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Development of a web-based Multimedia Learning Management System (MLMS) in High School physics learning

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Abstract
Purpose: To develop and evaluate a web-based Multimedia Learning Management System (MLMS) for high school physics integrating text, images, video, animation, and simulations to address post-pandemic learning challenges and improve outcomes in static and dynamic electricity.
Research Methodology: Research and Development using the ADDIE model. Needs analysis involved questionnaires to teachers (n=30) and students (n=107). The MLMS was designed and developed with multimedia and PhET-based virtual labs, then validated by material and media experts, followed by small-group (n=17) and field trials with teachers and students. Data were analyzed using 4-point Likert means; learning-outcome instruments were prepared with validity/reliability procedures, and effectiveness was examined with a pretest–posttest (N-Gain) design.
Results: Needs analysis showed strong demand for accessible, multimedia physics resources (teachers 100% supportive; students 98% agree on development). Material validation achieved a very good category (~90%+), media validation very good (≈83.75%). Small-group practicality averaged 86.32% (very good); teacher field tests averaged 84.82% (very good); student responses averaged 79.98% (very good). Implementation indicates improved learning outcomes in static and dynamic electricity.
Conclusion: The web-based MLMS is valid and practical for classroom use, enhances engagement through interactive multimedia and simulations, and supports better monitoring of student progress.
Limitations: Trials were limited to selected schools and physics topics; no randomized control groups; effectiveness depends on stable internet access.
Contribution: Provides a validated MLMS prototype that operationalizes ADDIE for physics education, integrates interactive multimedia and virtual labs with progress tracking, and offers instruments and practical guidance for school-level deployment.

Keywords: *ADDIE Model, Learning Outcome, MLMS Development, Research and Development, Static and Dynamic Electricity*

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1. Introduction

After COVID-19, education faced several significant challenges that drastically changed the learning paradigm. Physical restrictions and school closures during the pandemic forced education to shift to distance learning on a massive scale. A key challenge is how to provide effective and stimulating learning experiences in virtual environments, where direct interaction between teachers and students is limited. Technology accessibility constraints and inequalities in the online learning infrastructure are also serious obstacles to ensuring that all students can access and participate equally in the post-pandemic learning process (Deng & Hag, 2024).

Based on data from the Program for International Student Assessment (PISA) survey and ranking the quality of education in all countries in the world, they surveyed every three years by taking samples of students aged 15 and over and measuring their performance in three main sections, namely, mathematics, science, and literacy. Quoting from Goodstats.id in its article "Comparison of Indonesia's PISA Scores from Year to Year; Experience a Decrease in 2022" PISA Mathematics scores from 2015, 2018 and 2022 respectively 386, 379, 366. PISA literacy scores from 2015, 2018 and 2022 respectively 397, 371, 359. The PISA Science scores from 2015, 2018, and 2022 were 403, 396, and 383, respectively (Jauhari, 2023). These data indicate that the decline in students' mathematics, reading, and science abilities is a challenge in the world of education, especially in physics learning.

Based on the results of interviews with physics teachers at several SMAI Alzahar BSD and SMAN 9 South Tangerang, lower learning outcomes were generally obtained compared with other science subjects. Several factors cause low learning outcomes, including low motivation to learn physics, easy distraction by devices (HP/iPad/Tablet/Latop), low basic mathematics as operational physics, and difficulty in measuring the extent of students' understanding of the material content. There are various reasons for this, namely the large number of students (in one class of more than 40 students), effective teaching time being reduced by the number of activities, and there being no place to monitor the students' learning process, both in class and at home. The mechanics, Static Fluid, and electrical material groups had low learning outcomes.

Based on previous research that has been conducted regarding the use of Internet networks for education, including the results of web-based learning, there is no significant difference between traditional/face-to-face learning and positive responses from users of web-based learning because one of them can be accessed anytime and anywhere (Kumari, Gautam, Nityadarshini, Das, & Chaudhry, 2021). The use of an MLMS increases independent learning motivation, and users of web-based learning media have higher metacognitive abilities than those who do not (Kalatting, Serevina, & Astra, 2015). In addition, MLMs help instructors and lecturers package appropriate materials. There was a significant increase in student performance compared to the previous semester where MLMs (Multimedia Learning Management Systems (MLMs) were not available. This improvement is significant for all students, regardless of their backgrounds or ability levels.

