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Development of E-Learning Physics Using Google Sites Assisted by Quizizz and PhET Simulations

I Gede Purwana Edi Saputra[1]
[1]Department of Physics Education, Universitas Sembilanbelas November Kolaka

Abstract

The urgency of this research is driven by a range of issues encountered in the implementation of the Merdeka Curriculum, particularly concerning the development of valid, practical, effective, and efficient learning media based on E-Learning to facilitate the digitalization of schools. This is particularly relevant in the context of physics education, which demands a meticulous approach to deliver immersive learning experiences grounded in real-world phenomena. The primary objective of this study is to develop E-Learning physics using Google Sites assisted by Quizizz and PhET Simulations, that are valid, practical, and effective to enhance students' interest and engagement in learning physics. These efforts are particularly significant in the context of implementing the Merdeka Curriculum in Senior High Schools. The research methodology is Research and Development (R&D) through modification on steps of 4D Models into 3D Models (Define, Design, and Develop) with an additional quantitative descriptive analysis to gauge the extent of teacher competence in utilizing the developed products. The results show that E-Learning using Google Sites assisted by Quizizz and PhET Simulations have been validated using Gregory index, namely 0.69 for the internal consistency coefficient on the material and 0.76 for the internal consistency coefficient on the media, and proven to be effective in boosting student engagement and interest namely 82% approval rating for the media developed in the realm of physics learning , particularly within the framework of the Merdeka Curriculum.

Keywords: *E-Learning; Physics; Google Sites; PhET Simulations ; Quizizz.*

Corresponding Author:
I Gede Purwana Edi Saputra
Department of Physics Education, Universitas Sembilanbelas November Kolaka, Indonesia
Jl. Pemuda No.339, Tahoa, Kec. Kolaka, Kabupaten Kolaka, Sulawesi Tenggara 93561.
Email: gedepurwana@gmail.com

1. INTRODUCTION

Digitalization of schools is essential for the Merdeka Curriculum to be implemented successfully. Using online platforms or digital media for E-learning is one aspect of digitizing schools. This study is significant importance for several reasons, that it concentrates on creating instructional materials or learning media that are appropriate, useful, efficient, and effective while staying under the parameters of the Merdeka Curriculum. In addition, this study looks into how to help students in the current technological era have simpler, more pleasurable, and self-directed learning experiences. In the end, this strategy aims to raise educational standards generally and increase students' interest and engagemen in learning physics.

The general problems of education in Indonesia are start after Covid-19 in Indonesia, there have been changes in aspect of education which is a benchmark for the human development index in the world (Elistia & Syahzuni, 2018). These changes have implications for the learning system in high schools. Today's learning system implementing more online systems namely E-Learning (Khasanah et al., 2020). Apart from being a learning solution during a pandemic, E-Learning is also effective in increasing student interest and engagement, especially in physics learning (Sidin et al., 2020). Students' interest and engament in learning is important to enhance physics learning outcome, especially in Merdeka Curriculum paradigm.

The other problem is implementation of the Merdeka Curriculum (IKM) is currently being carried out in Indonesia as an effort to improve the quality of education and overcome the occurrence of post-pandemic learning loss (Mardin & Nane, 2020). The Merdeka Curriculum is designed with a more flexible and adaptive approach, and provides freedom for schools and teachers in designing learning that suits the needs of students and the conditions of their respective regions (Amany, 2020). In addition, as a form of adaptation to learning conditions in the era of industrial revolution 4.0, the Merdeka Curriculum has an intervention in digitizing schools in the learning process(Nurhayati, 2020). This of course can be done by schools by designing an integrated online learning system.

The intervention of IKM in high schools faces significant challenges, particularly concerning infrastructure readiness and the availability of digital resources. A primary impediment for students is the suboptimal provision of adequate digital-based media and teaching materials, which hinders their access to and engagement with contemporary online learning modalities (Jubaidah & Rizki Zulkarnain, 2020). This deficiency directly limits students' ability to interact with modern pedagogical approaches and restricts their access to diverse educational content. Furthermore, initial observations revealed uncertainty among teachers regarding subject matter determination, as the Merdeka Curriculum grants schools greater autonomy. Such issues, encompassing both content accessibility and instructional inconsistency, are prone to diminish students' learning interest, especially in subjects widely perceived as difficult, such as Physics. Concurrently, educators are challenged to enhance their competence in information technology mastery to innovate and establish effective, efficient, and meaningful learning systems aligned with current developments, thereby necessitating continuous adaptation through innovative media utilization (Rizqi & Subanji, 2021). These prevailing problems underscore an urgent demand for accessible, flexible, and engaging digital learning solutions capable of bridging resource disparities, providing adaptable content structures, and empowering teachers with effective technological tools.

In response to these multifaceted challenges, this research proposes a strategic solution: leveraging various free online platforms to construct an effective, efficient, and viable E-Learning system for instructional processes, specifically aimed at boosting student engagement and accelerating IKM implementation in schools. A comprehensive feasibility study indicates that the development of Physics E-Learning in this context can optimally capitalize on the synergistic combination of Google Sites, Quizizz, and PhET Simulations. This tripartite integration is anticipated to establish a comprehensive learning ecosystem that is responsive to the needs of both students and teachers, effectively mitigating the identified limitations in digital resource availability.

