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Development of a flipbook-based e-module using case study method in applied physics for civil engineering at Politeknik Negeri Nunukan

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Abstract

This study aims to develop and assess the feasibility of a flipbook-based e-module using the case study method for the Applied Physics course in the Civil Engineering for Urban Infrastructure Study Program at Politeknik Negeri Nunukan. The motivation behind this development stems from the absence of structured and contextual learning materials aligned with the 7th Main Performance Indicator (IKU 7), which emphasizes collaborative and participatory learning through project or case-based approaches. The research employed a Research and Development (R&D) approach using the 4D model Define, Design, Develop, and Disseminate although this study was limited to the Develop stage. Validation was carried out by material and media experts, while student feedback was gathered from a limited trial involving 22 first-semester students. The results of expert validation yielded an average score of 3.63 (91%), and student responses showed a mean score of 3.50 (88%), both categorized as "very feasible." Suggestions from experts led to several revisions, such as the addition of construction-related illustrations, real-world physics applications, glossaries, and enhancements in visual presentation. The e-module integrates case studies relevant to civil engineering projects, thereby enabling students to apply physics concepts in practical contexts. Furthermore, the flipbook format was found to increase interactivity and student motivation. The findings indicate that the flipbook-based e-module is a viable instructional medium that supports innovative learning strategies, enhances conceptual understanding, and aligns with institutional goals for quality education in technical fields.

Keywords: case study method; civil engineering; e-module; flipbook; physics

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INTRODUCTION

Politeknik Negeri Nunukan is one of the vocational higher education institutions committed to produce competent graduates ready to compete in professional world. As an institution focusing on human resources development in engineering, Politeknik Negeri Nunukan continues to strive to improve the quality of learning through innovations in teaching methods and media. One of the study programs is

Civil Engineering for Urban Infrastructure, which aims to create experts in civil engineering who are adaptive to technology developments and industrial needs (Nunukan, 2023).

Preliminary observations and interviews with the Head of the Engineering Department (January 30, 2025) revealed that the Applied Physics course in this study program lacks a structured learning module aligned with the 7th Main Performance Indicator (IKU). This indicator highlights the importance of collaborative and participatory learning, particularly through project-based or case study approaches (Werdiningsih et al., 2021).

Furthermore, the Applied Physics course in the Civil Engineering for Urban Infrastructure curriculum at Politeknik Negeri Nunukan does not include a practical component. This becomes a challenge in providing an applicable and relevant learning experience for students. Addressing this gap, the case study method is considered the most suitable approach to be applied (Kelana, 2023). This approach allows students to analyze and solve real problems related to the world of civil engineering, thereby improving critical thinking skills and problem-solving abilities (Aswad et al., 2024).

As the solution to support the implementation of Case Study Method, a flipbook-based e-module is considered as an innovative solution. Flipbook-based e-modules offer a more interactive, interesting, and easily accessible presentation materials for students (Charina Wadah et al., 2022; Kelana, 2023; Oktaviani et al., 2023; Utari et al., 2023). It is expected that using flipbook technology, learning materials can be presented dynamically, thus supporting student involvement in the learning process (Pradani & Aziza, 2019; Rohmatin et al., 2022).

Therefore, the development of a flipbook-based e-module utilizing the case study method for applied physics course in Civil Engineering for Urban Infrastructure Study Program aims to support the realization of the 7th IKU, that is creating collaborative and participatory classes (Werdiningsih et al., 2021), and improve the quality of learning in the Applied Physics course. This initiative is expected to offer students can gain a deeper and more applicable learning experience, in accordance with the professional (work) needs and academic demands in the civil engineering (Yuyun et al., 2022).

METHODS

The current study used research and development design to develop the e-module based on flipbook. It uses the Thiagarajan or 4D model with four stages, namely define, design, develop, and disseminate (Thiagarajan et al., 1976). The 4D model was chosen since it is systematic and suitable for developing learning tools (Siregar et al., 2022)(Tanjung & Nababan, 2018). Research and development design aims to produce new product through the development process. The products created in this study was teaching material in the form of module. However, this study only used the first three stages or development and initial validation of the product (Jhoni et al., 2023). This is because the research questions tried to find whether the module is viable or not. Therefore, disseminate stage was not conducted. the formulation of the problem in this study is limited to the Feasibility or Not of the developed flipbook-based e-module.

Development Procedure

The implementation of the 3 stages in this study are as follows: The define stage consists of several steps. The dirst step is initial analysis which aims to identify applied physics learning problems that are in accordance with MBKM (Merdeka Belajar- Kampus Merdeka). The analysis was used as a source for developing applied physics learning modules. The learning method taken by researchers in this study was case study method.

The second stage was the design stage. In this stage the module media was selected. Therefore, the media used in this study was flipbook-based e-module. The selection of the module format in this study refers to MBKM Program with the case study method.

The last stage is the development stage. In this stage a flipbook-based e-module with a case study method in the applied physics course was made. In addition, the assessment of the feasibility of the e-module used a questionnaire to collect the data. The feasibility assessment of the flipbook-based e-module acquired scores and suggestions to determine the quality of the product and improve the flipbook-based e-module. Furthermore, the revision stage was carried out based on the suggestions and input from expert validators. Moreover, the operational field test, the implementation of the field trial was carried out to Civil Engineering students takingtheir first semester at Politeknik Negeri Nunukan.

