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DEVELOPMENT OF FLIP LEARNING-BASED E-LKPD CODING TO IMPROVE LEARNING ACHIEVEMENT OF GRADE XI STUDENTS IN INFORMATICS LEARNING

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Abstrak
Fasilitas yang disediakan untuk mengikuti pembelajaran Informatika pada materi algoritma dan pemrograman masih terbatas dan tidak dapat digunakan secara langsung oleh seluruh siswa saat belajar menjadi hambatan dalam pembelajaran Informatika. Penelitian ini menggunakan model ADDIE untuk mengembangkan E-LKPD coding berbasis flip learning untuk menguji validitas, kepraktisan, dan efektivitasnya dalam meningkatkan prestasi belajar informatika siswa. Penelitian ini melibatkan subjek yaitu para ahli dan siswa kelas XI di SMAN 5 Denpasar. Hasil penelitian ini adalah dikembangkannya E-LKPD coding berbasis flip learning dalam format web yang interaktif, terstruktur, dan mudah diakses oleh siswa serta dilengkapi dengan aktivitas simulasi coding secara langsung sehingga siswa dapat menerapkan materi algoritma dan pemrograman yang dipelajari. Validitas media E-LKPD coding, validitas pembelajaran, dan validitas materi yang masing-masing memperoleh kriteria validitas sangat baik. Uji coba pada siswa menghasilkan skor kepraktisan dengan kategori sangat baik. Hasil pre-test dan post-test menunjukkan peningkatan skor rata-rata. Nilai N-gain berada pada kategori sedang, serta ketuntasan klasikal menunjukkan media E-LKPD coding efektif dalam meningkatkan prestasi belajar siswa. Penelitian berikutnya dapat menelusuri lebih lanjut tentang faktor-faktor yang mempengaruhi peningkatan prestasi belajar siswa khususnya pada mata pelajaran informatika.

Kata Kunci: algoritma; pemrograman; E-LKPD; informatika; prestasi belajar.

Abstract
The facilities provided for participating in Informatics learning on algorithm and programming materials are still limited and cannot be used directly by all students when learning, becoming an obstacle in Informatics learning. This study uses the ADDIE model to develop E-LKPD coding based on flip learning to test its validity, practicality, and effectiveness in improving students' informatics learning achievement. This study involved subjects namely experts and grade XI students at SMAN 5 Denpasar. The results of this study are the development of E-LKPD coding based on flip learning in an interactive, structured, and easily accessible web format for students and equipped with direct coding simulation activities so that students can apply the algorithm and programming materials learned. The validity of the E-LKPD coding media, learning validity, and material validity each obtained very good validity criteria. The trial on students produced a practicality score with a very good category. The results of the pre-test and post-test showed an increase in the average score. The N-gain value was in the moderate category, and classical completeness showed that the E-LKPD coding media was effective in improving student learning achievement. Further research can explore further the factors that influence the improvement of student learning achievement, especially in informatics subjects.

Keywords*: algorithms; programming; computer science; E-LKPD; learning achievement.*

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INTRODUCTION

Current computer technology is closely related to informatics education. The rapid development of science and technology today is driven by education, as science is based on education (Yulianti et al., 2020). The digitalization of education ultimately presents various challenges for educators, including those in the field of informatics (Hilhamsyah et al., 2024). In the current era of globalization, students must be able to use digital devices, develop cognitive abilities, think logically, structured, and creatively because technological aspects have become so important and influential in modern life (Hilhamsyah et al., 2024). This capacity can be developed by focusing on calculations, because calculations have a reasonable and solid design and are related to steps to address problems (Saputri & Yahfizham, 2023). Humans need to learn informatics from an early age to adapt and compete with other species in the future. Furthermore, the current reality is that the informatics learning system in schools is sessional, with half of students learning less effectively in the classroom and the other half in the computer lab. When children practice in the laboratory, they can apply the theories they have learned in class by answering questions based on what is in the textbook.

