Kodular-based learning media: Enhancing instruction on informatics education to vocational high school students

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Abstract: This study explores the development of Kodular-based learning media to enhance the quality of informatics education. The study addresses the need of more engaging learning media and better technology integration in teaching using a Research and Development (R&D) design and a modified 3D model out of the 4D development model, including defining, designing, and developing. The research involved 20 students from SMK Negeri 1 Bangkinang, employing all stages of the development model: need analysis, media development, validation, and trial to students. The defining stage revealed inappropriate teaching method uses, leading students to have less motivation in learning. Consequently, this research developed learning media, focusing on number systems material (decimal, binary, octal, hexadecimal), organized in a visually appealing and concise format. In the designing phase, the Kodular media was developed to be user-friendly, featuring quizzes, exercises, and interactive modules. Validation results showed high feasibility scores, with media experts rate on 88.57% and material experts rate on 95%. During the developing stage, a trial to students yielded a score of 4.81 out of 5, classifying the media as "Very Good". Students praised its clarity, ease of use, and ability to make learning enjoyable. This study highlights the potential of Kodular-based media to increase engagement and support student-centred learning in vocational education.

Keywords: media technology; quality education; research and development; student learning interest

1. Introduction

The rapid advancement of information and technology has significantly transformed the educational landscape, pushing educators to innovate and adapt their teaching methods (Kozinets, 2023; Lamb et al., 2022; Opesemowo & Adekomaya, 2024). These changes align with the 2030 Sustainable Development Goals, which emphasize the importance of quality education and advocate for inclusive and equitable education for all learners (García et al., 2020). In order to achieve these goals, educators are expected to harness modern technologies and implement innovative teaching strategies that foster critical thinking, creativity, and collaboration among students.

One practical approach is the integration of interactive learning media. Educators can use platforms like Kodular to increase student engagement and motivation, making learning more accessible and relevant (Nurjanah & Suprihatin, 2023; Yunianta et al., 2023). This approach not only meets the diverse learning needs of students but also equips them with essential skills to navigate the increasingly complex digital world.

Kodular, a web-based app development platform that requires no programming skills, offers an innovative solution for creating learning media that teachers and students can easily access and use (Mavropoulou, 2021). Kodular provides various tools that allow the development of interactive educational apps aligned with curricula, offering a more engaging and enjoyable learning experience (Dimas et al., 2024;

Wicaksana & Erlina, 2023). This innovation encourages students to actively participate in learning, fostering creativity and boosting motivation.

However, observations at SMK Negeri 1 Bangkinang's Electronics Department revealed challenges in utilizing learning media. Many teachers still rely on traditional methods such as lectures, PowerPoint presentations, and whiteboards, resulting in reduced student interest and engagement in learning (Criollo-C et al., 2024; Fortuna et al., 2024; Prasetya et al., 2024; Waskito et al., 2024). Therefore, this study aims to develop Kodular-based learning media that effectively enhances informatics education.

The novelty of this research lies in developing Kodular-based interactive learning media specifically designed for vocational education in Indonesia. This innovation addresses a critical gap in engaging and accessible teaching tools for informatics education. Moreover, the study provides a scalable and adaptable framework for integrating technology across various educational fields, fostering digital literacy, creativity, and student collaboration. This aligns with the 2030 Sustainable Development Goals, particularly in promoting inclusive and equitable quality education, equipping students with essential skills for the digital era. The findings are anticipated to serve as a model for developing learning media in other domains, encouraging more institutions to integrate technology into their teaching processes. Additionally, this research aims to improve educational outcomes and act as a benchmark for similar innovations in resource-constrained educational environments. By enhancing informatics education, this study establishes a foundation for modernizing teaching practices in alignment with global educational priorities.

2. Methods

2.1 Research design

This study outlines the type of research, subjects and objects, location and time, instruments used, sampling techniques, and data collection and analysis methods. The research employed a Research and Development (R&D) approach to develop Android-based electronic module learning media without defining assumptions (Muskhir et al., 2023, 2024). According to (Afandi et al., 2019), the R&D method aims to produce products and test their effectiveness. The product developed in this study is a Kodular-based learning medium for informatics. The development model adopted is the 4D model by (Thiagarajan et al., 1974), which includes the stages of define, design, develop, and disseminate. However, the model was modified to a 3D approach by omitting the disseminate stage due to limitations. The subjects included one content expert, one media expert, and 20 students from the X Electronics Department at SMK Negeri 1 Bangkinang.