Subject

The subjects for the product trial were 22 freshmen majoring in Civil Engineering for Urban Infrastructure. The subject were selected using random sampling method.

Data Collections Technique And Instruments

The data for flipbook based e-module were collected using the following techniques:

1. Observation and interview with Civil Engineering lecturers
2. Assessment of e-module feasibility using expert validated questionnaires
3. Assessment of students' readibility on the e-module using questionnaire

Data Analysis Technique

Data analysis technique in this study was foucused on the data from instrument which are product feasibility and practicality based on students responses.

1. Flipbook e-module feasibility test
   a. Finding the mean of every sub component
   b. Calculate the total score and the mean score of every component by using the following formula (Arikunto, 2010):

$$\bar{X} = \frac{\Sigma X}{n} \tag{1}$$

Where $\bar{X}$ is mean score, $\sum X$ is the total score and *n* is the numbers of score

   c. Change the mean score to 5 scaled score
      1) Calculating ideal mean score using the following formula (Riduwan, 2022).

$$\overline{X_t} = \frac{1}{2}(maximum\ ideal\ score + minimum\ ideal\ score) \tag{2}$$

$$ideal\ maximum\ score = \sum number\ of\ criteria\ \times highest\ scale \tag{3}$$

$$idea\ minimum\ score = \sum number\ of\ criteria\ \times lowest\ scale \tag{4}$$

      2) Determining ideal standard deviation using the following formula:

$$SD = \frac{1}{6}(sideal\ maximum\ score - ideal\ minimum\ score) \tag{5}$$

      3) Determining category based on the score using actual score conversion in Table 1.

Tabel 1. Actual Score conversion Guidelines

Interval Score	Category
$X > \overline{X_t} + 1{,}8\ SBi$	Very feasible
$\overline{X_t} + 0{,}6\ SBi < X \leq \overline{X_t} + 1{,}8\ SBi$	Feasible
$\overline{X_t} - 0{,}6\ SBi < X \leq \overline{X_t} + 0{,}6\ SBi$	Less feasible
$\overline{X_t} - 1{,}8\ SBi < X \leq \overline{X_t} - 0{,}6\ SBi$	Not feasible
$X \leq \overline{X_t} - 1{,}8\ SBi$	Very unfeasible

The feasibility result percentage was calculated using the following formula (Arikunto, 2010).

$$\text{Feasibility percentage } = \frac{Total\ score}{Maximum\ score} x100\% \quad (6)$$

2. Flipbook e-module practicality
   Flipbook e-module practicality was assessed based on students' questionnaire on the e-module readibility. The scoring guideline for students's questionnaire can be seen in Table 2.

Table 2. Students' Questionnaire Scoring Guidelines

Response	Score	
	Positive	Negative
Yes	1	0
No	0	1

The analysis of students' response was done using the following steps

a. The data were calculated to obtain the percentage of Flipbook E-Module practicality. The formula used is as followed (Sugiyono, 2008).

$$\bar{x} = \frac{1}{number\ of\ observations} x \frac{\sum x}{n} x\ 100\% \quad (7)$$

Where $\bar{X}$ is mean percentage, $\sum X$ is the total score and *n* is the numbers of score

b. The calculation then compared with the criteria for e-module practicality. The criteria of e-module flipbook practicality is presented in Table 3.

Table 3. E-Module *Flipbook practicality criteria*

No	Interval (%)	Criteria
1	$k \geq 90$	Excellent
2	$80 \leq k < 90$	Good
3	$70 \leq k < 80$	Fair
4	$60 \leq k < 70$	Poor
5	$k < 60$	Very Poor

RESULTS AND DISCUSSION

E-module aspects were tested by two experts in civil engineering Politeknik Negeri Nunukan. The result of the assessment in every aspect can be seen in Table 4.

Table 4. E-Module Feasibility Testing

E-Module Aspects	Mean Score	Percentage (%)	Category
Content	3,50	88%	Very Feasible

E-Module Aspects	Mean Score	Percentage (%)	Category
Language	4,00	100%	Very Feasible
Layout	3,50	88%	Very Feasible
Integration of *Case Study Method* in Applied Physics subject	3,50	88%	Very Feasible
Mean	**3,63**	**91%**	Very Feasible

The mean score then converted into five-scaled qualitative data. It was acquired by including maximum and minimum score to decide $\overline{X_t}$ and the SD. Every e-module feasibility aspect has an item (ideal maximum score = 4 and ideal minimum score = 1, $\overline{X_t}$= 2,5, and SD= 0,5). Therefore, interval criteria for every category is listedin Table 5 (Rahmawati & Wilujeng, 2021).