Google Sites has been selected as the foundational platform for this E-Learning system due to its robust functionality as a Learning Management System (LMS) and its remarkable user friendliness for teachers in designing and hosting dynamic instructional websites (Andrizal & Arif, 2017; Saputra et al., 2025; Yana et al., 2019), This directly addresses the issue of inadequate digital media provision by offering a centralized, easily manageable platform where teachers can upload diverse learning materials and embed videos, thereby substantially enhancing content accessibility for students. The intuitive content management features within Google Sites further assist teachers in navigating curriculum uncertainties by enabling flexible organization and deployment of subject matter in line with curriculum autonomy. Consequently, Google Sites plays an instrumental role in cultivating a structured and readily accessible learning environment, thereby minimizing access difficulties encountered by students concerning instructional media.

To specifically counter the decline in student learning interest and augment assessment flexibility, two supplementary platforms are strategically integrated. Quizizz will be utilized to deliver engaging, gamified interactive quizzes that are capable of catalyzing student motivation while providing immediate feedback, thus rendering the assessment process more dynamic and appealing (Nirwana et al., 2021; Untajana et al., 2024). Quizizz can help teachers conduct online tests on students in a transparent and accountable manner. Quizizz can help teachers to see the level of mastery of the material that students have directly when giving tests(Wibawa et al., 2019). In addition, Quizizz can also increase student activity and interest in doing questions online because of the many variations in test forms that teachers can make online(Novemby, 2021).

To attract students' interest and engagement in understanding physics concepts, it can be presented through interactive simulations using PhET Simulations (Mukti & ZD Anggraeni, 2020). By using PhET Simulations, students become more enthusiastic and not bored, making it easy to understand the

material taught by the teacher (Arifin et al., 2022). Concurrently, PhET Simulations will be incorporated to address students' conceptual difficulties inherent in Physics (Pranata, 2024). These interactive simulations facilitate visual and experiential exploration of physical phenomena, thereby fostering a deeper conceptual understanding that may be challenging to achieve through traditional pedagogical methods (Perkins et al., 2005; Rizaldi et al., 2020). Through the synergy of Google Sites as the content platform, Quizizz as an engagement and comprehension metric, and PhET Simulations for conceptual visualization, this proposed E-Learning system is meticulously designed to holistically mitigate the identified challenges related to resource scarcity, curriculum adaptation, and enhancement of student learning interest in Physics education. While numerous studies have explored E-Laboratory, PhET, and Quizizz in education, this research identifies a novelty gap, analyzed using VOSviewer as presented below.