Physics learning can be made more effective by utilizing online multimedia learning. Using this approach, students can experience dynamic and interactive learning experiences. Multimedia, such as animations, videos, simulations, and images, can provide clear and concrete visual depictions of abstract concepts in physics. Based on the research results above, this study developed a web-based multimedia learning management system (MLMS) for physics learning to improve student learning outcomes. Based on these problems, the author aims to conduct research on the development of a web-based multimedia learning management system (MLMS) for high school physics learning.

2. Literature review

2.1. Theoritical review

2.1.1. Web based Multimedia Learning Management System (MLMS)

A Multimedia Learning Management System (MLMS) is a Learning Management System that is enriched by the advantages of multimedia in the form of text, audio, images, video, animation, and simulation. MLMS is a system designed to integrate interactive multimedia with online learning management (Shahzad, Nadeem, & U-Nisa, 2021). It allows instructors to create, manage, and deliver instructional materials using multimedia elements such as text, images, audio, video, and animation." An MLMS is designed to combine interactive multimedia with online learning management. This system allows instructors to create, manage and deliver learning material using multimedia elements such as text, images, audio, video and animation (Quah, 2023; Sugiyanto, Pintakami, Sukesi, Nurhadi,

& Fitriana, 2023). The MLMS integrates multimedia technology with learning management. The system facilitates the delivery of diverse learning content, including text, images, audio, video, animations, and other interactive elements. MLMS also includes management, evaluation, and collaboration features that enable instructors to monitor and organize the learning process effectively." An MLMS combines multimedia technology with learning management. This system facilitates the delivery of diverse learning content, including text, images, audio, video, animation, and other interactive elements. The MLMS also includes management, evaluation, and collaboration features that enable teachers to monitor and manage the learning process effectively (Suharto, Japlani, & Ali, 2021; Suharto & Yuliansyah, 2023).

Web-based learning (WBL) is a form of Physics MLMS where the material and method of delivery is via the Internet (web) or any experience or learning environment that relies on the Internet (World Wide Web). So the definition of Web-based learning (Web Based Leaning) is defined as a learning experience that utilizes the Internet to communicate and convey learning information (Parela, Hudalil, Ariswandy, & Pradana, 2022; Suharto & Hoti, 2023; Syarif & Riza, 2022).

Web-based learning (WBL) systems have revolutionized educational institutions by creating opportunities and challenges for educators to develop new programs and curricula. Collaborative technologies have created communities of practice in which people achieve shared goals through collective action. Learning systems, as a consequence of advances in network technology, include web-based systems that support groups of students involved in general. Web-based systems facilitate the implementation of learning activities by providing an interface in shared environments. They play a fundamental role in communication channels (Quah, 2023).

2.1.2. MLMS Supporting Learning Theory

In this study, the underlying theories of the Multimedia Learning Management System (MLMS) are constructivism, information processing, cognitive load, and cognitive theories of multimedia learning. Constructivism, often referred to as constructivism in the educational context, is a theoretical view that focuses on the active role of individuals in the construction of their own knowledge and understanding. This theory states that individuals are actively involved in building their knowledge through interactions with their environment and experiences (Rahmayanti & Nirwana, 2021). Constructivism departs from the assumption that individuals have previous knowledge and understanding that shapes their understanding of new information. They use frameworks, schemas, or concepts that they have previously developed to interpret and relate to new information they encounter. Thus, constructivism emphasizes the important role of individuals' experiences in constructing their understanding of the world. Jean Piaget developed the theory of cognitive constructivism, which emphasizes that children develop knowledge through active interactions with their physical and social environments. Piaget identified four stages of cognitive development: the sensorimotor, preoperational, concrete operational, and formal operational periods.

Information Processing Theory is a theoretical framework used to explain how humans receive, process, organize, store, and retrieve information from their environment. This theory was developed in the field of cognitive psychology in the 1950s and the 1960s and is the dominant approach to understanding human cognition (Atkinson & Shiffrin, 1968). The basic principle of the Information Processing Theory is that the human mind can be compared to a computer-processing system. Similar to computers, humans have processors that process information, take inputs, produce outputs, and store information in memory. Human information processing involves a series of sequential stages, including the retrieval of sensory information, processing and encoding of information in memory, and retrieval of information from memory when needed.