Table 5. Interval Criteria for every aspect in E-Module

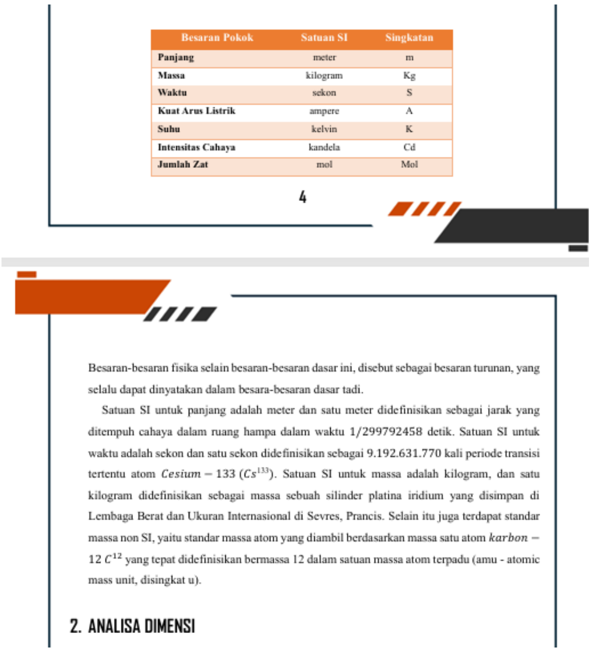
No	Interval Score	Mean Score	Percentage (%)	Category
1	$X > \overline{X_t} + 1{,}8\ SBi$	$X > 3{,}4$	$X > 85$	Very Feasible
2	$\overline{X_t} + 0{,}6\ SBi < X \leq \overline{X_t} + 1{,}8\ SBi$	$2{,}8 < X \leq 3{,}4$	$70 < X \leq 85$	Feasible
3	$\overline{X_t} - 0{,}6\ SBi < X \leq \overline{X_t} + 0{,}6\ SBi$	$2{,}2 < X \leq 2{,}8$	$55 < X \leq 70$	Less Feasible
4	$\overline{X_t} - 1{,}8\ SBi < X \leq \overline{X_t} - 0{,}6\ SBi$	$1{,}6 < X \leq 2{,}2$	$40 < X \leq 55$	Not Feasible
5	$X \leq \overline{X_t} - 1{,}8\ SBi$	$X \leq 1{,}6$	$X \leq 40$	Very Unfeasible

Table 5 shows the results of the e-Module feasibility assessment. It obtained an average value of 3.63 with a percentage of 91% which is included in the very feasible category. This result indicates that the e-Module was very feasible and can be both distributed and implemented in applied physics subject. In addition, validators also gave some suggestion to the e-module. They suggested that the module should be supported with application of physics material related to civil engineering in each chapter and added some illustrations of physics events in civil engineering. The details of the revised e-Module section are in the e-Module revision section.

E-Module Revision (Suggestions from Validators)

The revision of the e-Module was carried out based on suggestions from validators and during the preparation process. The results of the revision are as follows.

1. Adding Physics applications material related to civil engineering in every chapter of the E-module.
   Based on the images provided (Figure 1 – Figure 4), the differences between the pre-revision and post-revision content in the module are quite significant.
   In Figure 1 before the revision, the material presented was limited to general explanations without clear examples of physics applications related to civil engineering. After the revision, Figure 2 shows the addition of relevant material, such as the explanation of physical quantities and units used in civil engineering. This revision connects the theoretical concepts of physics with their practical application in daily life within the civil engineering field, making the learning more contextual and applicable



Besaran Pokok	Satuan SI	Singkatan
Panjang	meter	m
Massa	kilogram	Kg
Waktu	sekon	S
Kuat Arus Listrik	ampere	A
Suhu	kelvin	K
Intensitas Cahaya	kandela	Cd
Jumlah Zat	mol	Mol

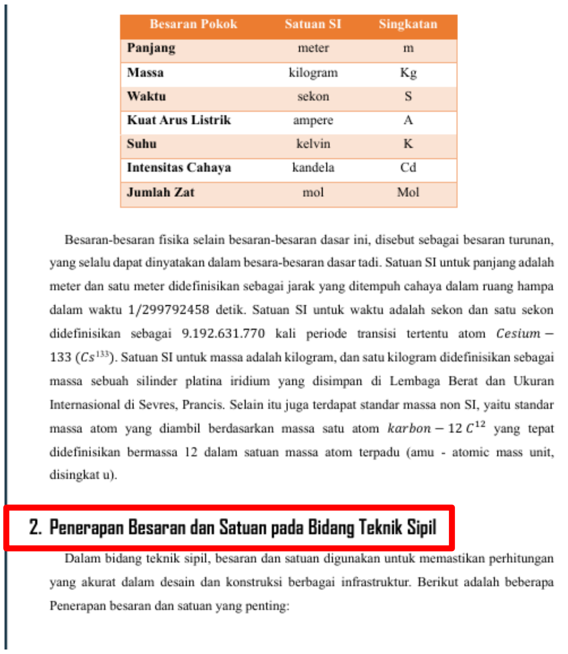
4

Besaran-besaran fisika selain besaran-besaran dasar ini, disebut sebagai besaran turunan, yang selalu dapat dinyatakan dalam besara-besaran dasar tadi.

