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Development of an e-module for sensors and transducers using Kvisoft Flipbook to enhance 4Cs skills in vocational education students

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Abstract: This study aims to develop sensor and transducer e-modules based on 4Cs skills using the Kvisoft Flipbook application to improve the quality of learning in automotive engineering. The main focus of the study is to assess the validity, practicality, and student response to the e-module design developed. This study is a Research and Development (R&D) with the ADDIE model. Data collection techniques included validation questionnaires, user practicality questionnaires, and student response questionnaires to the e-modules. The e-module was rated highly valid by 89% of e-module experts and 88% of material experts and highly practical according to the assessment of lecturers (89.09%) and students (81.81%). The evaluation showed that students who used the e-module achieved a higher average score than the control group, signalling the effectiveness of the e-module in improving critical thinking, creative thinking, communication, and collaboration skills (4Cs), and material understanding. These findings emphasize the urgency of technology integration in vocational education to improve 4Cs among students.

Keywords: Quality education; 4Cs skills; Kvisoft Flipbook; Vocational education; Industrial revolution 4.0

1. Introduction

In order to prepare students for the technological challenges posed by the Industrial Revolution 4.0, vocational education needs to equip them with relevant skills and knowledge (Anwar et al., 2024; Roll & Ifenthaler, 2021; Spurk, 2021; Xu et al., 2018). Besides hard skills, vocational education graduates must also have soft skills to compete in the world of work (Jalinus et al., 2023; Le et al., 2022). Data from the Central Bureau of Statistics in February 2021 shows that the highest Open Unemployment Rate is vocational high school graduates (11.54%), followed by senior high school (8.55%), junior high school (5.87%), university (6.97%), diploma (6.61%), and elementary school (3.31%). The leading cause of this high unemployment is low soft skills and expertise.

Soft skills are the ability to behave adaptively and constructively, enabling individuals to be professional and effective in facing life's challenges (Wahyudi et al., 2023). Individuals without soft skill qualifications will lose out in the job competition (Collins, 2018) because soft skills predict success in life (Cinque, 2016). Based on the study of competencies needed in the Industrial Revolution 4.0, soft skills are as necessary as technical skills (hard skills) in engineering (Maisiri et al., 2019). Necessary soft skills in the 21st century are critical thinking, creative thinking,

communication, and collaboration, known as the 4Cs (P21 Framework for 21st-century learning, 2007).

4Cs skills must be possessed by vocational education graduates to face the challenges of the 21st century due to the Industrial Revolution 4.0 (Varas et al., 2023). The industrial world in the 21st century requires a workforce with the ability to think critically and solve problems (Le et al., 2022; Samala, Boji, et al., 2023; Silber-Varod et al., 2019; van Laar et al., 2020). Aligning that, education should build creativity because it further, creates innovations (Prasetya et al., 2024; Samala et al., 2024). Creativity is essential in today's technological era, both in the creative thinking process and in producing creative products (Febrianti et al., 2023; Lesmana et al., 2023). Everyone needs creativity to produce something useful (May et al., 2020).

Learning in vocational education begins with a predetermined curriculum (Muskhir et al., 2024; Nasution et al., 2024; Putra et al., 2024; Rahim et al., 2024). In order to foster soft skills in the learning process, the curriculum must include soft skills content. This will make it easier for lecturers to design learning activities relevant to the competencies required by business and industry. One of the critical courses in the automotive engineering program for forming soft skills is the sensor and transducer course.

The sensors and transducers course develops students' knowledge and skills in learning the characteristics, working principles, and applications of sensors and transducers in electronic control systems in the automotive industry (Song et al., 2023). The creative and innovative lecturer in the teaching and learning process affects 21st-century learning skills (Setiyani et al., 2022). The learning process will be effective if supported by dynamic learning media and methodologies that allow students' potential to develop optimally (Jumaroh et al., 2022; Sansi et al., 2023; Siallagan & Hanafi, 2024). Teaching materials such as printed books and e-books (Setiyani et al., 2022), and innovative e-modules with video, animation, and audio make learning more effective, efficient, and relevant (Supriadi et al., 2019).