Figure 1.
Model of 4D
(Thiagarajan et al., 1974)
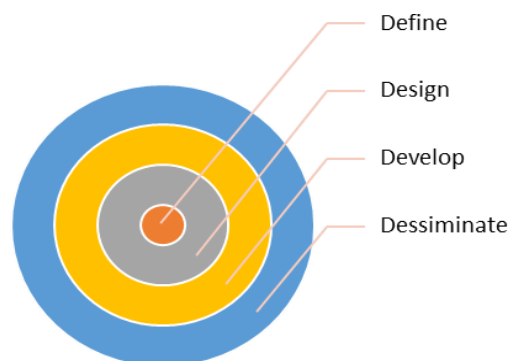
2.2 Research procedure

Due to time and budget constraints, this study used a modified version of the 4D development model, simplified to 3D. The first stage, Define, involved initial analysis through pilot tests and limited observations. During this stage, the lack of technology integration in teaching methods was identified,

with teachers relying on lectures, presentations, and whiteboards (Backfisch et al., 2021; Ngao et al., 2022; Pamuk, 2022). Furthermore, students showed low learning interest when lectures were the primary teaching method, as observed at SMK Negeri 1 Bangkinang.

The researcher addressed these issues in the Design stage by developing Kodular-based learning media for informatics instruction. This stage involved organizing learning materials, creating assessment tools, selecting suitable media formats, and designing the initial framework for Kodular-based learning media. The final stage, Develop, focuses on validating the learning media with the involvement of media experts, teachers, and content experts to ensure its suitability (Arifin et al., 2023; Sulistyanto et al., 2022). After revisions based on expert feedback, the learning media was deemed ready for use and tested in a limited trial with students. Student feedback was gathered via questionnaires to evaluate the effectiveness of the media and their responses to its use in learning.

2.3 Data collection technique

Data collection in this research involved several techniques to gather and compile the necessary information. This process is crucial to achieving research objectives with appropriate methods. One technique used was a questionnaire, which provided questions to respondents, including teachers and students, to be answered according to instructions (Bihu, 2023). This method aimed to measure program indicators related to content, appearance, and the quality of learning media and evaluate the feasibility of the developed media. The questionnaire format used a checklist response, where respondents could check relevant options (Magnus & Chen, 2023; Molléri et al., 2020).

Table 1. Material expert assessment grid

Indicator	Assessment Aspect
Suitability of material with essential competencies	Suitability of material with learning indicators
	Depth of material following core and essential competencies
The accuracy of the material	The accuracy of the concepts presented
	The accuracy of the concept sequence
	The correctness of the material presented
	The suitability of the sequence of material with existing indicators
Straightforwardness of language	The language used in the media (not convoluted)
Sentence presentation	The accuracy of the sentence structure used in the codular-based media
	The material presented is easy to understand
	Sentences in the media follow excellent and correct Indonesian language
	The accuracy of the sentence structure used in the codular-based media
	Appropriateness of language with students' intellectual development
Presentation of material	The suitability of the material to the intellectual development of students
	The suitability of the material with the curriculum used
Use of terms	The accuracy of the terms presented
	Consistency in the use of terms

Additionally, observation was used as a data collection method to obtain information that could serve as a basis for drawing conclusions or making diagnoses (Ganesha & Aithal, 2022). This technique involved

observing various aspects relevant to the development of informatics learning media, such as school environment conditions, facilities, learning materials, students, and teaching methods applied in the classroom. Furthermore, the data collection instruments in this research consisted of questionnaires divided into three types: one for media experts, one for content experts, and one for students. According to (Duckett, 2021), research instruments are tools used to measure observed variables in both natural and social sciences. The instrument grid for data collection is presented in Table 1.