Satuan SI untuk panjang adalah meter dan satu meter didefinisikan sebagai jarak yang ditempuh cahaya dalam ruang hampa dalam waktu 1/299792458 detik. Satuan SI untuk waktu adalah sekon dan satu sekon didefinisikan sebagai 9.192.631.770 kali periode transisi tertentu atom $Cesium - 133$ (Cs^{133}). Satuan SI untuk massa adalah kilogram, dan satu kilogram didefinisikan sebagai massa sebuah silinder platina iridium yang disimpan di Lembaga Berat dan Ukuran Internasional di Sevres, Prancis. Selain itu juga terdapat standar massa non SI, yaitu standar massa atom yang diambil berdasarkan massa satu atom $karbon - 12\ C^{12}$ yang tepat didefinisikan bermassa 12 dalam satuan massa atom terpadu (amu - atomic mass unit, disingkat u).

2. ANALISA DIMENSI

Figure 1. Before Revision



Besaran Pokok	Satuan SI	Singkatan
Panjang	meter	m
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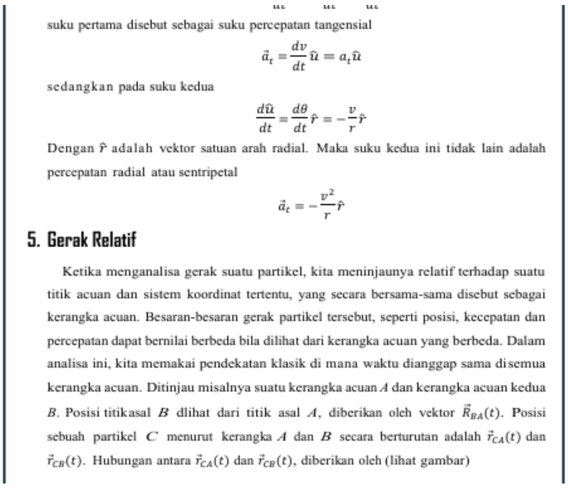
2. Penerapan Besaran dan Satuan pada Bidang Teknik Sipil

Dalam bidang teknik sipil, besaran dan satuan digunakan untuk memastikan perhitungan yang akurat dalam desain dan konstruksi berbagai infrastruktur. Berikut adalah beberapa Penerapan besaran dan satuan yang penting:

Figure 2. After Revision (additional material in Physical Quantitiy and Units chapter)



suku pertama disebut sebagai suku percepatan tangensial

$$\vec{a}_t = \frac{dv}{dt}\hat{u} = a_t\hat{u}$$

sedangkan pada suku kedua

$$\frac{d\hat{u}}{dt} = \frac{d\theta}{dt}\hat{r} = -\frac{v}{r}\hat{r}$$

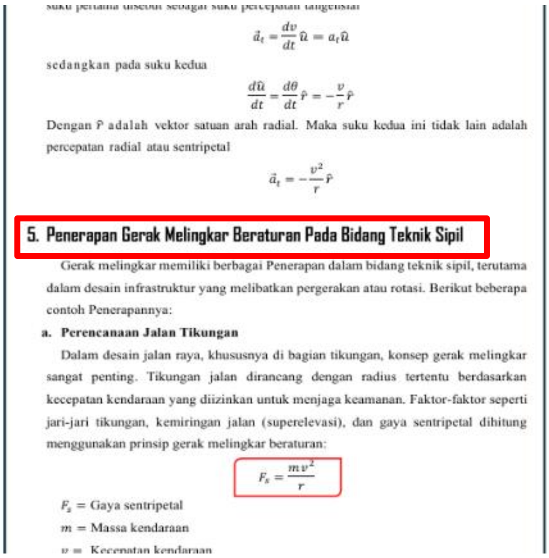
Dengan $\hat{r}$ adalah vektor satuan arah radial. Maka suku kedua ini tidak lain adalah percepatan radial atau sentripetal

$$\vec{a}_t = -\frac{v^2}{r}\hat{r}$$

5. Gerak Relatif

Ketika menganalisa gerak suatu partikel, kita meninjaunya relatif terhadap suatu titik acuan dan sistem koordinat tertentu, yang secara bersama-sama disebut sebagai kerangka acuan. Besaran-besaran gerak partikel tersebut, seperti posisi, kecepatan dan percepatan dapat bernilai berbeda bila dilihat dari kerangka acuan yang berbeda. Dalam analisa ini, kita memakai pendekatan klasik di mana waktu dianggap sama di semua kerangka acuan. Ditinjau misalnya suatu kerangka acuan A dan kerangka acuan kedua B. Posisi titik asal B dlihat dari titik asal A, diberikan oleh vektor $\vec{R}_{BA}(t)$. Posisi sebuah partikel C menurut kerangka A dan B secara berturutan adalah $\vec{r}_{CA}(t)$ dan $\vec{r}_{CB}(t)$. Hubungan antara $\vec{r}_{CA}(t)$ dan $\vec{r}_{CB}(t)$, diberikan oleh (lihat gambar)

Figure 3. Before revision



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$$\vec{a}_t = -\frac{v^2}{r}\hat{r}$$