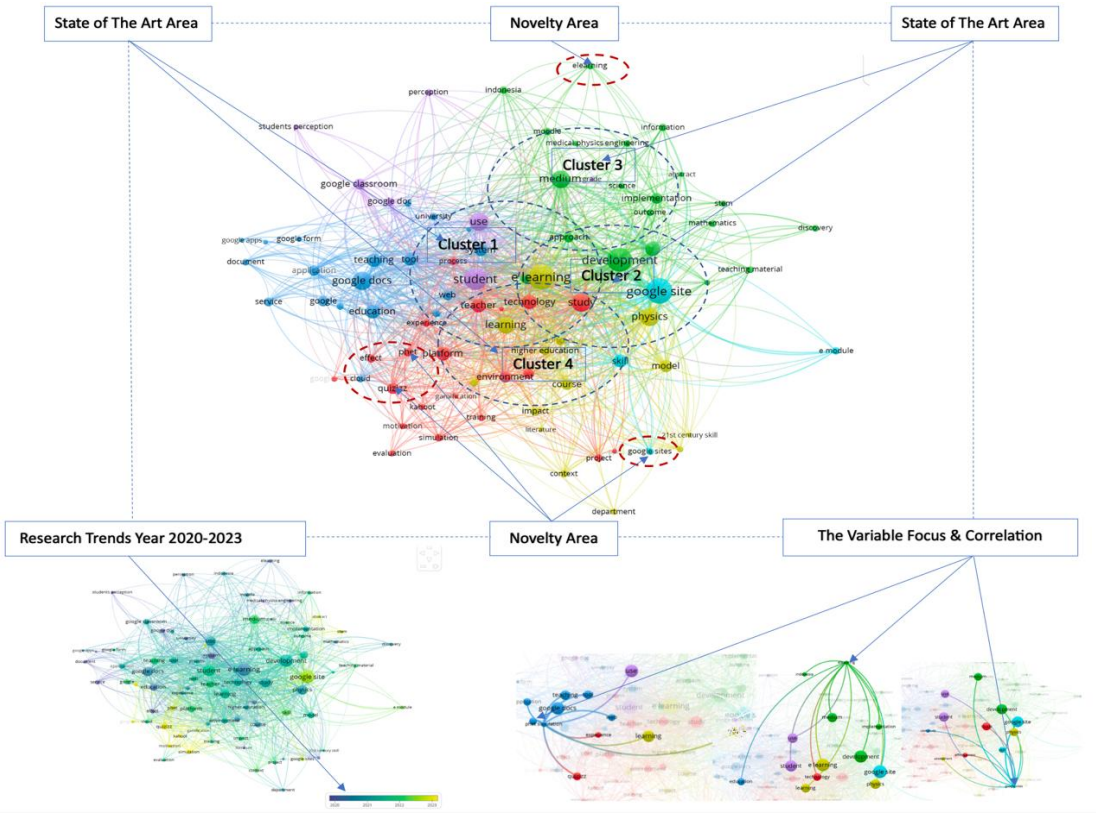


Figure 1. Variable Analysis on Gap Research and Novelty using Vosviewer

The VOSviewer analysis of bibliometric data reveals a complex landscape of interrelated research variables while simultaneously identifying a gap for further exploration in this study. In the State of the Art area, the dominant research clusters are centered around variables such as 'student', 'e-learning', 'development', 'material', 'medium', and 'outcome', indicating a strong research focus on the teaching and learning process, instructional material development, and learning outcomes evaluation. Other clusters highlight variables like 'Google Sites', 'educational media', and 'technology', suggesting that the development of technology-based media particularly using the Google Sites platformhas been a widely studied area in education. Research trends from 2020 to 2023 show a significant increase in the adoption of technology in learning, aligned with the growing demand for remote education during the pandemic. However, in the Novelty Area, the variables 'Google Sites', 'Quizizz', and 'PhET simulation' reappear in distinct and distant clusters, indicating that these three variables have not yet been comprehensively explored within a unified research framework. Their separation suggests an untapped potential for novelty, particularly in combining these platforms within a single integrative study.

Previous studies have extensively examined the effectiveness of the variables in this research independently. The use of Google Sites as an e-learning platform has been proven effective in improving student learning outcomes (Hidayat et al., 2023; Kumalasari et al., 2024) and in enhancing

students' critical thinking skills (Nurdin et al., 2023; Susanti et al., 2023). Quizizz has been recognized as a game-based assessment tool that enhances student motivation, interest, and learning achievement in physics (Nirwana et al., 2021; Untajana et al., 2024; Yana et al., 2019). Meanwhile, PhET simulations have been shown to be effective in helping students understand abstract physics concepts and improve their critical thinking and problem-solving abilities through interactive experiences (Faizah et al., 2023; Muzana et al., 2021; Wirda et al., 2023). However, most of these studies tend to focus on a single platform or a combination of two platforms, without systematically integrating all three components into a single, comprehensive learning platform.

The identified research gap lies in the lack of studies that holistically integrate these three platforms into a cohesive Physics E-Learning ecosystem. While VOSviewer mapping positions 'Google Sites' within the state of the art, its specific integration with 'Quizizz' and 'PhET Simulation' both appearing in the novelty area highlights a significant gap. Previous research has yet to explicitly investigate the potential synergy that may emerge from developing an e-learning system that utilizes Google Sites as the main platform, Quizizz for interactive formative assessment, and PhET Simulations for visual and interactive exploration of physics concepts. This gap also includes the unexplored potential of how this specific combination can synergistically enhance both the learning process and student outcomes in physics education.

Therefore, the novelty of this research lies in the development of a Physics E-Learning model that uniquely integrates Google Sites as the foundational platform, Quizizz as a tool for evaluation and gamification, and PhET Simulations as a medium for conceptual exploration and understanding. This study aims to address the identified gap by investigating how the specific combination of these three tools can create a more engaging, interactive, and effective physics learning experience. Through the development of this integrated e-learning system, the research is expected to contribute significantly to the body of literature on educational technology utilization particularly in the field of physics education while also offering practical solutions for educators in designing innovative and comprehensive online learning environments. Finally, based on the problems, solutions, and novelty the purpose of this study is to develop E-Learning physics using Google Sites and supported by Quizizz and PhET Simulations, that are valid, practical, and effective to enhance students' interest an engagement for learning physics.

2. METHODS

The method used was Research dan Development (R&D) through modification on steps of 4D Models (Gorbi Irawan et al., n.d.) into 3D Models (Define, Design, and Develop) (Rizki et al., n.d.). The front-end analysis, idea analysis, task analysis, and specifying instructional objectives are all parts of the phase Define, phase Design is creating a simulation, and phase Develop consists of developmental testing of product. The subjects for this study were Grade X high school students located within Kolaka Regency. The selection of participating schools and students employed a purposive sampling method, based on specific criteria to ensure the relevance and feasibility of the developmental testing. These criteria included: the geographical diversity of the state high schools within Kolaka Regency representing near distance and equal condition of internet network. Than capture varied contexts; their demonstrated readiness and active participation in the implementation of the Merdeka Curriculum (IKM); and a preliminary assessment of the existing technological infrastructure and willingness to adopt digital learning innovations. Specifically, a total of 20 students from SMA N 1 Kolaka as a distinct schools were involved in this developmental testing phase, like show in this figure.

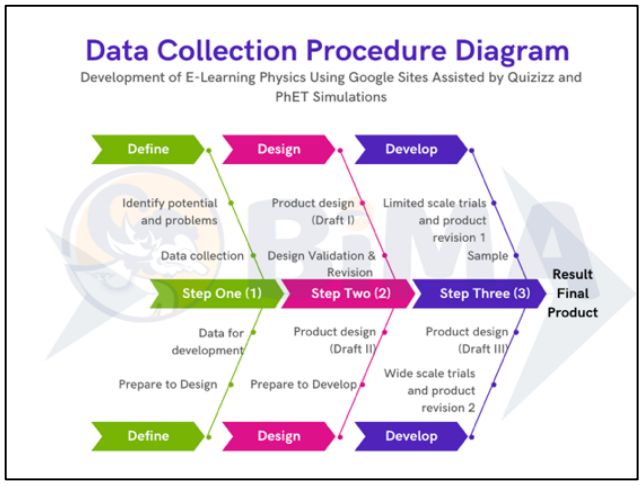


Figure 2. Flowchart of the research metdhod

Data collection was carried out using observation sheet instruments, limited interviews, product feasibility questionnaires, student physics learning interest questionnaires and competency test question instruments for understanding and mastery of physics concepts by students. Product validation is carried out by expert judgment test with Gregory model analysis (Hana Andriana et al., 2016) .

