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Initial design and validation of Google Sites-based physics learning media on thermodynamics

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ABSTRACT
This research aims to develop Google Sites-based learning media on Thermodynamics material and test its feasibility through expert validation. The research method used is research and development (R&D) based on the Borg and Gall model, but it is limited to the fifth stage. The development process includes identifying potential and problems, data collection, product design, validation by experts, and revision. The media was developed in the form of an interactive learning site that contains Thermodynamics material, learning videos, practice questions, AR, e-LKPD, and Augmented Reality (AR) content. Validation was carried out by a material expert and a media expert using a questionnaire in the form of a rating scale. The results of the data analysis show that the Google Sites-based learning media obtained a "Good" feasibility category with an average assessment percentage above 80%. This shows that the developed media is suitable for use as an alternative digital learning medium that is interactive, flexible, and supports the visual and systematic understanding of physics concepts.

Keyword: *Learning Media; Google Sites; Thermodynamics; Physics*

INTRODUCTION
The advancement of information and communication technology has had a significant impact on various aspects of life, including education. This development allows the learning process to be more flexible, interactive, and accessible anytime and anywhere. (Subagio & Limbong, 2023) state that technological developments open up new opportunities for implementing education in various ways, including the use of devices like computers, tablets, and smartphones to access a wide range of learning resources. In the digital era, students are accustomed to using technology devices, especially smartphones, in their daily lives.

In fact, these devices have become an important part of supporting independent and contextual learning processes (Hutami & Azizah, 2023). This condition is a strategic opportunity for educators to use technology as a learning medium that is relevant to the learning styles of today's students.

One platform that can be used in the development of digital learning is Google Sites. Google Sites is a free service from Google that allows users to create interactive websites that can be integrated with various digital content. This platform is dynamic and flexible, making it easy for teachers to design and present interactive teaching materials (Pratama & Alamsyah, 2023). In addition, Google Sites can be accessed through various devices, including smartphones, making it suitable for the principles of digital learning that are adaptive and mobile-friendly. Google Sites is one of the most widely used platforms in schools because of the ease of combining various information on a single page and its ability to present information precisely according to user needs (Mardin & Nane, 2020; Rikani et al., 2021). Furthermore, Google Sites also provides positive benefits in learning activities, both for educators and students (Prihatiningtyas et al., 2023).

However, even though the use of technology has been widely developed in the world of education, the reality is that physics learning in schools is still considered uninteresting by some students. Based on the findings of Firmansyah and Saputra (2022), abstract physics concepts often become an obstacle for students in understanding and interpreting the material. This has an impact on students' low interest and understanding of physics, especially on the topic of Thermodynamics, which requires strong visual representation and contextual links.

Various previous studies have tried to present digital learning media to support student understanding, but they are still limited to certain platforms such as PowerPoint, videos, or e-learning LMS that require certain technical skills or infrastructure. In this case, the use of Google Sites as an interactive learning medium on Thermodynamics material is one innovation that is still rarely developed systematically, especially at the high school level.

Therefore, this research has a novelty value by developing Google Sites-based learning media as an interactive, lightweight, easy-to-use alternative media that is in line with technological developments and the characteristics of digital native students. This research not only supports the results of previous studies that emphasize the importance of integrating technology in learning but also contributes in the form of a new media product that can help students understand Thermodynamics concepts visually and contextually. This research aims to develop Google Sites-based physics learning media on Thermodynamics material and assess its feasibility based on expert validation.

METHOD

This research is a Research and Development (R&D) study that aims to produce a Google Sites-based learning media product on Thermodynamics material and test its feasibility. The development model used is the Brog and Gall model, which consists of ten systematic steps (Figure 1). However, in this study, only the first five steps were carried out due to time and focus limitations, namely: Potential and Problems, Data Collection, Product Design, Design Validation, and Design Revision.