5. Penerapan Gerak Melingkar Beraturan Pada Bidang Teknik Sipil

Gerak melingkar memiliki berbagai Penerapan dalam bidang teknik sipil, terutama dalam desain infrastruktur yang melibatkan pergerakan atau rotasi. Berikut beberapa contoh Penerapannya:

a. **Perencanaan Jalan Tikungan**

Dalam desain jalan raya, khususnya di bagian tikungan, konsep gerak melingkar sangat penting. Tikungan jalan dirancang dengan radius tertentu berdasarkan kecepatan kendaraan yang diizinkan untuk menjaga keamanan. Faktor-faktor seperti jari-jari tikungan, kemiringan jalan (superelevasi), dan gaya sentripetal dihitung menggunakan prinsip gerak melingkar beraturan:

$$\boxed{F_s = \frac{mv^2}{r}}$$

F_s = Gaya sentripetal

m = Massa kendaraan

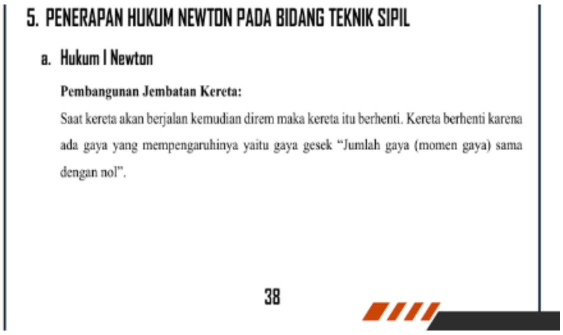
v = Kecepatan kendaraan

Figure 4. After revision (Additional material in Kinematics chapter)

In Figure 3 before the revision, the explanation of radial motion appears limited and only provides theoretical content without real-world applications to engage civil engineering students' practical understanding. The explanation might have seemed abstract to those new to the concept. However, in Figure 4 after the revision, the material not only explains the concept of radial motion theoretically but also shows how this concept is applied in kinematics used for structural design analysis in civil engineering. This provides a stronger and more in-depth context to help students understand how the concept is relevant in their professional world.

2. Adding illustrative pictures of physics events related to civil engineering.
   The revisions made in this part of the module significantly improve the visual representation of physics

events, making the material more engaging and contextually relevant to civil engineering students.


5. PENERAPAN HUKUM NEWTON PADA BIDANG TEKNIK SIPIL

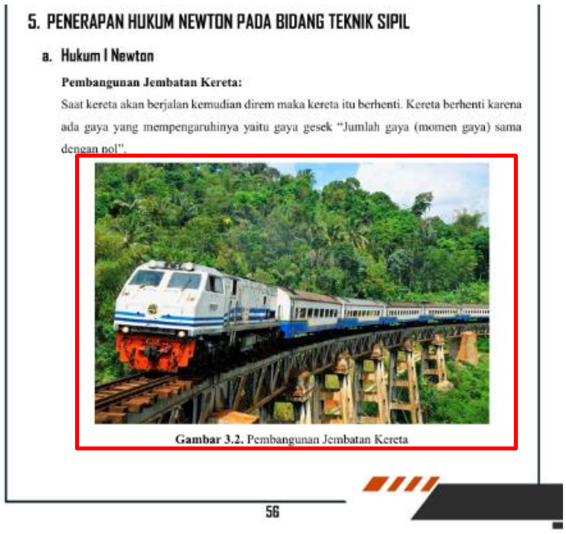
a. Hukum I Newton

Pembangunan Jembatan Kereta:

Saat kereta akan berjalan kemudian direm maka kereta itu berhenti. Kereta berhenti karena ada gaya yang mempengaruhinya yaitu gaya gesek "Jumlah gaya (momen gaya) sama dengan nol".

38

Figure 5. Before revision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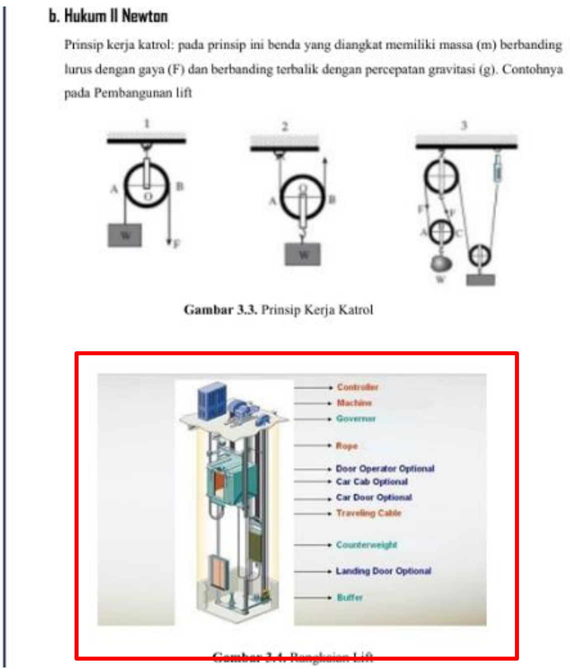
Gambar 3.2. Pembangunan Jembatan Kereta