Kvisoft Flipbook application supports interactive learning media because it is not only fixated on writing but also includes motion animation, video, and audio, making learning more fun (Haryanto et al., 2020). This combination helps students visualize the abstract sensor and transducer subject matter as concrete. Therefore, innovation is needed in sensor and transducer courses so that students feel happy and understand the material well. Thus, this study develops sensor and transducer learning e-modules using the Kvisoft Flipbook application to improve the 4Cs Skills of vocational education students in automotive engineering.

2. Methods

Type of study

This study is a Research and Development (R & D). It used the ADDIE development model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation (Dick & Carey, 1990), as shown in Figure 1.

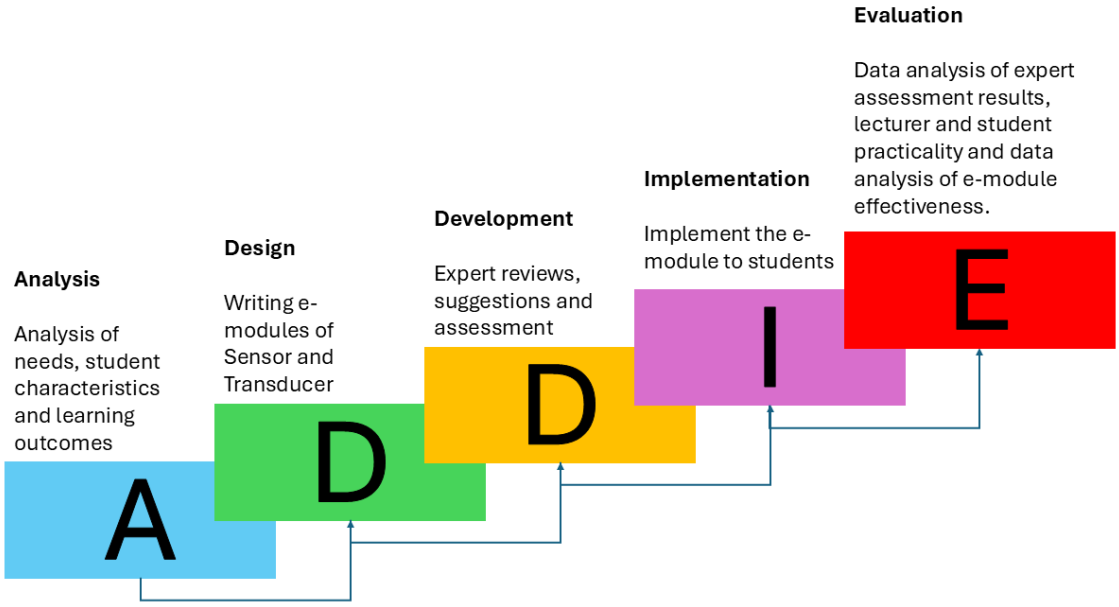

Figure 1. ADDIE model development procedure

Analysis

The analysis stage includes needs analysis, student characteristics, and concepts. The needs analysis aims to assess the extent of the need for the use of modules as teaching materials in sensor and transducer courses. Previous learning methods and teaching materials were also explored at this stage. Analysis of student characteristics aims to understand students' habits and ways of learning. Concept analysis aims to identify, detail, compile, and collect information about the material taught based on the curriculum of the Automotive Engineering Study Program.

Design

This study made sensor and transducer e-modules at the design stage using the Kvisoft Flipbook application. The results of the needs analysis, student characteristics, and concepts were used as the basis for making sensor and transducer e-modules.