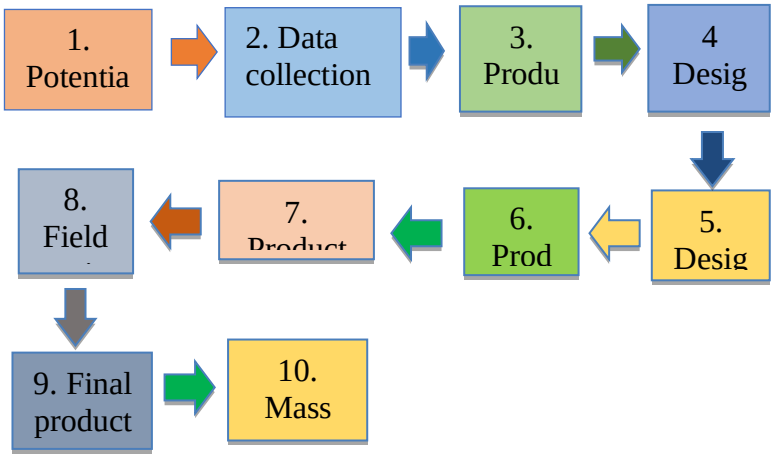


Figure 1 Sugiyono Development Model

Design and Research Approach

This research uses a quantitative and qualitative descriptive approach. Quantitative data were obtained from the validation scores given by experts, while qualitative data came from open suggestions and feedback given on the assessment sheet.

Research Subjects

The subjects in this study were two validators, namely a physics material expert and a learning media expert, who were tasked with assessing the developed product.

Implementation Procedure

The stages of research implementation include:

- Identifying potential and problems through initial observation and literature review.
- Collecting data to explore the need for relevant digital learning media.

- Designing the product in the form of Google Sites learning media with visual, text, and interactive content.
- Validating the design by two validators by filling out a validation sheet online via Google Form.
- Revising the design after receiving suggestions from the validators

Tools, Materials, and Instruments
- The tools and platforms used in media development are Google Sites and Google Forms as a means of data collection.
- The research instrument is a learning media validation sheet, which consists of indicators of content feasibility, appearance, language, and technical aspects. This instrument was prepared in the form of a 5-point Likert scale.

Data Collection and Analysis Techniques
- Data was collected online by sharing a Google Form link with the validators.
- Data analysis was performed using quantitative descriptive techniques to process scores from the validation sheets and qualitative descriptive techniques to interpret comments and suggestions for improvement.
- Validation scoring uses the scale in Table 1 below:

Table 1 Validation Sheet Scoring Guidelines

Criteria	Skor
Very Good	5
Good	4
Fair	3
Poor	2
Very Poor	1

The validator's scores were calculated in the form of a percentage to determine the feasibility level of the media using a simple formula:

$$\text{Value} = \frac{\text{Achieved Score}}{\text{Maximum Score}} \times 100\%$$

The feasibility criteria based on the percentage of validation results are shown in Table 2 below:

Table 2 Validity Score Guidelines

Percentage (%)	Kriteria Validasi
81 – 100	Vary Good
61 – 80	Good
41 – 60	Fair
21 – 40	Poor
0 – 20	Very Poor

RESULT AND DISCUSSION

Result

This research refers to the initial steps of product development according to Brog and Gall (1983), which have been simplified into the first five stages, namely: (1) identification of potential and problems, (2) data collection, (3) product design, (4) design validation, and (5) product revision. The results of each stage are described as follows:

1. Potential and Problem

The first stage aims to identify the potential that can be developed and the problems that occur in the field. The main potentials in this research include:
- Rapid advancement of information technology.
- The availability of digital devices (especially smartphones) has become part of students' daily lives.
- The availability of the Google Sites platform supports the creation of learning media in a flexible, interesting, and easy-to-access way.

The problem identified is the low interest of students in learning Physics, especially in the abstract and difficult-to-understand Thermodynamics material, without visual and contextual media. This creates a gap between learning needs and conventional methods that are still predominantly used.

2. Data Collection

Data was collected through initial observations, literature studies, and informal interviews with teachers and students. The results of data collection confirmed that:

- Students tend to like technology-based learning.
- Teachers need media that is practical, easy to access, and does not require high technical skills.
- Google Sites is the right choice because it is easy to use, lightweight, and compatible with various devices.

These findings reinforce the urgency of developing Google Sites-based physics learning media on Thermodynamics material.

3. Product Design

At this stage, the researcher designed a prototype of Google Sites-based learning media that includes three main parts:

- Opening: A home page containing the material title. The main site navigation is at the top of the page, containing the following menus: home page, introduction, bibliography, biography. From the home page, users can enter the core of the media through the "Introduction" button.