Practicality was assessed through teacher and student questionnaire scores, which measured aspects such as ease of use, clarity of content, and perceived usefulness of the developed E-Learning system. Each item on the questionnaire used a 5-point Likert scale and was validated by experts prior to implementation. The average score was interpreted based on the interval criteria for practicality levels.

Effectiveness was measured using the interest and engagement using a pre and post survey on trial product, instrument consisting of 20 items on a 5-point Likert scale, adapted and validated from existing interest inventory models. The change in learning interest and engagement was determined by comparing the average score befor intervention the product and after intervention on limited scale trial and wide scale trial to evaluate the degree of improvement.

All quantitative data were analyzed using SPSS version 25. Descriptive statistics were used to analyze questionnaire results. N-gain score was applied to assess significant differences in students' learning interest before and after the intervention. For effectiveness, the percentage of classical completeness was calculated, and where necessary. All statistical decisions were made at a significance level of $p < 0.05$.

3. RESULT AND DISCUSSION

The implementation of the research on the development of Physics E-learning using Google Sites with the assistance of Quizizz and PhET Simulations has successfully achieved several significant outcomes. The overarching aim of this E-learning development is to enhance students' interest in learning through the digitalization of education, in alignment with the pedagogical framework of the Merdeka Curriculum. The tangible research outcomes are structured as follows:

Firstly, Development of the E-learning Platform: In this foundational phase, the researchers successfully designed and developed an E-learning platform hosted on Google Sites. This platform has been rigorously validated, subsequently disseminated at an international conference, and formally registered for Intellectual Property Rights (HKI). Crucially, this platform demonstrated effective integration with both Quizizz and PhET Simulations applications, thereby enabling the interactive presentation of complex physics materials.

Secondly, Creation of Interactive Materials: This stage yielded physics learning materials meticulously aligned with the Learning Outcomes specified in the Merdeka Curriculum for the high school level. These materials were seamlessly integrated into the Google Sites-based E-learning platform. To actively engage students and foster a dynamic learning experience, Quizizz was leveraged for interactive assessments and gamified learning, while PhET Simulations provided rich opportunities for visual exploration and conceptual understanding in physics.

Thirdly, Testing and Evaluation: The outcomes derived from this critical stage include comprehensive data pertaining to the E-learning platform's effectiveness for both students and teachers. This evaluation was conducted through the systematic testing of the platform on a sample group of students at SMA Negeri 1 Kolaka. Data collection methodologies encompassed the administration of questionnaires and systematic observations, which collectively provided insights into the platform's perceived effectiveness and its acceptance among students.

Lastly, Improvement in Learning Interest: A notable enhancement in students' learning interest was clearly evident, manifested through their active and sustained participation in learning activities utilizing the developed E-learning platform. This finding signifies a highly positive response from students towards the interactive pedagogical approach and the strategic incorporation of technology in physics education. Consequently, this research makes a substantial contribution to supporting the practical implementation of the Merdeka Curriculum by harnessing E-learning technology to augment both interest and effectiveness in high school physics education.

Despite these promising findings, it is crucial to acknowledge several inherent limitations that may influence the broader generalizability of the study's outcomes. Firstly, the testing and evaluation phase was exclusively conducted with a specific sample group of students from a single institution, SMA Negeri 1 Kolaka. This localized focus, coupled with the employment of a purposive sampling method, inherently constrains the diversity of the participant pool. Consequently, the observed improvements in learning interest and the perceived effectiveness of the E-learning platform may not be directly transferable to students in other geographical regions, schools with varying socio-economic backgrounds, or institutions possessing differing levels of technological infrastructure. Secondly, while questionnaires and observations provided valuable qualitative and quantitative insights into effectiveness and acceptance, these data collection methods are susceptible to potential self-report biases and observer effects, respectively.

Future research endeavors should aim to address these limitations by employing a larger, more heterogeneous sample across multiple schools and diverse regions. Furthermore, the inclusion of more robust quantitative learning outcome data and longitudinal engagement metrics would provide a more comprehensive and generalizable understanding of this E-learning platform's impact, thereby validating its scalability and efficacy across broader educational contexts within the framework of the Merdeka Curriculum. More specifically, the data collection instruments and results obtained can be presented as follows:

Identification of Potentials and Problems

In this stage, the identification of potentials and problems is conducted. The improvement of post-pandemic education quality through the Implementation of the Free Curriculum (IKM) in Kolaka Regency, Southeast Sulawesi Province, has shown significant progress. This is evidenced by several schools that have independently implemented the free curriculum in the academic year 2022/2023, one of which is SMA Negeri 1 Kolaka. With the flagship program of developing local resources in the operational curriculum, SMA Negeri 1 Kolaka has become the only high school in Kolaka Regency that has facilitated students to develop expertise and interests according to their abilities and characters through learning projects outlined in the operational curriculum.