The e-module was developed using the Kvisoft Flipbook application and can be accessed via laptop or smartphone (Marta et al., 2023). Kvisoft Flipbook is software that allows the creation of classic animations, mimicking a physical book with pages that can be flipped and appear to move (Ladamay et al., 2021; Samsu et al., 2021). This application allows adding various types of files, such as images, SWF, FLV, MP4, and other formats. The output of Kvisoft Flipbook can be in HTML, EXE, ZIP, and APP formats (Setiyani et al., 2022). The HTML output format allows the e-module to be uploaded to a website for online access and allows the EXE file to be run independently without the need for additional applications.

Figure 2. Sensors and Transducers E-module

Figure 2 shows the design of the sensor and transducer e-module available in EXE and HTML file formats. The module includes various sections, including the front page, scope, instructions for use, material description, learning activities, assignments, summary, feedback, follow-up, evaluation, bibliography, glossary, and author bibliography. The e-module material for sensor and transducer courses includes sensors and transducers, Arduino, and sensor installation and configuration.

Development

Subsequently, at the development stage, the sensor and transducer e-modules are reviewed. The suggestions for improvement are given, and experts assess them to examine the validity. This study involved four experts with more than 10 years of teaching experience and doctoral education background, including a professor. The sensor and transducer e-module assessment indicators used by the experts are presented in Table 1.

Table 1. Indicator of sensor and transducer e-module assessment instrument

No	Aspects	Indicator
1	E-Module requirements	1. Didactic 2. Construction 3. Technical
2	Material Quality	1. Content 2. Learning 3. Interaction 4. Display

Assessment from experts were analyzed using the coefficient V in Equation (1) (Aiken, 1985).

$$V = \sum s/[n(c-1)] \quad (1)$$

Where:

V = the value of the validity coefficient of Aiken
s = the value of the rating scale minus 1
n = the number of experts used in the validation
c = the highest score in the rating scale

The coefficient V based on assessment from experts is categorised as presented in Table 2.

Table 2. Assessment criteria category

No	Coefficient V	Category
1	0.3 – 1.00	Valid
2	< 0.3	Invalid

Implementation

The implementation of e-modules involved 46 students, who were compared with learning outcomes between experimental and control classes using the Static Group Comparison design. The design used the static group comparison as shown in Table 3.

Table 3. The static group comparison design

Class	Treatment	Post-test
Experiment	X	O1
Control	-	O2

Evaluation

Practicality instruments by lecturers and students are used to assess the ease and practicality of using the developed learning e-modules. The learning e-module practicality instrument as presented in Table 4.

Table 4: Practicality questionnaire grids

No	Assessment indicator of e-module	
	For lecturer	For student
1	Ease of use	Ease
2	Time effectiveness	Time required
3	Interpretation	Media appeal
4	Equivalence	

Indicators for lecturers include ease of use, time effectiveness, interpretation, and equivalence. Meanwhile, indicators for students include ease, time required, and media appeal. Twenty-three students from the experimental group filled out the practicality instrument for students.

From the analysis, an overall average was obtained, which showed the level of practicality of the e-module as shown in Table 5. This instrument uses a Likert scale for its assessment.

Table 5. The practicality category is based on assessment by lecturers and students

No	Achievement level (%)	Category
1	81-100	Highly practical
2	61-80	Practical
3	41-60	Moderately practical
4	21-40	Less practical
5	0-20	Not practical

Each aspect of learning and innovation skills (4Cs) used in this study is detailed in Table 6.

Table 6. Learning and innovation skills (4Cs) (P21 Framework for 21st century learning, 2007)

Learning and innovation skills (4Cs)	Aspects
Critical thinking	1. Effective reasoning 2. Using systems thinking 3. Making judgments and decisions 4. Solving problems
Creative thinking	1. Think creatively 2. Working creatively with others 3. Implementing innovation
Communication	Communicate clearly
Collaboration	Collaborate with others

Population and sample

The subjects of this study were 46 students from the Department of Automotive Engineering enrolled in one of the higher education institutions, in Indonesia who took the sensor and transducer course. This research has obtained permission from the educational institution with letter number 0794/UN.35.2.1/LT/2022, and the students involved have consented to become samples. This study follows the Declaration of Helsinki, which regulates the involvement of humans as research samples.