Informatics learning in various schools is not without challenges that must be addressed. The lack of technological facilities and infrastructure and interactive teaching media in the classroom leads to low learning achievement (Hasnawiyah & Maslena, 2024). Furthermore, there is a lack of teaching materials that meet student needs, such as the need for varied use of online learning materials that include indicators of algorithmic reasoning and programming skills (Retta et al., 2020). Considering these various studies, observations at SMAN 5 Denpasar found that 143 11th-grade students still had not achieved a passing grade in informatics. Furthermore, this school also experiences limited facilities and infrastructure, resulting in students not being able to fully participate in informatics learning. Practical work on algorithms and programming materials, which require specialized equipment to design computer programs, is hampered in its effectiveness because students must take turns using the computers. This leads to a lack of student motivation in learning informatics, which impacts student achievement.

Informatics education requires high-skills and must be improved. By posing relevant problems and asking students to solve them, the development of e-LKPD can help improve student achievement (Wahyuni & Zulyusri, 2023). By making the content more engaging and interactive, e-LKPD development can contribute to improved learning achievement in technology. This medium can help improve the efficiency of informatics education by facilitating access to more useful content and better monitoring student progress (Septonanto et al., 2024). Several previous studies provide evidence that previously developed e-LKPDs, such as those based on a scientific approach, can improve student achievement at the elementary school level (Ni Wayan Nabela & Gede Wira Bayu, 2022). Furthermore, e-LKPDs based on higher-order thinking skills in grade school students are also effective in producing learning achievement with a 90% completion rate (Ketut Sri Puji Wahyuni et al., 2021). Similar product developments have also demonstrated excellent validity, practicality, and effectiveness (Azizah et al., 2025; Parwati et al., 2025). Therefore, in general, e-LKPD supports improved student achievement in the teaching and learning process. However, based on previous research, no e-LKPD developed has examined the effectiveness of this medium and optimized its learning focus with coding challenges in informatics subjects.

To make learning more engaging, it is necessary to develop interactive learning models, one of which is the Flip Learning model, which is used online (Dilla, 2023). Essentially, the concept of the Flip Learning model is that students learn at home, as is typically done in class, while completing homework at school. According to Meilisa & Pernanda (2020), the Flip Learning

model is an alternative that can effectively utilize the relatively limited face-to-face learning time and help improve student learning outcomes. However, implementing flipped learning in the digital era requires considering various challenges (Faznah et al., 2025). Therefore, flip learning can be integrated into E-LKPD (Educational Worksheets), becoming a pedagogical innovation that impacts student achievement, particularly in informatics. Furthermore, this integration of flip learning is also carried out to adapt to the situation and conditions in schools, which prioritize student access to materials for greater equity. Based on the above description, it can be concluded that informatics learning in schools, particularly in algorithms and programming, still faces obstacles in the form of limited facilities, a lack of interactive teaching media, and low student achievement. Observations at SMAN 5 Denpasar indicate that most eleventh-grade students have not achieved learning mastery, primarily because programming practice is still hampered by the limited number of devices used in rotation. On the other hand, previous research has shown that E-LKPD can improve learning effectiveness, but there has been no study that specifically integrates coding challenges with innovative learning models in the context of informatics subjects. The flip learning model offers great potential to expand student access to materials, increase learning independence, and maximize problem-solving activities in the classroom. Thus, the development of flip learning-based coding E-LKPD is relevant to creating more effective informatics learning. Therefore, this study aims to develop flip learning-based coding E-LKPD and test its validity, practicality, and effectiveness in improving the learning achievement of eleventh-grade students in informatics subjects.

METHOD

The type of research used in this study is Research and Development. This study focuses on the development of E-LKPD for coding learning on algorithms and programming in informatics subjects. This study uses the ADDIE research and development design model (Figure 1), which consists of several stages, including analysis, design, development, implementation, and evaluation (Branch, 2009). Using the ADDIE model is a very effective step in creating learning media and various types of learning resources (Fajjriah et al., 2023).