The presence of SMA Negeri 1 Kolaka in the city center with supporting facilities and learning resources is one of the potentials to create an enjoyable and engaging learning process, especially in physics education. However, this condition is not yet optimal with the pattern of IKM implementation, which mostly focuses on digital school interventions. With the habit of learning from home during the pandemic, there is an impact on students' learning patterns and behaviors. Teachers and students face serious challenges in conducting effective and enjoyable structured learning, especially in physics subjects. This condition is depicted from the results of observations and interviews with physics students and teachers at SMA Negeri 1 Kolaka.

The interview results reveal that the learning conditions in the free curriculum must be made more interesting and enjoyable, especially considering that students' learning styles are still influenced by the pandemic learning conditions, which are not optimal if only conducted in the classroom. Additionally, the pandemic situation, which reduced operational costs, also affected the maintenance costs of laboratories, resulting in limitations in physics laboratory equipment and materials that cannot adequately support practical activities.

In this stage, based on initial observations, the researcher analyzes and maps the effective media needs to present enjoyable physics materials for students. In this regard, the proposed solution is to develop a website-based E-Learning using Google Sites combined with PhET Simulations and Quizizz. The development of this media adopts the concept of a Learning Management System (LMS) by combining simulation and interesting exercise media. The developed material will cover all physics topics from grade 10 to grade 12. Based on the analysis and mapping, the results show that Google Sites is a media platform with a high level of ease of use, which is crucial for students to support the learning process, especially considering that this media does not require high costs. Furthermore, the development of this media also combines the Quizizz platform as a student assessment tool and PhET simulations as a medium to demonstrate physics concepts to replace the limitations of practical activities that students have experienced during this time.

Figure 3. Layoute of Google Sites before development

Data Collection

In this stage, data collection is conducted regarding the needs for using media that can overcome the ineffectiveness of learning in the implementation of the free curriculum and facilitate the delivery of physics material from abstract concepts to more tangible ones through simulations. Google Sites is chosen as the main software in media development. In this stage, information related to the strengths and weaknesses of Google Sites is analyzed to serve as a reference for media development, focusing on its user-friendliness with an attractive and flexible interface for customization, which becomes the strength of Google Sites. The ease of use of the interface in Quizizz and PhET as media to be integrated into Google Sites is also considered in the selection of this platform. In collecting data on the needs for practical media, the validation instrument is also prepared for the feasibility of the media and the feasibility of the material.

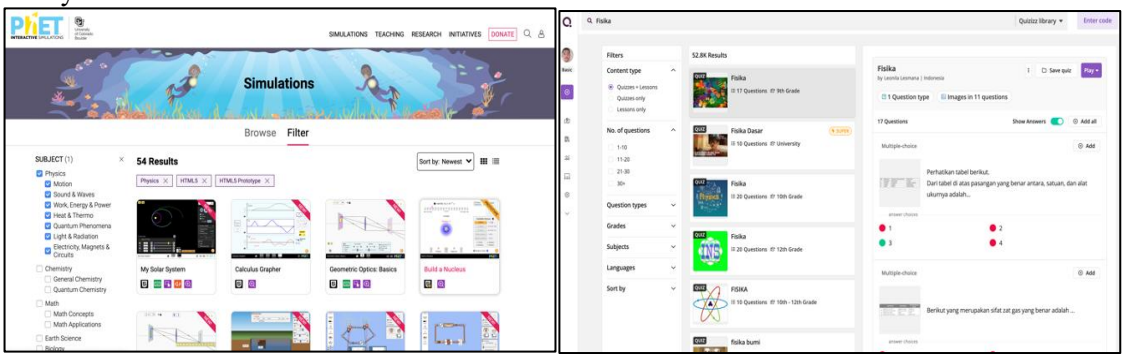


Figure 4. PhET Simulation and Quizizz Display

Data for Development

E-Learning using Google Sites as a web-based and network-based (online) learning medium is developed by considering the needs according to the current implementation of the free curriculum, to facilitate an engaging and enjoyable learning experience unrestricted by school schedule and location. After choosing Google Sites as the development medium for E-Learning, the researcher sought information about supporting computer/PC hardware and software that could be used to design the

media. To run Google Sites-based media on a computer, the required hardware specifications include a minimum hard disk capacity of 50 MB, a minimum Windows 7 or Mac OS 4.0 based operating system, a processor equivalent to at least Intel Pentium III, a minimum 1 GB Windows 7 memory, and a minimum screen resolution of 800 x 600 pixels (Ayu Suraya, 2014). The media developed using Google Sites is then combined with PhET and Quizizz as platforms for conducting material simulations and exercises virtually. To access the full features, the Professional versions of PhET and Quizizz are used. Other data used include physics material for grades 10-12 of high school, which is organized into media and adapted to the school's operational curriculum, in this case, SMA Negeri 1 Kolaka.

(d) Product Design (Draft I)

The development of media in this research was not carried out by changing or composing Google Sites platform components from scratch for use as a learning medium. Instead, the researcher designed and modified templates provided by Google Sites. The design process involved several stages, including the layout, selection of core material, drafting scripts or experimental procedure flows adjusted to the components or features within Google Sites, the preparation of media usage module scripts, and final editing. The systematic structure of the media begins with the title of the learning website or dashboard page, the student login menu, the class menu, and submenus for each class according to the material structure presented in Google Sites.