3. Results

Validity of e-modul requirements

The validity of e-module requirements is presented in Table 7.

Table 7. Validity of e-module requirements by expert

No	e-module requirement aspects	Assessment			
		V1	Category	V2	Category
1	Didactic	0.83	Valid	0.91	Valid
2	Construction	0.83	Valid	0.92	Valid
3	Technical	0.90	Valid	0.91	Valid
Average		**0.85**	**Valid**	**0.91**	**Valid**
Total average				**0.89**	
Category				**Valid**	

It shows a didactic aspect obtaining 0.83 (V1) and 0.91 (V2). The construction aspect obtained 0.83 (V1) and 0.92 (V2), technical aspect obtained 0.90 (V1) and 0.91 (V2). Average scores from V1(0.85) and V2 (0.91) show that the requirement of the e-module is considered valid and feasible to use from the perspective of the e-module and material experts.

Validity of e-Modul Quality

The validity of e-module quality is presented in Table 8. It shows a content aspect obtaining 0.91 (V1) and 0.83 (V2). The learning aspect obtained 0.90 (V1) and 0.85 (V2), the interaction aspect obtained 0.91 (V1) and 0.84 (V2), display aspects obtained 0.90 (V1) and 0.90 (V2). Average scores from V1(0.92) and V2 (0.85) show that the quality of the e-module is considered valid and feasible to use from the perspective of the e-module and material experts.

Table 8. Validity of e-module quality by expert

No	Quality aspects	Assessment			
		V1	Category	V2	Category
1	Content	0.91	Valid	0.83	Valid
2	Learning	0.90	Valid	0.85	Valid
3	Interaction	0.91	Valid	0.84	Valid
4	Display	0.90	Valid	0.90	Valid
Average		**0.92**	**Valid**	**0.85**	**Valid**
Total average		**0.88**			
Category		**Valid**			

Practicality

A graph showing the level of practicality of e-modules based on lecturers' and students' perspectives can be seen in Figure 3.

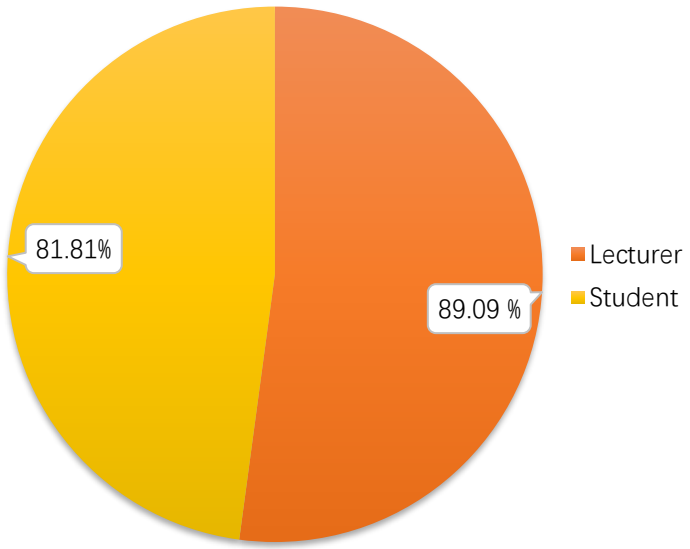

Figure 3. The practicality of e-modul from lecturers' and students' perspectives

The results of data analysis from the questionnaire filled out by lecturers showed an e-module practicality score of 89.09%, which indicated that the e-module was highly practical based on the

lecturers' perspectives. So based on the student's perspective where an overall e-module practicality score of 81.81%, indicates that this e-module is considered highly practical.

Effectivity

Implementation of e-module among students is conducted to examine effectivity of e-module. Data of experimental and control groups descriptively is depicted in Table 9.