Cognitive Load Theory was developed in the field of cognitive psychology to understand how humans' cognitive capacities influence their ability to process information and learn. This theory was first introduced by John Sweller in 1988 and has since become one of the most influential theories in the field of teaching and learning. According to the Cognitive Load Theory, humans have a limited capacity to process information simultaneously in their short-term memory. Cognitive load refers to the amount and complexity of information that the brain must process to perform a particular task (Jordan et al., 2020).

2.1.3. Physics Learning

Etymologically, the word "learning" comes from the root word "teach.” Learning can be defined as the process of acquiring knowledge, skills, or understanding through various methods, experiences, and environmental interactions. In this word, "pem-" denotes an action or process, and "learning" has a root word that refers to acquiring knowledge or skills. Learning is an interactive and dynamic process in which individuals acquire, understand, and internalize new knowledge, skills, attitudes, and values through various experiences and interactions with their environments. This process includes observable changes in behavior and internal changes in an individual's thinking, understanding, and cognition. Learning can occur consciously or unconsciously and involves various sources of information, including teachers, peers, books, the media, and direct experience.

In formal education, teachers or facilitators direct learning by designing learning experiences to achieve specific educational goals. This may involve the delivery of material, practical activities, discussions, and evaluations to ensure understanding and mastery of the material. In informal or everyday situations, learning can occur naturally through observation, experimentation, and interactions with the surrounding environment. Physical learning is an educational process that aims to teach students the basic principles and concepts of physics. This scientific discipline includes an understanding of various natural phenomena, the basic laws of physics, and their applications in everyday life. By learning physics, students are given the opportunity to develop analytical, critical, and problem-solving skills, which are important competencies for understanding the world of physics.

Physics learning is often achieved through a combination of theory, experimentation, and application of concepts in real-world contexts. This process aims to provide a deep understanding of the principles of physics while facilitating the development of practical skills to observe, measure, and analyze data. According to Tuveri, Sanna, and Cadoni (2025), effective physics learning involves integrating conceptual, problem-solving, and mathematical understanding. Physics learning is directed toward understanding basic concepts, such as mechanics, thermodynamics, electromagnetism, and optics. Applying this theory to real-world situations helps students connect physics concepts to the natural phenomena they experience daily. Various learning methods, including laboratory experiments, computer simulations, and group discussions, have been used to increase the understanding of concepts and promote students' activeness in exploring physics knowledge (Sera et al., 2025).

2.2. Conceptual framework

This mapping was based on initial studies that identified several issues. Researchers have attempted to provide the best solution to this problem by considering the initial studies that have been conducted. Physical learning outcomes are the problems that will be examined in this study. As an alternative to solving the above problems, a web-based physics MLMS was developed. The development of this web-based Physics MLMS requires considerable study and input from experts before it can be given to students. Based on supporting theories, the Multimedia Learning Management System (MLMS) can help improve student learning outcomes. The development of Physics MLMS is not directly given to students, but it still needs to be validated and tested. From the validation and trial results, the advantages and disadvantages of the module will be discovered, so that revisions can be made. After revisions have been made, this electronic module can be widely used. One of the things that must be of concern to a teacher and educational unit is being able to create and/or implement a complete and clear development of a web-based physics MLMS to improve student learning outcomes.

3. Research methodology

3.1. Types of Research

The research was conducted at several high schools, namely Insan Scholar Madani BSD High School, Al Azhar BSD High School, Insan Rabbany High School, and N 19 South Tangerang High School. This study used research and development using the ADDIE model. The ADDIE model is a systematic learning design model,, as the procedural aspect of the systems approach has been realized in many methodological practices for the design and development of texts, audiovisual material,s, and computer-based learning materials. ADDIE is a validation process because it verifies all products and procedures related to continuous learning development. Validation is a guiding feature of ADDIE, and credibility is added through analytical, evaluative, and philosophical procedures. Goal-oriented learning design paradigm. Valid learning objectives must reflect the reality in which students are expected to perform, and thus maintain a high degree of alignment between the learning space and the place where the tasks are actually performed (Amalia, Pratiwi, Al Razieb, & Maab, 2024).