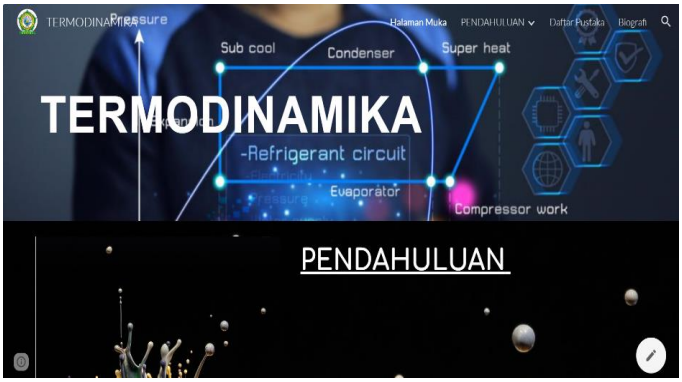


Figure 2 Home Page

- Core: After entering the introduction, students will be directed to a page containing several initial components, including: learning outcomes, learning objectives, and other introductory information containing a navigation menu that directs to the following three main pages:

Figure 3 Introduction Menu

- Start Learning": This contains a brief introduction to thermodynamics, along with a link to a PPT material file (created with Canva), and a learning video that explains the basic concepts.

Figure 4 Start Learning Menu

- E-LKPD: This page contains student independent activities, in the form of downloadable LKPD (student worksheets), a supporting learning video for the LKPD, an additional quiz based on the Formative web, and AR (Augmented Reality) content in the form of visualizations of steam engines and distillation. Although not directly related to thermodynamics, it is expected to increase students' interest in science in general and enrich the digital learning experience.

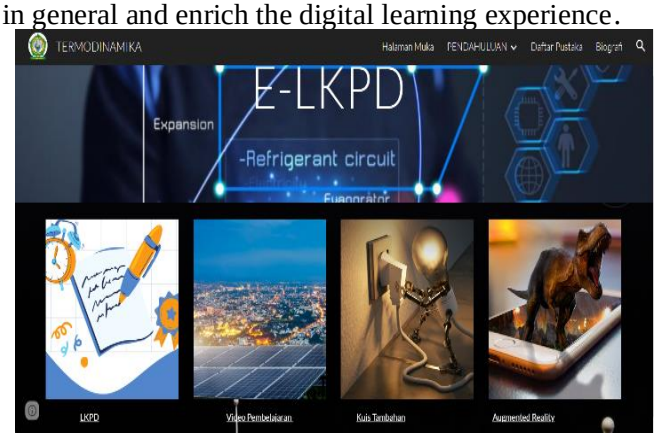
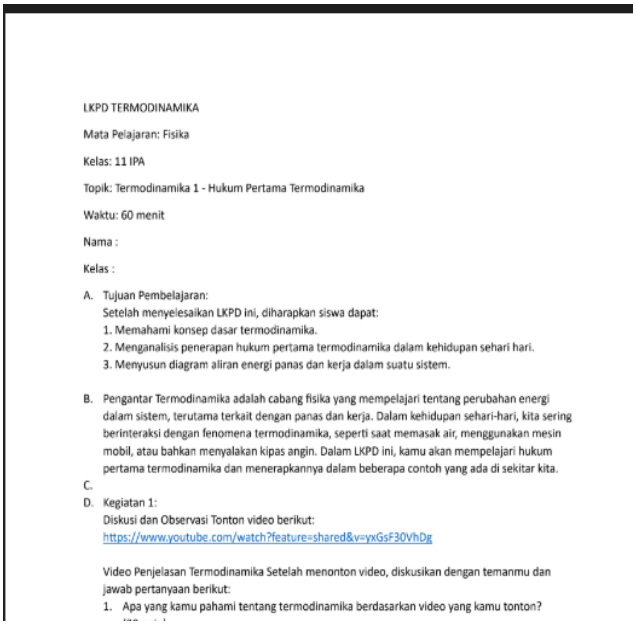


Figure 5 E-LKPD Menu



LKPD TERMODINAMIKA

Mata Pelajaran: Fisika

Kelas: 11 IPA

Topik: Termodinamika 1 - Hukum Pertama Termodinamika

Waktu: 60 menit

Nama :

Kelas :

A. Tujuan Pembelajaran:
Setelah menyelesaikan LKPD ini, diharapkan siswa dapat:
1. Memahami konsep dasar termodinamika.
2. Menganalisis penerapan hukum pertama termodinamika dalam kehidupan sehari hari.
3. Menyusun diagram aliran energi panas dan kerja dalam suatu sistem.

B. Pengantar Termodinamika adalah cabang fisika yang mempelajari tentang perubahan energi dalam sistem, terutama terkait dengan panas dan kerja. Dalam kehidupan sehari-hari, kita sering berinteraksi dengan fenomena termodinamika, seperti saat memasak air, menggunakan mesin mobil, atau bahkan menyalakan kipas angin. Dalam LKPD ini, kamu akan mempelajari hukum pertama termodinamika dan menerapkannya dalam beberapa contoh yang ada di sekitar kita.

C.