Table 9. Descriptive analysis of implementation e-module among experimental and control groups

Group	N	Min	Max	Mean	SD
Experimental	23	74	89	80.22	3.837
Control	23	63	78	69.26	4.464

Based on Table 9, the following results were obtained: a) The mean value for the experimental class was 80.22, while the mean value for the control class was 69.26; b) The highest value in the experimental class reached 89, while in the control class it was 78; c) The lowest value in the experimental class was 74, while in the control class it was 63; d) The standard deviation for the experimental class was 3.837, while the standard deviation for the control class was 4.464. This data is the final test results of students after the treatment was given to the experimental class and without treatment for the control class, with each class consisting of 23 students. It is shown that students who use the 4Cs-based sensor and transducer e-module show an increase in their scores. Scores mean of the experimental group (80.22) is higher than the control group (69.26). However, to confirm that the difference is significant, the inferential test results should be referred. Before the inferential test, the normality and homogeneity tests are presented in Table 10.

Table 10. Normality and homogeneity analysis of experimental and control group

Group	Normality		Homogeneity	
	Statistics (S-W)	Sig.	Leven's Statistic	Sig.
Experimental	0.638	0.043	0.443	0.436
Control	0.635	0.51		

Table 10 shows the results of normality and homogeneity tests for experimental and control group data. The normality test results show that the experimental group data has a Shapiro-Wilk (S-W) value of 0.919 with a Sig. value 0.63, while the control group data has an S-W value of 0.915 with a Sig. value 0.51. Since the Sig. value for both groups is more significant than 0.05, and it can be concluded that the data from both groups are normally distributed. Additionally, the homogeneity test results showed a Levene's Statistic value of 0.638 with a Sig. value of 0.629, indicating that the variance between the experimental and control groups is uniform or homogeneous. The inferential test result of independent sample T is depicted in Table 11.

Table 11. Independent Sample T-test result for experimental and control group

		F	Sig.	*t*	*df*
Value	Equal variances are assumed	0.638	0.006	1.723	44
	Equal variances are not assumed			1.723	43.029

To confirm the difference in scores mean between the experimental and control groups, Table 11

was referred to. The results of the independent sample t-test in Table 11 showed a significant difference between the experimental group and the control group, with a t value of 1.723 and a Sig value 0.06 ($p < 0.05$). Evaluation activities of e-module development using Kvisoft Flipbook are carried out thoroughly through the stages of analysis, design, development, implementation, and evaluation. The e-module developed using the ADDIE model was assessed in terms of its validity, practicality, and effectiveness based on data analysis. The quality of the e-module was improved based on the assessment results and feedback from validators, practicality from users (sensor and transducer lecturers), and the effectiveness of the e-module in improving 4Cs skills. Based on the evaluation results, all students completed the sensor and transducer material with the help of the e-module.

4. Discussion

The 4Cs skills-based sensor and transducer e-module using the Kvisoft Flipbook application is an alternative learning resource that can be applied online, in blended learning, or the classroom (Jalinus et al., 2023; Samala, Dewi, et al., 2023; Syahril et al., 2022). In this study, the e-module was rated valid by 89% of e-module experts and 88% of material experts, which is included in the valid category. This finding aligns with the study (Rochsun & Agustin, 2020), which developed an e-module on set material with a valid category. This e-module development offers innovation as well as a challenge for teachers or lecturers to teach with different methods than usual (Nugroho et al., 2023; Wijayanto et al., 2023).

Kvisoft Flipbook offers several advantages, such as the ability to create e-modules with displays that are not only text but can also include sound, links, videos, and animations, as well as providing various design templates, and additional features such as control buttons, navigation bars, hyperlinks, background sounds, and backgrounds (Linda et al., 2020). Nevertheless, one of the drawbacks of this media is that it requires significant time and effort to create illustrations for each page. Nevertheless, using Kvisoft Flipbook does not require high costs, as this software is available online and offline in the form of digital files that can be downloaded for free. This e-module comes with study guides that make it easy for students to open and use it whenever they want (Astalini et al., 2019).