Table 2. Media expert assessment grid

Indicator	Assessment Aspect
Media display size	Balance of the size of each display on codular-based media
Media design	Screen display
Programming	Accuracy of color selection and composition
	Image display quality
	The video sound is clear
	The writing can be read well.
	Background colour with text Sub Aspects of Media Use Programming
	Clarity of navigation
	Consistency of button usage
	Clarity of instructions
	Ease of use
	Text efficiency
	Image efficiency
	Program speed and media appeal
	Ease of selecting the presentation menu
	Attractiveness of media
Ease of use	Kodular software does not run slowly.
	Kodular software does not stop during operation.
	Kodular software is easy to run.
	The flow of using Kodular software is straightforward.
	Simple operation

The Kodular-Based Learning Media instrument is divided into media and content. This questionnaire was assessed by four experts, comprising two lecturers from informatics education and two teachers from SMK Negeri 1 Bangkinang. In this evaluation, the researcher set clear criteria, requiring validators to have 30–40 years of teaching and research experience. Additionally, the teachers were required to hold at least a master's degree, while the lecturers held doctoral and professor-level qualifications (Prasetya, Fortuna, et al., 2023; Syahril et al., 2021).

Table 3. Student response questionnaire grid

No	Indicator
1.	The use of codular-based learning media is effortless.
2.	Videos on kodular-based learning media support better mastering informatics material
3.	The existence of kodular-based learning media can motivate people to learn informatics material.
4.	The language used in kodular-based media is easy to understand.
5.	The material presented in the kodular-based learning media is easy to understand.
6.	Informatics material is more enjoyable with kodular-based learning media
7.	Kodular software can be installed easily.
8.	Kodular software can be used without an internet connection.

It is important to note that the instrument used in this study was developed by the researcher and validated by experts, ensuring that the version presented is final and meets the minimum reliability criteria. Similarly, the student response questionnaire framework was designed to evaluate the trial implementation of Kodular-based learning media. The questionnaire encompasses student engagement, ease of use, visual appeal, and contribution to material comprehension. This instrument also underwent a rigorous validation and reliability testing process, guaranteeing that each item effectively measures relevant indicators with accuracy and consistency.

2.4   Data analysis technique

The data analysis technique used in developing Kodular-based learning media at SMK N 1 Bangkinang involved assessments from media experts, material experts, and a trial conducted with 20 students participating in the study. The data was collected through observation and questionnaires, which were then analyzed. Each response provided by the respondents was rated using a Likert scale, where one indicated "strongly disagree" and five indicated "strongly agree" (Baliyan & Mokoena, 2024). After gathering the assessments, the data was processed to calculate the average score, reflecting how users accepted the developed learning media. The analysis was performed following data collection using validation questionnaires from media experts, material experts, and student responses based on the Equestion 1.

$$P = \frac{\sum x}{N \times \sum x_1} \times 100\% \tag{1}$$

Description:

P	= Feasibility Percentage
$\sum x$	= Skor total Validator
$\sum xi$	= Maximum Score
N	= Number of questionnaire items

Additionally, both qualitative and quantitative analyses were employed in the validation and feasibility assessment of the Kodular-based learning media. The qualitative analysis sought to investigate the perspectives and recommendations of media and material experts regarding the content and design of the learning media. In contrast, the quantitative analysis evaluated the numerical data gathered through the Likert scale (Halim et al., 2024). The criteria for the validation and feasibility assessment are presented in Table 4.

Table 4. Rating scale criteria

Description	Score Range	Category	Value Range
Very good	4.21-5.00	Very Feasible	81% - 100%
Good	3.41-4.20	Feasible	61% - 80%
Fairly good	2.61-3.40	Less Feasible	41% - 60%
Not good enough	1.81-2.60	Not Feasible	21% - 40%
Very poor	1.00-1.80	Very Not Feasible	0% - 20%

3.   Results

The development of Kodular-based learning media in this study followed the 4D development model, which was modified to 3D. Media experts, material experts, and students assessed the developed media product as valid and practical. Each stage of media development, along with its analysis, is systematically described below:

3.1 Define

In the Define stage, problem analysis and identification were conducted to gather information about the developed product. Through initial (Front-end) analysis based on direct observation, several issues were identified in the learning process. One major problem was the lack of engaging learning media for students and the limited use of technology in teaching and learning. These factors contributed to an ineffective learning experience. In order to address this issue, Kodular-based learning media was developed and tailored to the needs of teachers and students. Learner analysis revealed that educators' limited use of learning media and lack of technological knowledge resulted in teaching methods confined to lectures, PowerPoint presentations, and blackboard usage. These methods were deemed unappealing to students, leading to a declining interest in learning.