56

Figure 6a. After Revision (Additional illustration in Force chapter

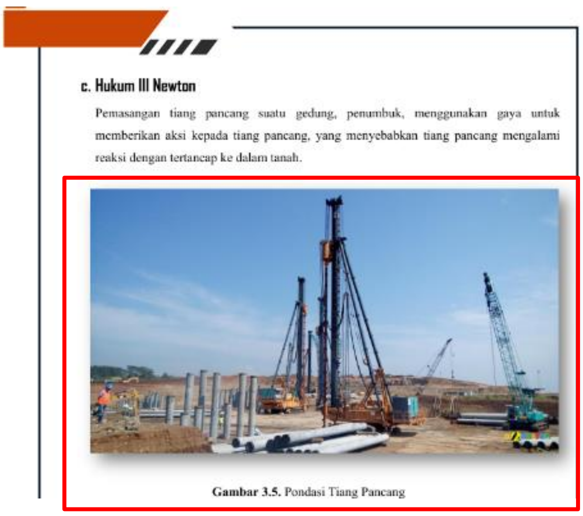

b. Hukum II Newton

Prinsip kerja katrol: pada prinsip ini benda yang diangkat memiliki massa (m) berbanding lurus dengan gaya (F) dan berbanding terbalik dengan percepatan gravitasi (g). Contohnya pada Pembangunan lift

Gambar 3.3. Prinsip Kerja Katrol

Gambar 3.4. Rangkaian Lift

Figure 6b. After Revision (Additional illustratition in Force chapter)


c. Hukum III Newton

Pemasangan tiang pancang suatu gedung, penumbuk, menggunakan gaya untuk memberikan aksi kepada tiang pancang, yang menyebabkan tiang pancang mengalami reaksi dengan tertancap ke dalam tanah.

Gambar 3.5. Pondasi Tiang Pancang

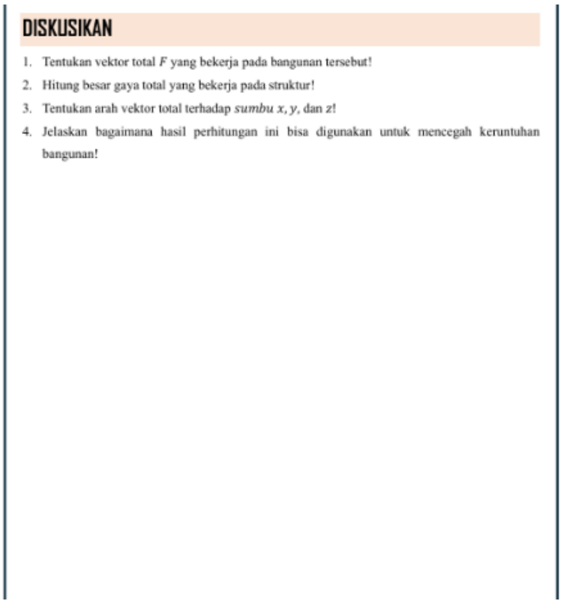
Figure 6c. After Revision (Additional illustration in Force chapter)

In Figure 5, before the revision, the material presented the explanation of Newton's Laws of Motion in the context of civil engineering, but it lacked any illustrative images to help students visualize the concepts in real-world applications. After the revision, Figure 6a shows the addition of a relevant image in the "Force" chapter. The image of a train moving along railway tracks provides a clear visual example of Newton's Laws in action, making the concept more relatable and easier to understand. This kind of illustration helps students see how forces play a crucial role in engineering projects like transportation systems. Similarly, Figure 6b introduces a detailed illustration of a hydraulic lift in the "Force" chapter, showing the practical application of force in construction and engineering contexts.

This image enhances the understanding of how force is used in civil engineering systems and equipment, adding a more practical perspective to the theoretical concepts. Finally, Figure 6c further adds to the revision with an image showing a construction site with pile drivers. This visual is especially relevant to civil engineering students, as it demonstrates the application of force in construction practices, particularly in the foundation work of buildings and other infrastructure.

3. Adding Glossary

   The revision made in this section significantly enhances the learning material by adding a glossary to help students better understand technical terms used throughout the module. In Figure 7, before the revision, the module simply included a discussion section, which lacked any defined glossary to clarify technical terms. The absence of a glossary made it challenging for students, especially those unfamiliar with certain civil engineering terms, to fully grasp the material. After the revision, Figure 8 introduces a comprehensive glossary section at the end of the module. The glossary is now included to define key terms and concepts used in the module, making it easier for students to look up and understand technical vocabulary. The addition of a glossary improves the overall usability of the module, offering clear definitions of terms like "Deflection," "Force," "Modulus of Elasticity," and others that are central to the civil engineering concepts being taught.



DISKUSIKAN

1. Tentukan vektor total F yang bekerja pada bangunan tersebut!
2. Hitung besar gaya total yang bekerja pada struktur!
3. Tentukan arah vektor total terhadap *sumbu* x, y, dan z!
4. Jelaskan bagaimana hasil perhitungan ini bisa digunakan untuk mencegah keruntuhan bangunan!