The ADDIE model is a systematic learning design model as the procedural aspect of the systems approach has been realized in many methodological practices for the design and development of texts, audiovisual materials and computer-based learning materials (Tegeh & Kirna, 2013).

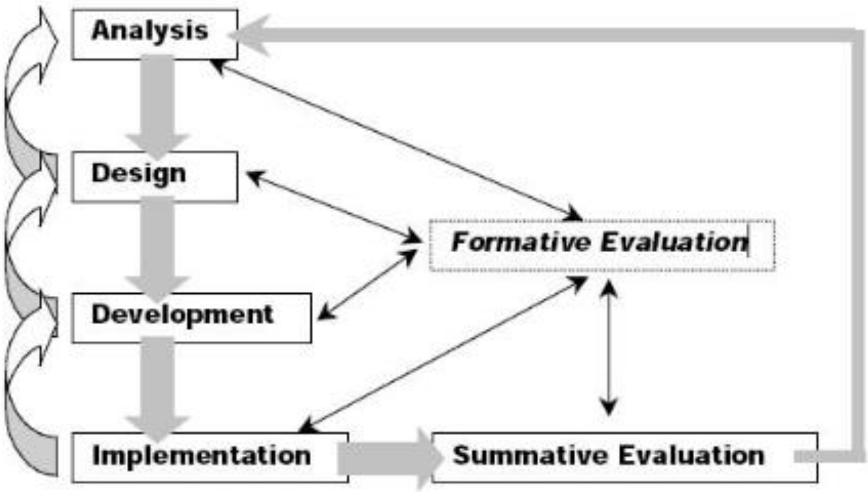

Figure 1. Stages of the ADDIE Model

3.2. Research Instrument

3.2.1. Questionnaire needs analysis instrument

In this research, the instrument was used to distribute needs analysis to students and physics teachers (Sunarti, Hafizah, Rusdinal, Ananda, & Gistituati, 2022). This stage was conducted to obtain information about the conditions and needs of students and educators in implementing physics learning in the 2013 Curriculum.

Table 1. Student questionnaire needs analysis instrument grid

No	Indicator	Instrument Items
1.	Classroom teaching methods	1, 2, 3
2.	Learning Support Facilities	4, 5, 6, 7, 8, 9, 10
3.	Instructional Media	11, 12, 13, 14, 15
4.	Expected benefits of using the media being developed	16, 17, 18, 19,

Table 2. Physics teacher questionnaire needs analysis instrument grid

No	Indicator	Instrument Items
1.	Curriculum and learning methods	1, 2, 3, 4, 5
2.	Knowledge of learning media	6, 7, 8, 9
3.	Web-based MLMS development	10, 11, 12, 13
4.	Categories of subjects that students find difficult	14, 15

3.2.2. Validation Instrument

The completed website-based MLMS was made into a product and then validated by a team of experts consisting of material and media experts. This test aimed to determine the validity of the resulting media.

Table 3. Media Expert Validation Instrument Net Grid

No	Assessment Aspects	Indicator	Nomor Item	Jumlah item
1.	Presentation	usage instructions	1	8
		Presentation of writing, animation, images and videos.	2-5	
		The display provides comfort for students	6	
		Image and video resolution	7,8	
2.	Layout (layout)	Design home page and page images	9-11	7
		Suitability of type, letters in written text	12,13	
		Suitable color combination	14	
		Suitability of the location of images, animations and videos	15	
3.	Access	Ease of use of MLMS	16,17	5
		Hyperlinks and hypertext run smoothly and appropriately	18	
		Easy use of animations, simulations and videos	19	
		Web maintenance	20	
		Total		20

Table 4. Material validation instrument grid

No	Assessment Aspects	Indicator	Item Number	Number of items
1.	Feasibility of Teaching Material Content	The material presented	1-3	11
		Concepts, definitions and topic apperception are appropriate	4-6	
		Presentation of examples in MLMS	7-9	
		The level of difficulty and abstractness of the concept	10	
		Use of terms	11	
2.	Material writing language	Use of language in the content of the material	12-19	11
		Coherence between paragraphs	20	
		Effective sentence	21	
		Use of symbols in physics	22	
		Total		22

3.2.3. Field Trial Instrument

The website-based MLMS was revised based on the results of media expert validation, materials, and small group trials, and continued with field trials. The field trial questionnaire had the same indicators as the small-group trial questionnaire. The field trial questionnaire grid used in this study is presented in the following table.