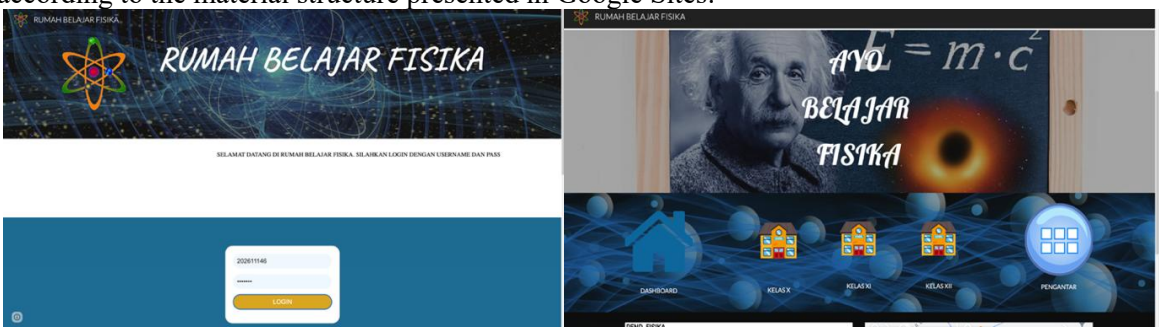
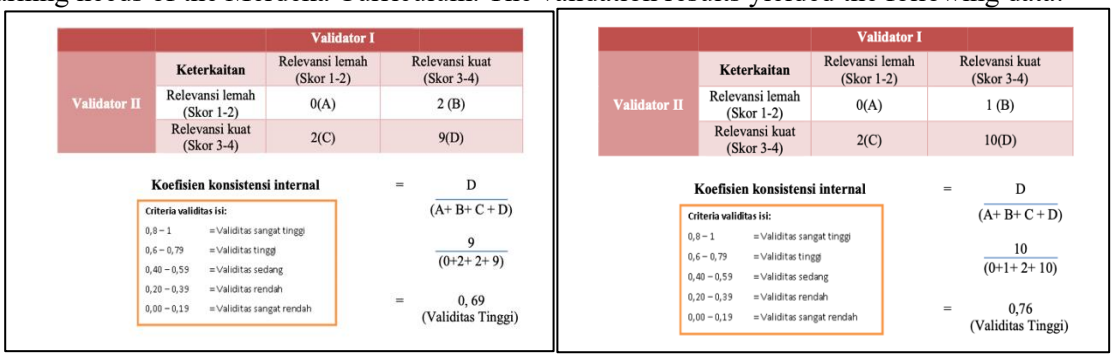


Figure 5. Display of Login an Dashboard Menu on Draft I

Validation & Design Revision

In this stage, the initial product of the development was submitted to multimedia experts and content experts for validation, considering both the appearance and content of the material developed in this Physics E-Learning. Feedback from experts was used to address any shortcomings in the product, ensuring that both the multimedia design and content substance align with the standards and learning needs of the Merdeka Curriculum. The validation results yielded the following data.



		Validator I	
	Keterkaitan	Relevansi lemah (Skor 1-2)	Relevansi kuat (Skor 3-4)
Validator II	Relevansi lemah (Skor 1-2)	0(A)	2 (B)
	Relevansi kuat (Skor 3-4)	2(C)	9(D)

Koefisien konsistensi internal = D / (A+ B+ C + D) = 9 / (0+2+ 2+ 9) = 0, 69 (Validitas Tinggi)

Criteria validitas isi:
0,8 – 1 = Validitas sangat tinggi
0,6 – 0,79 = Validitas tinggi
0,40 – 0,59 = Validitas sedang
0,20 – 0,39 = Validitas rendah
0,00 – 0,19 = Validitas sangat rendah

(a)

		Validator I	
	Keterkaitan	Relevansi lemah (Skor 1-2)	Relevansi kuat (Skor 3-4)
Validator II	Relevansi lemah (Skor 1-2)	0(A)	1 (B)
	Relevansi kuat (Skor 3-4)	2(C)	10(D)

Koefisien konsistensi internal = D / (A+ B+ C + D) = 10 / (0+1+ 2+ 10) = 0,76 (Validitas Tinggi)

Criteria validitas isi:
0,8 – 1 = Validitas sangat tinggi
0,6 – 0,79 = Validitas tinggi
0,40 – 0,59 = Validitas sedang
0,20 – 0,39 = Validitas rendah
0,00 – 0,19 = Validitas sangat rendah

(b)

Figure 6. (a) Media Validation Results and (b) Material validation results

From the data analysis results using the Gregory model for expert judgment analysis, it was found that the content or material and the media on the developed platform have high validity, namely 0.69 for the internal consistency coefficient on the material and 0.76 for the internal consistency coefficient on the media. This indicates that the Physics E-Learning platform based on Google Sites, which was developed, is suitable for use with some minor revisions to the material and media display.

Draft II

Draft II is a product that has passed expert validation. The product has been refined based on expert feedback, resulting in a more mature version that aligns with the established criteria. Some views of the developed Physics E-Learning in Draft II, following input and suggestions from experts during the product validation process, can be seen in the following images.