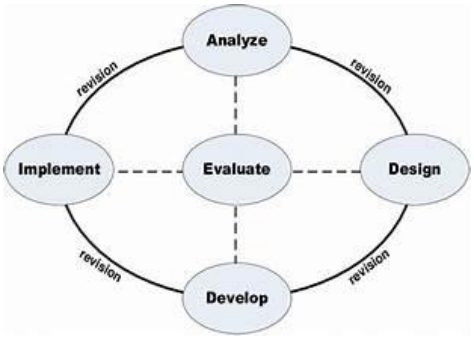

Figure 1. ADDIE Model

This research was conducted at SMAN 5 Denpasar in the odd semester of the 2025/2026 academic year. The subjects in the study were one class of grade XI students of SMAN 5 Denpasar, as well as experts consisting of material experts, media experts, and learning experts. The instruments used to obtain data on the quality of the developed teaching materials were questionnaires and tests. A Likert scale questionnaire with five score gradations was used to collect the results of expert reviews and the practicality of the media from students. An informatics learning achievement test was used to determine student learning achievement before and after the implementation of E-LKPD coding based on flip learning in a one-group pre-test post-test design. Data on the validity and practicality of the developed E-LKPD were analyzed by percentage scores compared with the validity and practicality criteria in Table 1.

Table 1. Percentage Criteria for Validity and Practicality

Percentage	Description
P ≥ 80%	Very good
60% ≤ P <80%	Good
40% ≤ P <60%	Average
20% ≤ P <40%	Poor
P < 20%	Very poor

Meanwhile, learning achievement data were analyzed using the N-Gain Score and classical completeness criteria whose effectiveness was compared with the gain score effectiveness criteria in Table 2 (Hake, 1998).

Table 2. N-Gain Score Criteria

N-gain	Qualification
(N-gain) ≥ 0,7	High
0,7 > (N-gain) ≥ 0,3	Medium
(N-Gain) < 0,3	Low

Finally, classical learning completion needs to be classified to determine its effectiveness, referring to table 3.

Table 3. Classical Completion Criteria

Percentage	Effectiveness
P ≥ 80%	Very good
60% ≤ P <80%	Good
40% ≤ P <60%	Average
20% ≤ P <40%	Poor
P < 20%	Very poor

RESULT

The activities carried out to produce this E-LKPD coding began with a needs analysis and product design. The results of the analysis phase were the acquisition of learning problems in the algorithm and programming material, student capacity in accessing technology, and outlines of the material to be included in the E-LKPD coding as well as various software that can be used in product development. The images and designs of the teaching materials were developed using the Canva and Heyzine applications. For interactive questions, Liveworksheets were used. And for programming simulations, the Programiz online simulator was used. This design resulted in a flip learning-based E-LKPD coding media in an interactive, structured, and easily accessible web format for students. The main features are a guide menu, a start learning menu with five learning activities and a learning outcomes menu designed to facilitate an active and independent learning process.

Figure 2. Display of E-LKPD Coding Based on Flip Learning

This product is also equipped with live coding simulation activities so that students can experience the algorithm and programming material being studied. The design of this flip learning-based E-LKPD product is poured into flexible learning activities and the advantages of the E-LKPD product which can be easily accessed anytime and anywhere. Students study at home or outside the classroom by carefully examining the material provided in the E-LKPD. In-class activities during informatics lessons focus more on discussions and programming practicals. To improve its quality as a learning tool, the E-LKPD coding has also undergone various expert testing. An example of the E-LKPD coding display can be seen in Figure 2.

The validity of the flipped learning-based E-LKPD coding was tested in collaboration with media, learning, and content experts from Ganesha University of Education. The experts involved in this study specialized in digital learning strategies, digital media and learning resources, and informatics engineering education. The results of the content validity test are shown in Table 4.