D. Kegiatan 1:
Diskusi dan Observasi Tonton video berikut:
https://www.youtube.com/watch?feature=shared&v=yxGsF30VhDg

Video Penjelasan Termodinamika Setelah menonton video, diskusikan dengan temanmu dan jawab pertanyaan berikut:
1. Apa yang kamu pahami tentang termodinamika berdasarkan video yang kamu tonton?

Figure 6 Downloadable LKPD

Figure 7 Supporting Video for LKPD

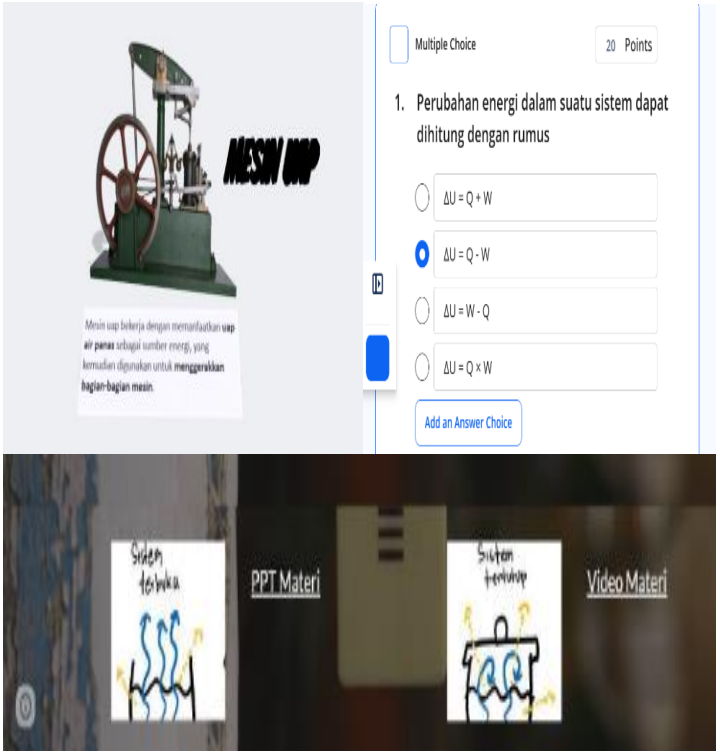


Figure 8 Additional Quiz Based On Formative Web

Figure 9 AR Steam Engine and Distillation

- Closing: Located in the introduction menu in the form of practice questions that contain a link to an interactive Kahoot! A quiz that students can use to test their understanding of the material they have learned.

Figure 10 Kahoot! Based Practice Questions

- Appendix: Contains a bibliography and author biography

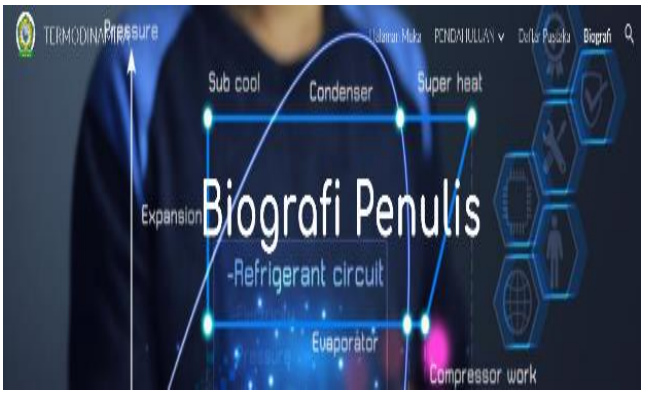


Figure 11 Bibliography And Author Biography

4. Design Validation

At the design validation stage, the developed learning media were assessed by two experts to ensure the feasibility of the product before it is used further. Validation was carried out by a material expert, who has a background in physics education, and a media expert, who has expertise in the field of learning media development.

- Hasil Validasi Ahli Materi

Validation of the content was carried out by three Physics Education lecturers from Universitas KH. A. Wahab Hasbullah, Tambak Beras Jombang. The validation process was carried out online using a digital validation sheet distributed via Google Form.