In the Concept Analysis stage, students identified and systematically organized vital materials, such as decimal, binary, octal, and hexadecimal number systems. Observations showed that students were more inclined to read and learn when the material was presented concisely, clearly, and with appealing visuals. Therefore, the Kodular learning media material was summarized in simple language and supported by attractive images and colours to maintain student interest. Finally, task analysis was conducted by mapping the analyzed materials and organizing them into several sections. The core materials were systematically organized within the learning media to facilitate student understanding of the concepts being taught and to achieve learning objectives.
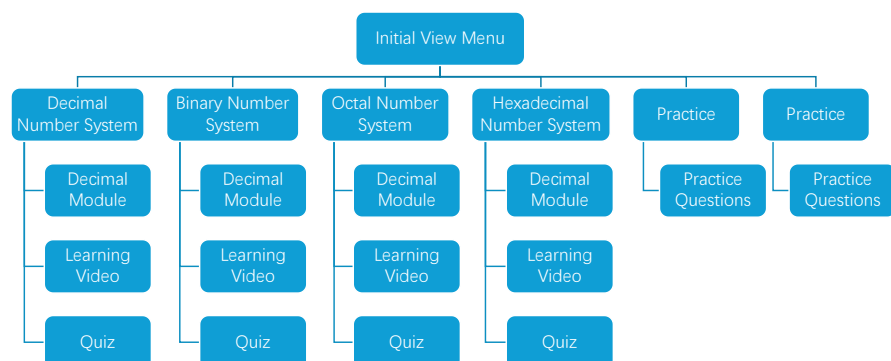
3.2 Design

After completing the Define stage, the next phase was the design of Kodular-based learning media for Informatics instruction. This stage aimed to produce simple and easy media for students and educators to understand. Critical steps in the design process included:

3.2.1 Flowchart

A flowchart was created to facilitate the development of the Kodular-based learning media. The media was designed to be simple, ensuring ease of use for both students and teachers. The flowchart depicting the features of the application is shown in Figure 2.


Figure 2.
Condular application flowchart

3.2.2 Product design

The learning media design was developed according to the storyboard, focusing on aligning the planned workflow and the main features integrated into the application. The Kodular application design is illustrated in Figure 3, showcasing key elements such as user interface, navigation, and main functionalities designed to support interactive and easy-to-understand Informatics learning for both students and educators.

The initial screen features buttons for decimal, binary, octal, and hexadecimal systems and options for exercises and assistance. The material screen includes clickable buttons for accessing a material module, YouTube-based learning videos, quizzes, and a home button to return to the main menu. Clicking the module button opens an e-module. The quiz screen starts with a "start" button, presenting five questions with answer choices and displaying a score based on correct answers, along with a home button to return to the material screen. The exercise screen provides practice questions covering previously learned material, with navigation buttons to move forward, return, or return to the main menu. The instructions screen explains how to use the various buttons in the Kodular-based learning media.
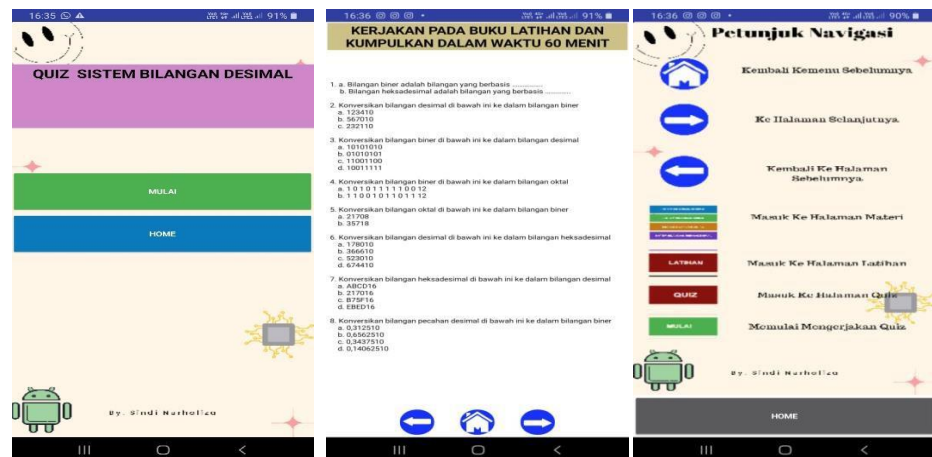
Figure 3.
Kodular Learning Media for Teaching Informatics
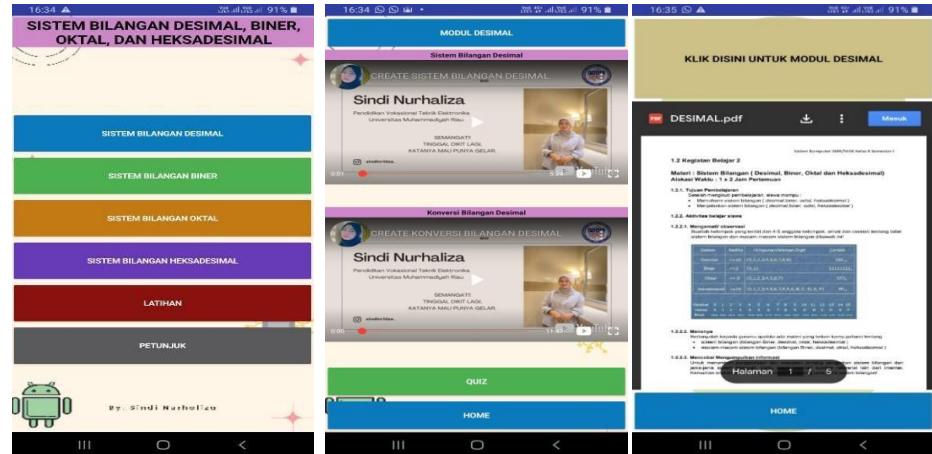
(a) Media start view   (b) Material display   (c) Module content display