Table 4. Media Validity Test Results

No	Aspects	Percentage
1	E-LKPD Content Components	92%
2	E-LKPD Language Components	88%
3	Graphic Components	88%
4	Suitability of E-LKPD Components to Students	96%
5	E-LKPD Technical Components	96%
Total Score		110
Maximum Score		120
Total Percentage		92%
Media Validity Criteria		Very good

Based on the results of the media validity test, the total score percentage reached 92%, with the highest score being achieved by the E-LKPD component suitability aspect and the E-LKPD technical component aspect, which together scored 96%. The lowest score was for the language component and the graphic component, which scored 88%. Each aspect was assessed, with the final conclusion being that the validity of the E-LKPD media, according to media experts, was very good. The following are the results of the learning validity test, shown in Table 5.

Table 5. Results of Learning Validity Test

No	Aspects	Percentage
1	Providing Attention	100%
2	Informing General and Specific Objectives	100%
3	Stimulating Prior Skills	83%
4	Presenting Interesting Material	92%
5	Providing Learning Instructions	96%
6	Providing Students with Opportunities for Self-Practice	100%
7	Providing Feedback	92%
8	Providing Tests	100%
9	Providing Reinforcement	92%
Total Score		205
Maximum Score		216
Percentage		95%
Criteria		Very good

Table 5 shows that the highest percentages were achieved by the aspects of attention-getting, objective information, training, and giving tests to students, which reached the full criteria of 100%. The aspect with the lowest score was the aspect of stimulating previous abilities, with a percentage of 83%. However, overall, a total score of 95% was obtained, which is in the very good validity category. This indicates that the developed E-LKPD was assessed as very good by learning experts. The following are the results of the validity test by the material experts.

Table 6. Results of the Material Validity Test

No	Aspects	Percentage
1	Compatibility of E-LKPD Components	88%
2	Accuracy of E-LKPD Components	83%
3	Arousing Curiosity in E-LKPD	71%
4	Language Suitability of E-LKPD Content	83%
5	Graphics of E-LKPD Components	75%
Total Score		96
Maximum Score		120
Percentage		80%
Criteria		Very good

The results of the material validity test in the table above show that the aspect with the highest percentage was the compatibility aspect of the E-LKPD components, with a percentage of 88%, while the lowest was the aspect of arousing curiosity, with a percentage of 71%. Overall, the score was 80%, which falls into the very good validity category. This test provided critical and comprehensive results and revisions, as conveyed by the experts.

Table 7. Results of the E-LKPD Coding Practicality Test

No	Aspects	Percentage
1	Ease of Use	82%
2	Learning Benefits	82%
3	Convenience of Use	81%
Total Percentage		82%

After the validity testing and product revision by experts, the E-LKPD coding media then underwent practicality testing by students at the implementation stage. This stage was intended to find the practicality and effectiveness of the development of the flipped learning-based E-LKPD coding that had been created and tested previously. The practicality test of the E-LKPD coding product was conducted together with class XI-4 which consisted of 36 students. A questionnaire was sent to students via Google Form to test the developed E-LKPD coding product. The following are the results of the practicality test of the E-LKPD coding.

It can be seen that, according to a group of students, namely class XI-4, the ease of use and learning benefits aspects achieved the highest percentage scores, at 82%. On the other hand, the comfort of use aspect achieved a similar percentage score, at 81%. However, the total score percentage reached 82%, indicating excellent practicality.

This study determined that the developed E-LKPD Coding product is said to be effective if it achieves the criteria of a minimum average gain score of moderate and student completion of more than or equal to 80% in the student learning achievement test. The effectiveness of the E-LKPD Coding media is explained in the evaluation stage as the final part of the development model used. The following are the results of the N-gain score analysis from students' pre-test and post-test scores.