Figure 7. Before Revision

GLOSARIUM

Besaran Vektor	:	Besaran yang memiliki nilai dan arah, seperti kecepatan, gaya, dan percepatan
Komponen Vektor	:	Proyeksi suatu vektor pada sumbu-sumbu koordinat (x, y, z) yang membentuk vektor dalam ruang tiga dimensi.
Pengurangan Vektor	:	Proses pengurangan satu vektor dari vektor lainnya, sama dengan menjumlahkan vektor dengan lawan arah.
Penjumlahan Vektor	:	Proses penggabungan dua atau lebih vektor untuk menghasilkan vektor baru, sesuai sifat komutatif dan asosiatif.
Perkalian Silang (Cross Product)	:	Perkalian dua vektor yang menghasilkan vektor baru yang tegak lurus terhadap kedua vektor asal. Rumusnya adalah $A \, x \, B = AB \sin \theta$, di mana θ adalah sudut antara kedua vektor.
Perkalian Skalar (Dot Product)	:	Perkalian dua vektor yang menghasilkan besaran skalar. Rumusnya adalah $A \, . \, B = AB \cos \, \theta$, di mana θ adalah sudut antara kedua vektor.
Proyeksi Vektor	:	Komponen vektor sepanjang arah tertentu, biasanya dihitung terhadap sumbu x, y atau z
Sistem Koordinat Kartesian	:	Sistem koordinat tiga dimensi (x, y, z) yang digunakan untuk menentukan posisi suatu titik dalam ruang.
Sudut Vektor	:	Sudut antara vektor dengan salah satu sumbu koordinat atau antara dua vektor.
Teorema Pythagoras	:	Teorema yang menyatakan bahwa dalam sebuah segitiga siku-siku, kuadrat panjang sisi miring sama dengan jumlah kuadrat panjang dua sisi lainnya. Digunakan untuk menghitung besar vektor.
Vektor Basis	:	Vektor-vektor yang saling tegak lurus dan biasanya searah dengan sumbu x, y, dan z pada sistem koordinat kartesian. Simbolnya adalah

Figure 8. After Revision (Additional Glossary)

4. Revising illustration to avoid double meaning

   In this section of the revision, the focus is on clarifying the illustration to avoid any potential confusion in its interpretation, specifically regarding the calculation of surface area in civil engineering. In Figure 9, before the revision, the illustration included an image of a road construction site that could be interpreted in multiple ways. The use of this image could cause confusion because the focus was on machinery involved in construction, and it might lead to a misunderstanding about the concept of calculating road surface area. The image didn't effectively illustrate the concept of measuring area in a way that was directly related to the mathematical formula for surface area. After the revision, Figure

10 shows the updated illustration. The new image now clearly features a surveyor measuring the road using appropriate tools, which directly ties into the lesson about calculating surface area. The updated image eliminates the potential for double meaning by focusing on a more relevant scene where the measurement of surface area is visually clear and directly related to the concept being taught.

Figure 9. Before revision (the image still has a double meaning to calculate the road surface area)

Figure 10. After Revision (the illustration did not have double meaning)

5. Adding frame to physics fromula

   In this revision, the focus is on improving the presentation of physics formulas to enhance clarity and highlight important content.

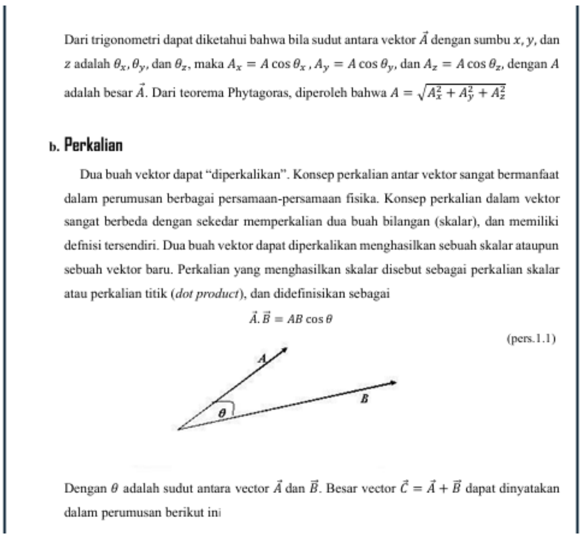


Figure 11. Before Revision (No frame)

Figure 12. After Revision (Additional frame for physics formulas)

In Figure 11, before the revision, the physics formulas were presented without any visual emphasis, making it harder for students to identify them as key elements of the material. The formulas were included in the body text, but their presentation did not stand out, which could make them less noticeable or harder to focus on for students trying to understand the mathematical aspects of the lesson. After the revision, Figure 12 shows the updated layout where the physics formulas are now enclosed within a frame. This additional framing draws attention to the formulas, clearly separating them from the surrounding text and making them easier for students to identify and focus on. The frame helps to visually distinguish the formulas as important elements in the learning process, which improves the overall readability and organization of the content.

6. Use only final article on the case study without mentioning complete anlysis process
   In this revision, the goal is to streamline the presentation of the case study by removing the detailed explanation of the analysis process and focusing only on the final article and its relevant link.