Table 5. Validation grid for professional high school physics teachers

No	Assessment Aspects	Indicator	Item Number	Number of items
1.	Feasibility of Teaching Material Content	The material presented	1-3	11
		Concepts, definitions and topic apperception are appropriate	4-6	

		Presentation of examples in MLMS	7-9	
		The level of difficulty and abstractness of the concept	10	
		Use of terms	11	
2.	Material writing language	Use of language in the content of the material	12-19	11
		Coherence between paragraphs	20	
		Effective sentence	21	
		Use of symbols in physics	22	
3.	Presentation	instructions for use	1	8
		Presentation of writing, animation, images and videos.	2-5	
		The display provides comfort for students	6	
		Image and video resolution	7,8	
4.	Layout (layout)	Design home page and page images	9-11	7
		Suitability of type, letters in written text	12,13	
		Suitable color combination	14	
		Suitability of the location of images, animations and videos	15	
5.	Access	Ease of use of MLMS	16,17	5
		Hyperlinks and hypertext run smoothly and appropriately	18	
		Easy use of animations, simulations and videos	19	
		Web maintenance	20	
		Total		42

Table 6. Grid of appropriateness of learning resources (students)

No	Assessment Aspects	Indicator	Nomor Item	Jumlah item
1.	Feasibility of Teaching Material Content	Material presented	1-3	6
		Presentation of examples in the LMS	4-6	
2.	Material writing language	Use of language in the content of the material	7-11	5
		Coherence between paragraphs	12	
3.	Presentation	instructions for use	13	7
		Presentation of writing, animation, images and videos.	14-17	
		The display provides comfort for students	18	
		Image and video resolution	19,20	
4.	Layout (layout)	Design home page and page images	21,22	5
		Suitability of type, letters in written text	23,24	
		Suitable color combination	25	
5.	Access	Ease of use of MLMS	26,27	4
		Hyperlinks and hypertext run smoothly and appropriately	28	
		Easy use of animations, simulations and videos	29	
6.	Benefit	MLMS as a flexible alternative learning resource	30	5
		MLMS helps in self-learning	31	

	MLMS increases learning motivation and achievement of learning outcomes	32,33	
	MLMS helps you prepare for the written National Examination and entrance to PTN	34	
	Total		34

3.3. Data Analysis Techniques

3.3.1. Analysis of questionnaire results

Data analysis was conducted using the average score obtained from observations by physics material experts, media and learning resource experts, and high school physics teachers. These results are the basis for assessing the quality of the module based on 4 point Likert scale (1 = strongly disagree to 4 = strongly agree). The assessment limit for whether a module is good for use as an alternative learning resource is based on the score interpretation criteria for the Likert scale. The Likert scale is used to measure the attitudes, opinions, and perceptions of individuals or groups regarding social phenomena.

3.3.2. Learning Outcome Instrument

3.3.2.1. Validation

A good instrument must fulfill two important requirements: validity and reliability. A valid instrument indicates that the measuring instrument used to obtain data is valid. Validity means that the instrument can be used to measure what it is supposed to measure. The degree of validity in this research was < 0.4 = low, < 0.4 and < 0.6 = sufficient, and < 0.6 = good. To determine the validity of this instrument in the form of descriptive questions, we used the product-moment correlation formula as follows:

$$r_{xy} = \frac{N\sum xy - \sum x \sum y}{\sqrt{\left(N\sum x^2 - \left(\sum x\right)^2\right)\left(N\sum y^2 - \left(\sum y\right)^2\right)}}$$

With :

rxy = correlation coefficient between instrument item scores and total score

X = respondent's score on the instrument item

Y = total score on instrument items

After the validity coefficient value for each question item was obtained, it was necessary to carry out a significance test to measure the significance of the correlation coefficient based on a normal curve distribution using t-test statistics.

$$t = r_{xy}\sqrt{\frac{N-2}{1-{r_{xy}}^2}}$$

With:

t = calculated value of the validity coefficient

rxy = correlation value for each question item

N = number of trial students

The results were then compared with the t value from the table at a confidence level of 95% and degrees of freedom (dk) = N–2. If tcount>ttable, then the validity coefficient of the question item is at the significance level.