Table 8. Results of the E-LKPD Coding Effectiveness Test

N-Gain Score Criteria	Total	Percentage
High	7	18%
Medium	30	79%
Low	1	3%
Average		0.59 (medium)

Based on the data above, it is shown that 79% of students achieved the medium gain score criteria, 3% low, and 18% high. The average measured gain score obtained a score of 0.59 which is included in the medium category. Testing the learning objective completion criteria obtained 31

out of 38 (82%) students achieved a score of more than or equal to 75. This shows the percentage of passing the learning objectives of 82%. In accordance with the established gain score and KKTP criteria, it can be said that the E-LKPD coding media developed is effective in improving student learning achievement, especially the subjects of this study, namely class XI-8 SMAN 5 Denpasar.

DISCUSSION

The e-LKPD coding developed in this study was produced through the ADDIE model stages. This product was developed with Google Sites as the primary application as a packaging platform and integrated with various other tools such as Canva for visual display design, Liveworksheets for interactive activities, Heyzine as a digital flipbook maker, and Programiz for coding programming simulator exercises. The design of the e-LKPD coding integrated with flip learning aligns with the principles of multimedia-based learning, which emphasize the importance of appropriate displays, levels of interactivity, and the flow or structure of the material to motivate and reduce students' cognitive load (Mayer, 2017). The integration of interactive and simulation sections also influences students' level of understanding of the algorithm and programming material being studied, thus improving student achievement. This activity also creates innovative learning that is not as boring as simply reading a book (Sariani & Suarjana, 2022). Furthermore, the selection of e-LKPD as an interactive digital product that is practical and easily accessible on various devices also improves the quality of learning and material delivery to students (Ma'rufah & Wisanti, 2023). Therefore, the E-LKPD coding developed in this study can be said to be a product that is suitable for use in learning, in accordance with the principles of multimedia learning, and influences the improvement of student learning achievement in informatics subjects.

In the context of Flip Learning, e-LKPD serves as comprehensive pre-class material, allowing students to independently learn basic coding concepts before face-to-face sessions (Putri & Asri, 2024). The coding material presented (e.g., basic syntax, control structures, or functions) is designed to stimulate critical thinking and problem-solving, in line with the primary objectives of Informatics (Triana, 2021).

Media validity assesses the quality of the display, interactivity, and functionality of the flipbook application used (e.g., Flip PDF Professional or Heyzine Flipbook). A rating of "Very Valid" reflects that this e-LKPD is: Interactive and Engaging: The use of multimedia features (video, animation, interactive quizzes) integrated within the flipbook successfully visualizes abstract coding concepts, making them easier for students to understand (Hapsari, 2023). Ease of Access and Navigation: The flipbook design, which resembles a printed book but with a digital touch (page flipping), makes it easy for students to navigate and access materials anytime and anywhere (access flexibility), which is the core of the Flip Learning model (Simamora & Asri, 2024).

The practicality of the E-LKPD was assessed through observations of teacher and student activities during classroom implementation, as well as through a student response questionnaire. The results showed that the Flip Learning-based E-LKPD Coding was categorized as "Very Practical" and received very high (positive) student responses. These positive responses were primarily concentrated on four main aspects aligned with instructional design principles: attention-grabbing, objective information, training, and testing.

The high level of positive responses to the attention-grabbing aspect indicates that the E-LKPD's visual and interactive features successfully captured student interest. The flipbook's modern design and the integration of coding examples relevant to everyday life or current technological trends (e.g., simple game demonstrations) broke the monotony of conventional

teaching materials (Mirza, 2025). This is crucial in the Flip Learning model, where initial motivation is crucial for students to actively engage with pre-class material independently (Aisyah et al., 2024).

The E-LKPD presents learning objectives (learning outcomes) and learning outcomes (learning achievements) explicitly and measurably. Positive student responses in this aspect indicate that they understand what they should master after completing the E-LKPD. In the coding context, this means students clearly understand the expected output of each exercise (e.g., "Students are able to write a Python program to calculate the area of a plane figure"). This clear understanding of objectives serves as a guide for independent learning outside of class.