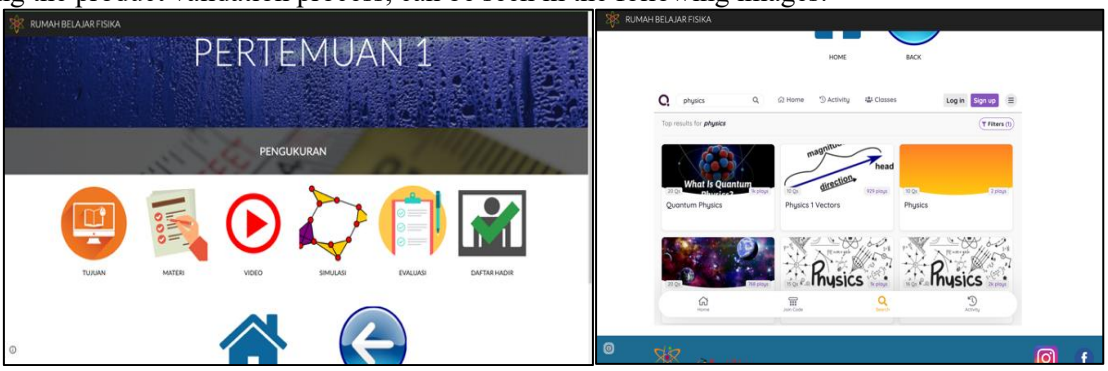


Figure 7. E-Learning Class Menu Display and PHeT Display on Draft II

Limited-Scale Trials and Product Revision 1

A limited-scale trials was conducted in one class at SMA Negeri 1 Kolaka with the participation of 20 students and a physics teacher. The test results were evaluated by collecting feedback from both the teacher and students. The identified shortcomings of the product were revised to enhance its quality and user response. The following represents student responses regarding their interest in learning physics after the limited-scale trial using the Physics E-Learning platform based on Google Sites.

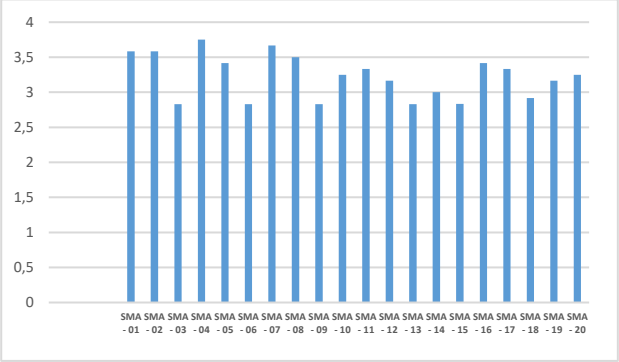


Figure 8. Average scores of student interest and egagement on limited trials

The revision made to the media includes only the addition of more interactive instructional videos, as seen in the image below.

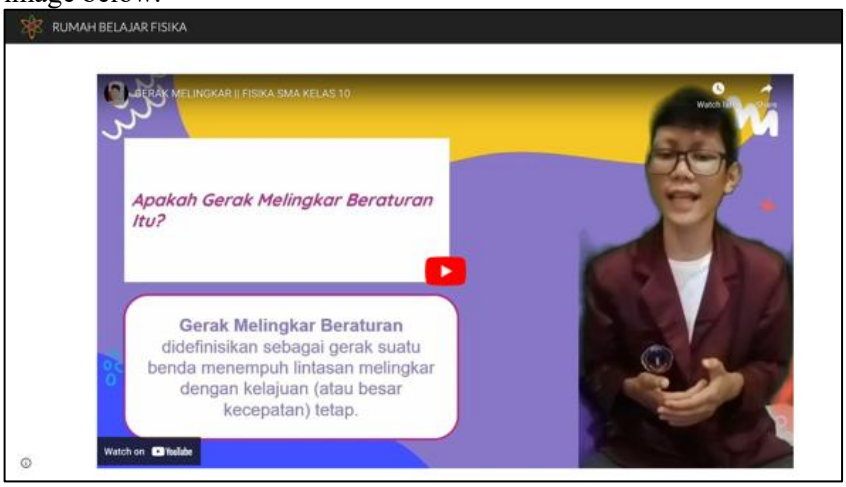


Figure 9. Interactive Learning Videos

Draft III

In this third draft, the product has undergone validation by experts, a limited-scale trial, and revisions. At this stage, the Rumah Belajar Fisika platform, accessible through the link https://sites.google.com/view/rumahbelajarfisika/beranda , is ready for a large-scale trial.

(i) Large-Scale Trial and Product Revision 2

A large-scale trial was conducted in 2 science classes at SMA Negeri 1 Kolaka with a total of 40 students. School selection used purposive sampling based on geographic location, as they have implemented the Merdeka curriculum and are close to the researcher's area. The results of the large-scale trial were evaluated, and if there were still shortcomings, improvements were made to the product (Draft IV) before the official launch. The results of the large-scale trial on students' interest in learning can be seen as follows.

