre-test and post-test will be compared to see the difference between before and after applying the flipped classroom e-learning model. The results of changes in knowledge from the two tests will be analyzed to see the effectiveness of the application of the e-learning flipped classroom model in improving the learning outcomes of class X semester 2 students of SMKN 1 Praya in IPAS subjects. The results of the pre-test and post-test trials are as follows.

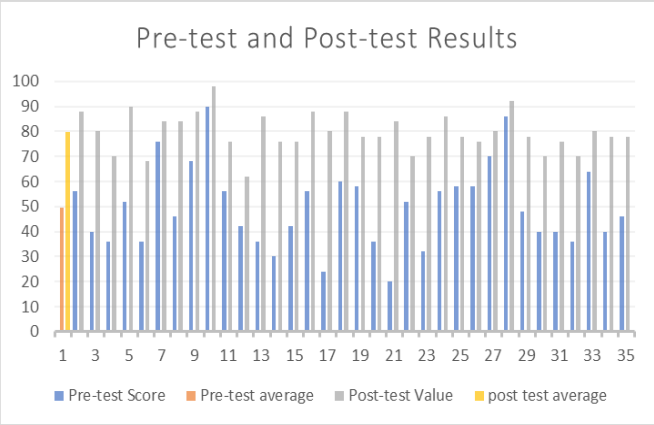

Figure 9. Results of student pre-test and post-test

Based on the calculation table of pre-test and post-test results, it can be seen from the average pre-test score of 49.59 and the average post-test score of 79.76. The maximum score in the pre-test implementation is 90 and the maximum score in the post-test implementation is 98. The average pre-test and post-test gain score is 0.59 and when converted into qualitative data, the average gain score is included in the "Moderate" category.

Based on student learning outcome data on the pre-test and post-test, namely before and after the implementation of e-learning, the calculation of student improvement scores after using e-learning is carried out using the N Gain formula as follows Oktavia et al.(2019).

$$g = \frac{S\ Post - S\ Pre}{S\ Max - S\ Pre}$$

$$g = \frac{79.76 - 49.59}{100 - 49.59}$$

$$g = \frac{30.17}{50.41}$$

$$g = 0.59$$

Based on student learning outcome data, an N-Gain value of 0.59 was obtained, which is included in the "moderate" category. This category shows a significant but not yet optimal increase in students' conceptual understanding after implementing the Moodle-based flipped class learning model. In a practical context, this value reflects that the learning model is able to overcome the gap in students' basic understanding before and after learning, and shows positive cognitive changes that are worthy of being widely applied (Faisal et al., 2023).The flipped class model provides a flexible learning space for students to understand the material independently before carrying out interactive class activities, which has been proven to be effective in encouraging conceptual understanding (Sukmawati et al., 2022).

The learning product developed is in the form of Moodle-based e-learning, equipped with a user guide, lesson plans, and syllabus as learning references. The results of the feasibility test were carried out through validation by material experts and learning design. Material experts gave a "very feasible" assessment based on indicators of content accuracy, suitability with synchronization, and relevance to student needs. Learning design experts assessed "feasible", especially in terms of navigation systems, interface displays, and integration of learning media.

The implementation of the practicality test was carried out through a limited trial in class X of SMK Negeri 1 Praya majoring in Hospitality for two weeks using the e-learning-based flipped classroom learning model. The evaluation was carried out through observation, interviews, and distribution of practicality questionnaires to students and teachers. The results of the questionnaire showed that students felt helped in understanding the material and felt more motivated in participating in learning. Concretely, there was a significant increase in student learning outcomes after the implementation of this model. The comparison between the pre-test and post-test showed an increase in the average score of more than 20%, indicating that this approach is effective in improving students' understanding of concepts and learning independence (Hariyadi et al., 2023). In addition, learning content in the form of videos, images, texts, and interactive exercises supports students' learning process visually and in depth. The flipped classroom model has been shown to provide space for students to prepare themselves independently before face-to-face, so that discussions in class become more effective and focused (Soraya et al., 2020; Yasin et al., 2024).

This learning model also has a positive impact on the learning atmosphere in the classroom. The learning environment becomes more active, participatory, and enjoyable because students come with material readiness and higher self-confidence. Students are not only recipients of material, but also play an active role in expressing opinions and discussing with peers. Teachers also find it easier to manage learning because students

are more independent and open in communicating. The classroom atmosphere becomes more collaborative and dialogical, reducing students' dependence on one-way explanations from teachers. This is in line with research by Bakti et al. (2023), Delfianza et al. (2023) and Ndoa et al. (2022) which states that the digital-based flipped classroom model can increase motivation, learning activity, and strengthen interactions between students and educators. This model also provides a personalized learning experience, where students can access materials at any time and communicate with teachers without time limits, making the learning experience more flexible and enjoyable (Nazhifah et al., 2023).

E-learning development is carried out using Moodle, a very flexible open source Learning Management System (LMS) platform. Moodle supports features such as learning video integration, discussion forums, question banks, automatic evaluations, tracking student learning progress, and the H5P plugin that allows embedding interactive content such as quizzes, presentations, and simulations. This platform also provides a gradebook feature for grade management, conditional activities for adjusting content based on achievement, and analytics to see student learning trends in real-time (Idrus et al., 2024). These features allow teachers to provide adaptive and responsive learning experiences to student needs, as well as facilitate personalization of materials based on pre-test results. Moodle also supports collaborative learning through features such as chat rooms, workshops, and feedback, which facilitate two-way communication between students and teachers. Other studies support the effectiveness of Moodle as an interactive and flexible learning tool, as expressed by Boma et al. (2023), Handri et al. (2023), and Rezaini et al. (2024), that Moodle is not only a place to store materials, but also a complete and dynamic learning management system in supporting the implementation of flipped classrooms.

Conclusion

The research and development of the flipped classroom e-learning model for IPAS in SMK Class X produced a web-based Moodle platform consisting of six structured meetings. Each meeting includes text-based learning materials, instructional films that function as substitutes for synchronous learning, and asynchronous discussion forums that promote active student engagement. The e-learning materials are arranged based on learning objectives and competencies, allowing students to progress according to their individual understanding. This platform was developed using the ADDIE model, ensuring that each stage—Analysis, Design, Development, Implementation, and Evaluation—was systematically followed. The feasibility of the product was validated through expert reviews, where media experts rated it at 4.0 ("Feasible") and material experts at 4.7 ("Very Feasible") on a 5-point scale, indicating that both the interface and content met quality standards. The practicality of the product was assessed through teacher evaluations at SMKN 1 Praya, resulting in an average score of 4.85, categorized as “Very Practical.” The effectiveness of the e-learning model was measured using a gain index, calculated from pretest and posttest scores. The gain index value of 0.59 falls within the "moderate" category, indicating a meaningful improvement in students' learning outcomes and conceptual understanding. In terms of learning impact, the e-learning flipped classroom model improved student participation, motivation, and comprehension, especially through the flexible use of multimedia content and independent learning strategies. This model supports self-paced learning and encourages higher-order thinking through peer discussions and reflection activities. The practical implications show that this model can be widely adopted in other vocational schools with similar contexts, providing an adaptable framework for digital learning. Scientifically, this research contributes to the integration of learning technology in vocational education, offering a validated and scalable model that can serve as a reference for further innovation in digital-based instructional design.

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Author Contributions
Muhammad Khairil Asrori: conducting data collection, data analysis, and drafting the original manuscript. Deni Hardianto: conducting research conceptualization, designing the research methodology, and reviewing and editing the manuscript.

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Conflicts of Interest
The authors declare no conflict of interests.

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