The "practice" aspect is at the heart of the E-LKPD Coding. The very high student response reflects the E-LKPD's success in providing varied and gradual coding exercises and simulations. Pre-Class Independent Practice: The E-LKPD contains initial coding assignments that students must complete as part of the pre-class phase of the Flip Learning model. This encourages students to try, make mistakes, and learn independently before meeting the teacher. Deeper In-Class Activities: Thanks to the mastery of initial concepts through E-LKPD, face-to-face time can be utilized for more complex problem-solving, discussions, and peer-coding. E-LKPD provides coding challenge scenarios that require higher-order thinking skills (HOTS), rather than just basic information transfer (Wahyuni et al., 2021). Providing Tests (Providing Feedback) E-LKPD is equipped with formative assessment features, such as interactive quizzes that provide instant feedback after students complete each coding segment or sub-topic. Highly positive responses indicate that this feedback feature is very helpful for students in: Detecting Errors: Students can immediately identify incorrect coding sections or concepts that are not yet understood. Self-Repair: Specific feedback allows students to debug and self-repair, which are essential skills in learning to code (Cahyadi & Purwanto, 2020).

The integration of the flipped learning approach into the developed E-LKPD coding is relevant to various previous studies that show this approach influences student learning achievement or academic achievement (Moghadam & Razavi, 2022). The implementation of flipped learning in various studies has demonstrated the effectiveness of this model in increasing student independence and learning progress (Kustandi et al., 2025). Other studies also show that flipped learning benefits student groups because it reduces cognitive load in learning, thus optimizing learning achievement (Mahardika Arsa Putra & Tri Agustiana, 2021). Research on flip learning literature consistently shows improvements in quantity and quality, with the main focus being the approach's efforts to improve student competency and its positive impact on learning outcomes, both cognitively, affectively, and psychomotorically (Birgili et al., 2021). Significant differences in learning achievement were also found between students who studied with the integrated flipped learning model (Warpala, 2023). Other research findings indicate that flipped learning, as an innovative pedagogical approach, significantly improves student achievement compared to traditional learning (Aybirdi et al., 2023; Nja et al., 2022). Learning using the E-LKPD coding developed with flipped learning in this study was integrated into the learning stages, where students first accessed the E-LKPD outside of school as preparation before finally engaging in practical work with the teacher in class. Therefore, the integration of flipped learning as a pedagogical approach into the developed E-LKPD is relevant for influencing student achievement.

The implications of these findings are that the developed E-LKPD coding media is considered effective in improving student achievement, with a moderate increase in gain scores and student completion exceeding the established criteria of 80%. These achievements also demonstrate that the E-LKPD coding, with its integration of simulation activities, easy-to-understand and

compatible displays, provision of exercises, and various characteristics emerging from the product developed in this study, can be an alternative media for Informatics subjects at the high school level. Further improvements can be made by enriching the content, multimedia, interactivity, and learning design to suit student needs. The differences in pre-test and post-test scores in this study could be caused by various factors other than the use of the developed E-LKPD coding. In accordance with input from experts and revisions to the developed product, future research can develop E-LKPD with similar programming simulations with a more motivating display, stimulate prior knowledge, and be able to arouse students' curiosity. Future research can also further explore the factors that influence the improvement of student learning achievement, especially in informatics subjects.

CONCLUSION

This study developed a flip learning-based coding E-LKPD for Informatics for grade XI high school students. Validation results showed that the developed learning media met the criteria of excellent, with media validity of 92%, learning validity of 95%, and material validity of 80%. The practicality test obtained a score of 82%, which is included in the very good category, while the effectiveness test showed an increase in student learning achievement with an average score increasing from 57.37 to 82.19, an N-gain value of 0.59 in the moderate category, and classical completeness reaching 82%. These findings confirm that flip learning-based coding E-LKPD is effective in improving student learning achievement in algorithm and programming learning. Further research is recommended to develop coding E-LKPD with more varied multimedia features, adapting to the needs of students in various school contexts, and examining other factors that influence learning achievement improvement, such as motivation, learning independence, and support for educational technology infrastructure.

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