(d) Quiz view   (e) Exercise view   (f) Display instructions

3.3   Develop

In the development stage, the Kodular-based learning media was first validated by experts to assess its feasibility before being tested in a classroom setting. This validation process aimed to ensure that the media was suitable for instructional use. Several steps were taken during validation, including media expert validation.

3.3.1   Media expert validation

A lecturer from the Vocational Electronics Education program at Universitas Muhammadiyah Riau conducted the media validation. The assessment questionnaire consisted of 21 items, each rated on a scale of 1-5. The results of the media expert's assessment are summarized in Table 5.

Table 5.
Media expert assessment results

No	Indicators Assessment	Assessment Aspect	Score
1	Media display size	Balance of the size of each display on codular-based media	4
2	Media design	Screen display	5
3	Programming	Accuracy of color selection and composition	4
		Image display quality	4
		The video sound is clear	5
		The writing can be read well	4
		Background colour with text Sub Aspects of Media Use Programming	4
		Clarity of navigation	5
		Consistency of button usage	5
		Clarity of instructions	5
		Ease of use	4
		Text efficiency	4
		Image efficiency	4
		Program speed and media appeal	4
		Ease of selecting the presentation menu	5
		Attractiveness of media	4
4	Ease of use	Kodular software does not run slowly	4
		Kodular software does not stop during operation	4
		Kodular software is easy to run	5
		The flow of using Kodular software is clear	5
		Simple operation	5
Overall			**93**
Average			**4.4**

$$P = \frac{\sum x}{N \times \sum x_1} \times 100\% = \frac{93}{21 \times 5} = \frac{93}{105} \times 100\% = 88.57\%$$

Based on the media expert's evaluation, the Kodular-based learning media received an average score of 4.4 out of 5, indicating that it fell within the "Very Good" category. This evaluation encompassed various aspects, including display size balance, navigation clarity, ease of use, sound quality, and colour composition accuracy. Several critical indicators, such as screen design, navigation clarity, button usage consistency, and ease of software operation, received the highest score of 5.

In contrast, aspects such as text efficiency, program speed, and media appeal received scores of 4, which were still in the "Good" category but indicated room for improvement. The feasibility percentage of the learning media was calculated to be 88.57%, suggesting that it was highly feasible for instruction, though some aspects might benefit from refinement.