Figure 13. Before Revision (case study was written completely)

Figure 14. After Revision (write the final article and the link only)

In Figure 13, before the revision, the case study was written completely, including the entire analysis process. The page presented a full detailed description of the study titled "Analisis Keselamatan Jalan pada Tikungan Berdasarkan Jari-Jari dan Kemiringan Melintang Tikungan" with all aspects of the analysis discussed in depth. This extensive explanation might have been overwhelming for students or readers who only needed the final results and findings, making the section longer and more complex than necessary. After the revision, Figure 14 shows the updated layout. The revised version focuses solely on the final article, with a brief mention of the study title and a link to the full article. The detailed analysis process is removed, making the content more concise and to the point. By providing only the essential reference and link, the revision improves the readability of the material, guiding students directly to the final article without getting bogged down in the step-by-step analysis details.

Results of Feasibility Assessment from the Students' Response Questionnaire for the Flipbook-Based E-Module with Case Study Method in Applied Physics Course

The questionnaire responses given to students regarding the e-Module based on flipbook with case study method in applied physics course were assessed for its feasibility. The e-Module was given to 17 freshmen of Civil Engineering without giving applied physics course learning activities. Although this module was designed to be used in the second semester, the distribution was carried out earlier to test the visual appearance, material presentation, media operation, and media benefits.

The responses from the freshmen were expected to provide initial feedback on the design and navigation of the module, which will be used for refinement before the module is officially implemented in the second semester. This dissemination was also intended to ensure the readiness of the module from technical perspective and make sure that all module features can function properly. The purpose of the e-module dissemination step is to check that the module can be accessed, used, and evaluated by target users before fully implemented. The results of student responses to the e-Module in this limited trial stage are shown in Table 6.

Table 6. Results of Students' Response on Flipbook-Based E-Module with Case Study Method in Applied Physics Courses Feasibility

Aspects	Mean	Percentage	Category
Visual appearance	3,51	88%	Very Feasible
Material presentation	3,51	88%	Very Feasible
Media operation	3,61	90%	Very Feasible
Media benefits	3,38	85%	Very Feasible
Rata-rata	**3,50**	**88%**	Very Feasible

According to Table 4, all aspects were concluded to be very feasible by the students. It can be seen that the media operation aspect is higher than the visual appearance aspect, material presentation, and media benefits. This proves that the e-Module can be easily accessed using computer devices or mobile phones. Moreover, all features on the e-Module can function properly. In general, the feasibility of the e-Module had an average value of 3.50 with a percentage of 88%. Therefore, the e-Module based on flipbooks with case study methods in applied physics course is very feasible to be used in applied physics courses.

These findings align with constructivist learning theory, which emphasizes that learning occurs actively through exploration and problem-solving. According to this theory, learners construct their own knowledge through interaction with their environment and engagement in meaningful activities (Piaget, J., & Inhelder, 2008). The application of the case study method in the module encourages students to think critically and relate applied physics concepts to real-world contexts, thereby fostering contextual and student-centered learning. In addition, cognitive learning theory supports the idea that the systematic and visually engaging presentation of material can enhance students' understanding, as it aids the processes of encoding and storing information in long-term memory (Anderson, 2005; Bruner, 1960). From the perspective of instructional media, the results are also consistent with Mayer's multimedia learning theory, which posits that media combining text and visuals effectively, and that are easy to operate, can improve student engagement and comprehension (Mayer, 2014). The high scores in the visual and media benefit aspects indicate that the module's design supports these instructional principles.

This study is also supported by findings from several journal articles. Research by Khaerunnisa in the *Jurnal Pendidikan Fisika Indonesia* reported that inquiry-based digital flipbook media is highly feasible for teaching sensory system materials (Khaerunnisa et al., 2023). Another study by Rukmi published in *Impulse* showed that a flipbook-based e-module on geometric optics was considered highly feasible and supported the development of students' problem-solving skills (Rukmi, I. P., Chintyawati, S., & Setiaji, 2022). Research conducted by Kartika also developed a physics e-book integrating flipbook and augmented reality (AR), which proved to enhance students' learning motivation (Kartika, H. A., Purwanto, A., & Risdianto, 2024). These findings are in line with the present study, where students gave positive responses to the use of the e-module, even though it had not yet been formally integrated into classroom learning activities.

Therefore, both from theoretical perspectives and comparative studies, the flipbook-based e-module using a case study method has been proven to be highly feasible for supporting the teaching of Applied Physics in the Civil Engineering study program.

CONCLUSION

Based on the feasibility evaluation results, the Flipbook-Based E-Module developed for Applied Physics instruction in Civil Engineering demonstrated strong potential for practical use. Expert validation yielded an average score of 3.63, corresponding to a feasibility percentage of 91%, placing the module in the "highly feasible" category. In a limited trial involving student feedback, the module received an average score of 3.50 with a feasibility percentage of 88%, reinforcing its readiness for classroom integration.

These findings suggest that the e-Module, which incorporates the case study method, not only meets technical and content-related standards but also supports active learning and enhances student engagement. Furthermore, its implementation aligns with broader educational goals, including the improvement of learning outcomes and institutional performance metrics such as IKU 7 (collaborative and innovative learning). Overall, the module shows significant promise as an effective instructional tool that contributes meaningfully to the quality of teaching and learning in Applied Physics.

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Declarations

Author Contribution	:	Author 1: Conceptualization, Writing - Original Draft, Editing and Visualization; Author 2: Translation; Author 3,4,5: Validation and Supervision;

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