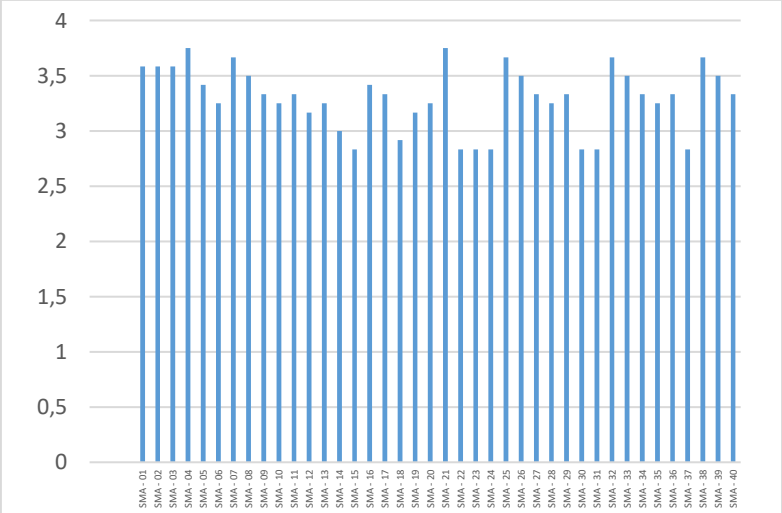


Figure 10. Average scores of student interest on wide trials

The comparative percentages of student responses between the limited-scale trial and the large-scale trial are shown as follows.

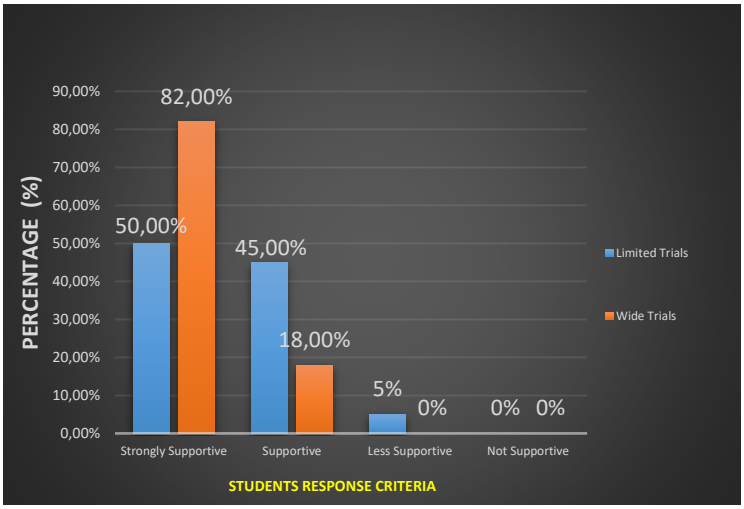


Figure 11. Percentage of comparing student interest and engagement scores for each trial

From the results of the extensive-scale testing, no further revisions were found necessary for the developed media. Overall, users, including both teachers and students, expressed an 82% approval rating for the media developed in this research. This aligns with Taufik's (2022) and Nurdin (2023), which explained that Google Sites-based physics learning media to improve students' concept mastery and critical thinking in high school is valid, effective, and efficient (Nurdin et al., 2023; Taufik et al., 2022). This result is also supported by Ismawati's (2021) research, where the validation scores from media experts and subject matter experts for the development of Google Sites-based E-Learning media

were deemed "appropriate." According to the experts, this media is suitable for use and testing by students (Ismawati et al., 2021), and Google Sites-based media can make it easy for students to understand the material taught, stimulating their creativity (Ketut Mahardika et al., 2022).

The feasibility of the Rumah Belajar Fisika platform, developed and used as a learning media, refers to the research results from Mukti & ZD Anggraeni (2020), stating that creating learning media using Google Sites is because Google Sites can combine various information in one place, such as videos, presentations, attachments, text, and more, and can be shared as needed by users. Furthermore, using a Google Suite-based learning media on the web is an innovative and interactive approach to physics learning that can enhance students' learning interest (Shabrina & R, 2019). This is also supported by research results indicating that Google Sites-based web learning media is highly effective in the learning process(Ali et al., 2022).

The implications of this research are highly significant, particularly in the context of developing physics E-Learning based on Google Sites. Several key implications from this study include: Interactive Learning Alternative, the development of E-Learning provides an alternative for more interactive learning and supports the digitization of the curriculum. Students can access physics learning materials online, enhancing their engagement and participation in the learning process, and Support for the Merdeka Curriculum, cause this E-Learning development aligns with the spirit of the Merdeka Curriculum, emphasizing more contextual and relevant learning. It offers a platform where students can engage with physics materials online, fostering a sense of independence in their learning journey. These implications suggest the potential benefits and positive outcomes of integrating E-Learning, specifically using Google Sites, in the education sector, especially at the high school level.

4. CONCLUSION

E-Learning physics using Google Sites assisted by Quizizz and PhET Simulations who was developed in this research has valid, practical, and effective. This obtained by data analaysis in validation and trials product. Based on the trials product the learning interest of students on physiscs who are taught using E-learning based on Google Sites assisted by PhET and Quizizz are increase significantly in wide scale trials. It means developed E-learning Physics using google sites can be practical and effective to help students for more interest to learn physiscs for accelerate the implementation of Merdeka Curriculum in high school level.

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BIOGRAPHIES OF AUTHORS

I Gede Purwana Edi Saputra is a Lecturer, Department of Physics Education, Universitas Sembilanbelas November Kolaka, Indonesia. His research focuses on physics education, learning technology, developing Instrument, evaluation and assessment. He can be contacted at email:
gedepurwana@gmail.com