3.3.2 Material expert validation

The material validation was conducted by an educator from the Electronics Engineering Department at SMK Negeri 1 Bangkinang using a questionnaire consisting of 16 evaluation items. Each item was measured using a Likert scale ranging from 1 to 5. Based on the Kodular-based learning media assessment results, several indicators, such as the material's alignment with essential competencies and learning indicators, depth and accuracy of concepts, material presentation, and the use of terminology, are presented in Table 6.

Table 6.
Material expert assessment results

No	Indicators Assessment	Assessment Aspect	Score
1	Suitability of material with essential competencies	Suitability of material with learning indicators	5
		Depth of material following core and essential competencies	5
2	The accuracy of the material	The accuracy of the concepts presented	5
		The accuracy of the concept sequence	4
		The correctness of the material presented	4
		The suitability of the sequence of material with existing indicators	5
3	Straightforwardness of language	The language used in the media (not convoluted)	5
4	Sentence presentation	The accuracy of the sentence structure used in the codular-based media	5
		The material presented is easy to understand	5
		Sentences in the media follow excellent and correct Indonesian language	4
		The accuracy of the sentence structure used in the codular-based media	4
		Appropriateness of language with students' intellectual development	5
5	Presentation of material	The suitability of the material to the intellectual development of students	5
		The suitability of the material with the curriculum used	5
6	Use of terms	The accuracy of the terms presented	5
		Consistency in the use of terms	5
	Overall		**76**
	Average		**4.75**

$$P = \frac{\sum x}{N \times \sum x_1} \times 100\% = \frac{76}{16 \times 5} = \frac{76}{80} \times 100\% = 95\%$$

The evaluation results indicate that this learning media demonstrates excellent alignment with essential competencies and learning indicators, achieving a perfect score (5) on key aspects such as material depth, concept accuracy, and sequence alignment with existing indicators. The language used in the media was also rated very highly for its clarity and appropriate sentence structure. However, minor improvements were suggested regarding sentence conformity with proper Indonesian language rules, although the sentences were generally easy to understand.

Regarding material presentation, the media was considered highly appropriate for students' intellectual development and the curriculum used. The accuracy and consistency of terminology also received high scores. Based on the evaluation results, the media achieved a total score of 76 out of 80, with an average

score of 4.75, equivalent to a 95% feasibility rating. Therefore, the Kodular-based learning media is deemed highly feasible for use without requiring revisions.

3.3.3 Development trial for students

The developmental trial of the Kodular-based learning media was conducted to evaluate its effectiveness in classroom implementation. A questionnaire of 8 evaluation items, rated on a scale from 1 to 5, was distributed to 20 students from class X TE2 at SMK Negeri 1 Bangkinang on August 10, 2023. The results of the students' assessments of the learning media are shown in Table 7.

Table 7.
Student response assessment results

No	Assessment Aspect	Total Score: 20 Students	Average	Criteria
1.	The use of codular-based learning media is effortless	98	4.85	Very good
2.	Videos on kodular-based learning media support better mastering informatics material	97	4.75	Very good
3.	With kodular-based learning, the media can motivate people to learn informatics material.	99	4.8	Very good
4.	The language used in kodular-based media is easy to understand.	99	4.75	Very good
5.	The material presented in the kodular-based learning media is easy to understand.	103	4.9	Very good
6.	Informatics material is more enjoyable with kodular-based learning media	104	4.9	Very good
7.	Kodular software can be installed easily	104	4.85	Very good
8.	Kodular software can be used without an internet connection.	103	4.75	Very good
Average		**4.81**		**Very good**

The trial of the Kodular-based learning media was conducted to evaluate its effectiveness in classroom implementation. A total of 20 students from Class X TE2 at SMK Negeri 1 Bangkinang completed a questionnaire consisting of 8 assessment items on August 10, 2023. The results indicated that the learning media was highly user-friendly, receiving the highest score of 4.85. Students also appreciated the videos embedded in the media, which helped them grasp the informatics material, with a score of 4.75. Additionally, the learning media successfully motivated students to study informatics, scoring 4.8. The language used in the media was considered easy to understand, scoring 4.75, while the presented content was rated very good, with a score of 4.9. The media made the informatics material more engaging for students, reflected in a score of 4.9. On the technical side, the ease of Kodular software installation (4.85) and its offline usability (4.75) were also rated positively. The overall average score was 4.81, categorizing the Kodular-based learning media as "Excellent." Therefore, it is considered highly suitable for supporting teaching and learning activities in the X Electronics Engineering class at SMK Negeri 1 Bangkinang.