Teachers who do not adapt to advances in information technology tend to be stagnant, do not try new things, and only rely on books provided by the government (Setiyani et al., 2022). Conversely, innovations in technology and information can be practical tools for learning, both online and face-to-face, such as electronic whiteboards and electronic modules (Anandari et al., 2019; Maksum & Purwanto, 2022; Wirahyuni et al., 2023). Therefore, e-modules should be designed with rich activities and clear instructions so students can learn independently. Based on the practicality evaluation by the sensor and transducer lecturer, the developed e-module was rated practical with a score of 89.09%, indicating an excellent level of practicality.

The analysis results from the student questionnaire showed that the overall e-module practicality score was 81.81%. This e-module has been proven practical and can be used anytime and anywhere as innovative teaching material (Zhang et al., 2017). The e-module developed based on the 4Cs skill indicators received a positive perspective from students, where 23 students who used this e-module achieved learning completeness. The Kvisoft Flipbook application facilitates the creation of e-modules with additional features such as animation, music, and video, making it more attractive and effective as a learning media (Anandari et al., 2019).

Unlike traditional textbooks, e-modules are learning materials designed to be used independently

without teacher assistance. Printed modules are sheets of paper, while e-modules are digital copies stored on a pen drive, laptop, or Google Drive (Marta et al., 2023). E-modules have the advantage of reducing the use of paper during the learning process, making them a more environmentally friendly option than printed books (Setiyani et al., 2022). Effective e-modules must meet five primary standards: self-instructional, self-contained, stand-alone, adaptive, and user-friendly (Marvilianti & Sugihartini, 2020; Morel & Spector, 2022). Based on the literature review, it can be concluded that e-modules are electronic teaching materials systematically designed to support independent learning by considering the five criteria (Setiyani et al., 2022).

5. Conclusion

This study develops a 4Cs skills-based sensor and transducer e-module using the Kvisoft Flipbook application, which aims to improve the quality of learning in automotive engineering. The developed e-module was rated highly valid by 89% of e-module experts and 88% of material experts, indicating its quality and feasibility in the context of vocational education. In addition, the e-module was also rated as highly practical by lecturers with a score of 89.09% and students with a score of 81.81%. The evaluation results showed that students who used the e-module obtained a higher average score than the control group, indicating that the e-module effectively improved 4Cs skills such as critical thinking, creativity thinking, communication, collaboration, and material understanding.

This study implies that technology in vocational education can significantly improve students' learning experiences and outcomes. E-modules designed with interactive features such as animation, video, and audio can make abstract subject matter more concrete and engaging and support the mastery of non-technical skills that are important in the era of the Industrial Revolution 4.0. Accordingly, vocational education institutions are advised to integrate technology-based e-modules in their curriculum to prepare students with relevant skills for the world of work.

Additionally, the vocational education curriculum needs to systematically incorporate soft skills content to ensure students not only master technical skills but also crucial non-technical skills. Lecturers must also continue developing creativity and innovation in their teaching methodologies. Training on using the latest technology in education can help lecturers create a more engaging and effective learning environment. Further research is needed to test the effectiveness of e-modules in various educational contexts and subject areas and refine e-modules based on user feedback. In addition to e-modules, other technologies such as online learning platforms and mobile applications should also be considered to enhance student's learning experience and ensure their readiness to face the challenges of the Industrial Revolution 4.0.

Author contribution

Joni Andre: Writing - review & editing, Writing - initial draft, Visualization, Software, Resources, Conceptualization. Witri Ramadhani: Writing - review & editing, Writing - initial draft, Visualization, Methodology, Conceptualization. Syahril: Writing - review & editing, Validation, Project administration, Investigation, Data curation. Wawan Purwanto: Writing - review & editing, Validation, Project administration, Data curation. Dedi Irfan: Writing - review & editing, Validation, Formal analysis. Irma Yulia Basri: Writing - review & editing, Visualization, Supervision, Resources, Methodology, Formal analysis.

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Conflict of interest

The authors have no conflict of interest with any party and agree to the review and publication process of the article.

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