3.3.2.2. Reliability

A test is said to be reliable if it can provide consistent results, meaning that if the test is applied to the same number of subjects at another time, the results will remain the same or relatively similar. The correlation coefficient category scale is as follows: 0.00 – 0.24 = Very Weak Correlation, 0.25 – 0.44 = Weak Correlation, 0.45 – 0.64= Medium Correlation, 0.65 – 0.84 = Strong Correlation, and 0.85 – 1.00 = very strong correlation. To determine the reliability of this objective test, we used the Kuder and Richardson-20 formula. It is often written as K-R 20.

$$r_{11} = \left(\frac{n}{n-1}\right)\left(\frac{S^2 - \sum pq}{S^2}\right)$$

With:
r11 = overall test reliability (objective)
P = Proportion who answered the item correctly
Q = 1 – p
Σpq = Σ(pxq)
n = number of items
S2 = Standard deviation

3.3.2.3. N-Gain Calculation
N-gain is the normalization of the gain obtained from pre- and post-test results. The N-Gain calculation was performed to determine the increase in students' learning outcomes before and after using the web-based physics-learning MLMS. The design used for data collection was a one-group pretest-posttest design. Each group of subjects was subjected to treatment for a certain period. Measurements were taken before and after the treatment, the effect of the treatment was given, and the effect of the treatment was measured as the difference between the initial measurement (T1) and the final measurement (T2). This is graphically depicted in the table below:

Pretest	Treatment	Postest
T_1	X	T_2

The N-gain value indicates the effectiveness of using web-based physics learning MLMS in improving students' learning outcomes. The N-Gain calculation was performed using the N-Gain equation as follows:

$$\langle g \rangle = \frac{\%\,\langle G \rangle}{\%\,\langle G \rangle_{max}} = \frac{\%\,(S_f) - \%\,(S_i)}{100\% - \%\,(S_i)}$$

Where:
S_i = initial test (pre-test) score
S_f = final test score (post-test)
$\langle g \rangle$ = average normalized gain (N-Gain)
$\langle G \rangle$ = average actual gain (gain)

Furthermore, N-gain can be classified into three categories.

Table 7. Average N-Gain Classification

Average N-Gain	Criteria
$(\langle g \rangle) \geq 0{,}7$	High
$0{,}7 > (\langle g \rangle) \geq 0{,}3$	Middle
$(\langle g \rangle) < 0{,}3$	Low

Kriteria keefektifan dapat di tentukan dengan skor rata-rata gain ternormalisasi minimal berada pada kategori sedang.

3.3.2.4. T-test
The test for different variants uses the difference between two mean tests using the t-test (t-test). The test forms for the different variants were as follows:

$$T = \frac{X_1 - X_2}{\sqrt{\left(\frac{S_1{}^2}{n_1}\right) + \left(\frac{S_2{}^2}{n_2}\right)}}$$

Information:

$n_1$dan n_2 = number of samples for groups 1 and 2
S_1dan S_2 = sample standard deviation for groups 1 and 2

Significance level (α = 0.05)
If T-hit < T-tab, H0 is accepted; if T-hit > T-tab, H0 is rejected.
If sig (ρ) >0.05, H0 was accepted, and if sig (ρ) <0.05, H) was rejected.
Hypothesis:

H0 = There is no significant difference in the increase in students' physics learning outcomes after implementing physics MLMS
H1 = There is a significant difference in the increase in students' physics learning outcomes after implementing physics MLMS

4. Results and discussions

4.1. Results of Needs Analysis

Needs analysis was carried out by distributing questionnaires via Google Forms to respondents spread across several schools in the provinces of Banten, West Java, and DKI Jakarta. The study included 30 teachers and 107 students. The results of the recapitulation of the needs analysis questionnaire are presented in Tables 8 and 9, respectively.