4.   Discussion

This study focuses on developing Kodular-based learning media to enhance the teaching and learning process at SMK Negeri 1 Bangkinang, particularly in the Electronics Engineering department. As rapid advancements in information and technology reshape education, educators face the challenge of adopting more interactive and engaging teaching methods (Fortuna et al., 2023; Prasetya, Fajri, et al., 2023; Wulansari et al., 2024). Observations revealed that many teachers still rely on conventional lecture methods, leading to low student engagement. Therefore, this study aims to address this issue by integrating technology into learning by developing interactive learning media.

The findings align with previous studies demonstrating how interactive learning media can enhance student motivation and engagement in the learning process (Dimas et al., 2024; Nurjanah & Suprihatin, 2023; Yunianta et al., 2023). For example, (Baxter & Hainey, 2024) revealed that incorporating technology in classrooms can transform the learning dynamic and provide more profound learning experiences. However, this study differs by focusing on using the Kodular platform, which allows teachers to create learning applications without programming skills. Thus, this research offers a more practical and accessible solution for educators to create innovative learning media.

The main contribution of this study is the development of Kodular-based learning media that not only aligns with the curriculum but also caters to the diverse learning needs of students. With this application, students are expected to be more actively engaged in the learning process, which could improve their motivation and understanding of informatics material. Moreover, this study is expected to serve as a model for developing learning media in other fields, encouraging more institutions to leverage technology in education. As such, the findings address existing challenges and contribute to improving the quality of education in Indonesia, particularly in the digital era.

5.   Research limitations and implications

This study has several limitations that should be noted. First, the modified 3D development model, instead of the 4D model, indicates that the dissemination phase was not conducted, limiting the potential for the widespread distribution of the developed learning media to other institutions. Additionally, the current learning media is only available in APK file format and can only be run on Android smartphones. Second, the application development on the Kodular platform has a project size limit of 20MB, meaning not all materials could be included in the application. Lastly, the media is accessible only with an internet connection, and it is not yet available on platforms such as Google Play or iOS, which restricts its usage reach.

This research implies that integrating technology in learning, such as using Kodular-based learning media, can increase student motivation and engagement. With engaging educational applications, students are expected to learn more effectively. This research also contributes to developing more innovative teaching methods, supporting the goal of quality and inclusive education per the 2030 Sustainable Development Goals. In addition, the results of this research can serve as a model for the development of learning media in other fields, encourage more educators to utilize technology in the learning process and enrich students' learning experience in the digital era.

6.   Conclusion

The results of this study demonstrate that integrating Kodular-based learning media can significantly improve student motivation and engagement in informatics learning at SMK Negeri 1 Bangkinang. The media development followed a systematic process, including problem analysis, design, and validation, meeting the required feasibility criteria. The use of interactive learning media not only enhances student engagement but also aids educators in delivering more engaging and comprehensible material. With

positive validation from experts and student feedback, this learning media is deemed suitable for use in teaching and learning processes. This study also opens opportunities for the development of learning media across various educational institutions, leveraging technology to enhance the effectiveness of the learning process in adapting to modern advancements.

Author's Declaration

Author contribution

Sindi Nurhaliza: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Noverta Effendi**: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – review & editing, Supervision. **Fitri Farida**: Conceptualization, Methodology, Data curation, Writing – review & editing, Project administration, Funding acquisition.

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Conflict of interest

No conflicts of interest in this research.

Ethical clearance

The involvement of teachers and students as subjects in this research is in accordance with the Declaration of Helsinki. This research has obtained permission to conduct research from SMK Negeri 1 Bangkinang with permit number 070/SMKN.1BK/2023/427. The school management, teachers, and students have agreed to the publication of data obtained from research at SMKN 1 Bangkinang.

AI Statement

The language structures used in this article were checked by using Grammarly and has been verified by an English language expert. In addition, none of the sentences and figures in this article was AI tool-generated. All the data were obtained from the process of the study, and authors' and previous research review.

Publisher's and Journal's Note

Researcher and Lecturer Society as the publisher and Editor of Journal of Computer-Based Instructional Media state that there is no conflict of interest towards this article publication.

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