The results of the assessment from the three validators were then recapitulated and presented in the form of a paraphrase in Table 3 below:

Table 3 Media Validation Results

Assessment Indicator	Percentage	Criteria
Font size is appropriate and easy to read	87%	Very good
Font type is appropriate and comfortable to view	80%	Good
Sentences in the text are easy to understand	80%	Good
Page layout is arranged systematically	60%	Fair
Tools/media are easily accessible to users	67%	Fair
Text placement supports readability	80%	Good
Graphic display is visually appealing	80%	Good
Icons and symbols are appropriate for their function	73%	Good
Interactive tools help the site use	67%	Fair
On-screen elements are easy to recognize and use	67%	Fair
Navigation between pages is easy to understand	73%	Good
Overall, how feasible is this media for learning in high school?	73%	Good
Average total validation result	74%	Good

- Material Expert Validation Results

Table 4 Material validation result

Assessment Indicator	Percentage	Criteria
Material is in accordance with basic competencies	80%	Good
The thermodynamics topic is relevant to the 11th-grade high school level	80%	Good
Concepts used in the learning media are appropriate and accurate	80%	Good
The material is quite in-depth but still easy for students to understand	73%	Good
Explanation of scientific concepts is accurate and clear	80%	Good
The presentation of the material is arranged sequentially and logically	80%	Good

The language used is appropriate for high school students	87%	Very Good
The use of examples clarifies concepts	80%	Good
Illustrations, images, or graphics support concept understanding	80%	Good
The tasks/exercises provided are in accordance with the learning objectives	80%	Good
Overall, how feasible is this media for learning in high school?	80%	Good
Average total validation result	80%	Good

Discussion

The research results show that the Google Sites-based learning media on Thermodynamics material is considered feasible to be used as an alternative digital learning media that is in line with the needs and characteristics of today's students. Validation from the material expert obtained an average percentage of 80% with a "Good" category, while validation from the media expert obtained an average percentage of 74%, also in the "Good" category. This shows that in terms of both material substance and media design, the product has met the pedagogical and technological feasibility criteria.

The developed learning media utilizes the advantages of Google Sites as an interactive, responsive, lightweight, and accessible web-based learning platform from various devices, including smartphones, which are very familiar to students in' daily lives. This finding is in line with Pratama & Alamsyah's (2023) statement that Google Sites provides an opportunity for teachers to create teaching materials that are flexible and integrated with various digital media, such as videos, quizzes, and presentation files.

In terms of material, the presentation of Thermodynamics concepts is designed in stages, starting from an introduction, learning objectives, interactive visual material (with PPT and videos), to practice questions based on a Kahoot! Quiz and e-LKPD. The use of interactive visual and audio content is considered effective in helping students understand abstract material, as also emphasized by Firmansyah & Saputra (2022), that physics concepts that are difficult to understand verbally require the help of visual media that supports concept representation.

One of the novelty values of this research is the use of Google Sites, which is integrated with various modern learning platforms such as Canva, Formative, Kahoot!, and Augmented Reality (AR). Although some of the AR content is not directly related to Thermodynamics material, its use aims to increase students' interest in science and technology-based learning in general, as well as enrich the digital learning experience.

In terms of appearance and accessibility, there are still notes from the validators, especially on the aspects of page layout and interactive navigation, which, although already good, can still be improved to provide a more comfortable user experience. This is important feedback for further product development, especially if this media will be widely implemented and used in "Merdeka" curriculum-based learning or blended learning systems.

This research strengthens the results of previous studies that emphasize the importance of integrating technology in learning, as conveyed by Subagio & Limbong (2023), that the use of digital technology provides a great opportunity to create learning that is more personal, flexible, and adaptive to the needs of students.

However, this research has limitations, including the scope of development that only reaches the design validation stage and has not yet reached a direct trial on users (students). Therefore, further research is needed that includes testing the effectiveness of the media on student learning outcomes and motivation, as well as analyzing user experience through experimental or quasi-experimental studies.

Thus, this learning media has the potential to be an innovative alternative in physics learning in the digital era, especially in conveying complex material such as Thermodynamics. In addition, the Google Sites-based development approach can be easily replicated and modified by other physics teachers without the need for programming skills, which has a practical impact on the world of education.

CONCLUSIONS

Based on the research results and data analysis that have been carried out, it can be concluded that the Google Sites-based learning media on Thermodynamics material has been successfully developed and meets the feasibility criteria based on the assessment of experts. The development process was carried out through systematic stages, starting from needs identification, media design, to validation by material and media experts. The validation results show that this media received a "Good" rating, both from the aspect of material content and the aspect of media appearance and interactivity. Thus, this learning media is considered feasible for use as a support for physics learning, especially in conveying abstract Thermodynamics concepts. The use of the Google Sites platform allows the integration of various interesting and interactive digital learning resources, such as videos, online quizzes, e-LKPD, and other interactive visual media, which can be easily accessed by students. In addition, this media also makes it easy for teachers to create technology-based teaching materials that are responsive to the developments of the digital era. Therefore, the initial development of this media addresses the need for digital learning media that is practical, flexible, and in line with the characteristics of today's students, and provides a technology-based learning alternative that can be implemented in school physics learning.

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