Table 8. Results of the needs analysis of 30 physics teacher respondents

No	Indicator	Questionnaire findings
1	Curriculum & learning methods	93.3% have implemented standard ICT-based learning processes. with 30% as media creators and the remaining 70% as users
2	Knowledge of learning media	Those who are users only run applications that are already available on the internet (website) such as khanacademic, phet simulation, bamboomedai, and Rumah Belajar.
3	Web-based MLMS development	If as an average creator you create a blog with a limited level of integration,
4	Teachers' expectations for developing MLMS learning resource media	100% supports the development of Web-based MLMS media in physics learning
5	Categories of subjects that students find difficult	The top three results of the questionnaire are 53.3% learning media that can be accessed anytime and anywhere, 40% media that is able to report the results of media use, whether assignments or tests, 36.7% learning media that can display physics teaching material integrated with simulation/animation/ tutorial video

Table 9. Results of the needs analysis for 107 student respondents

No	Indicator	Questionnaire findings
1	Classroom teaching methods	54% of teachers conduct lecture learning using ppt presentation media to help deliver the material. 68.2% find it difficult to learn physics
2	Learning Support Facilities	In general, more than 90% stated that there were no obstacles in supporting facilities for online-based learning media in each school
3	Instructional Media	98% agree regarding the development of learning media
4	Expected benefits of using the media being developed	The top three results of the questionnaire are 69.2% learning media that makes it easier to learn physics, 58.9% learning media that provides complete material with simulations/animations/learning videos, 56.1% learning media

	that can help in successfully facing the Semester Exam and entrance selection PTN.

In general, the results of the questionnaire above from both teacher and student respondents indicate a need to develop learning media that are easy to use and access anytime and anywhere, physics material content that is easy to understand and completely integrated with simulations/animations/learning videos, as well as media that can help improve student learning outcomes. Based on these findings, alternative solutions that can accommodate the needs of the field are being sought.

4.2. MLMS Development Model for Physics Learning

4.2.1. Phase I Analysis (Analyze)

This research began with an analysis to identify problems in research and the needs of students and educators in learning physics, knowing what problems in the field are felt by students and physics teachers, and the media is appropriate so that it is easy to use and flexible. Therefore, there is a need to develop a website-based Physics MLMS. This stage consisted of a needs analysis and literature review.

4.2.2. Needs Analysis

In this study, a needs analysis was conducted by analyzing primary and secondary data. Primary data were obtained through direct observation, interviews with physics teachers, and the distribution of needs analysis to students and teachers. Direct observations and interviews were conducted at high schools in BSD area of southern Tangerang. Meanwhile, the distribution of needs analysis received 30 physics teacher respondents and 107 student respondents spread across various high schools in both cities and districts in the provinces of Banten, DKI Jakarta, and West Java. Secondary data were obtained from the analysis of five journals related to current issues in the field. This stage was conducted to obtain information about the conditions and needs of students and educators in implementing physics learning in the 2013 curriculum.

Table 10. Student questionnaire needs analysis instrument grid

No	Indicator	Instrument Items
1.	Classroom teaching methods	1, 2, 3
2.	Learning Support Facilities	4, 5, 6, 7, 8, 9, 10
3.	Instructional Media	11, 12, 13, 14, 15
4.	Expected benefits of using the media being developed	16, 17, 18, 19,

Table 11. Needs analysis instrument grid for physics teacher questionnaires

No	Indikator	Instrument Items
5.	Curriculum and learning methods	1, 2, 3, 4, 5
6.	Knowledge of learning media	6, 7, 8, 9
7.	Web-based e-module development	10, 11, 12, 13
8.	Categories of subjects that students find difficult	14, 15

4.2.3. Stage II Design (Design)

At the planning stage, the material content is prepared, images are collected or created, videos are collected or created, and animations that support the selected subject matter in making MLMS Physics are collected or created.

4.2.4. Stage III Development (Develop)

Research activities in the third stage are development activities that combine material content with images, graphics, videos, animations, or simulations into a website to become a website-based MLMS Physics learning resource product. Collecting material references, searching for and making videos to support learning on electricity and magnetism, and finding and creating animations to support learning on electricity and magnetism must be adapted to the format and support capacity of the website. After the website and materials were created, an expert review and trial were performed. The first expert review was conducted with supervisors, material experts, and media experts, and then a trial was conducted with several users (teachers). After the trial, revisions were made to correct the deficiencies in tsmedia.web.id and the study materials.

The revised web-based MLMS was then subjected to expert validation by material and multimedia experts. The experts consisted of one material expert and one multimedia expert who was a lecturer in the physics department at Jakarta State University and the professional head of the ICM Information and Technology Division. After validation, revisions were made to improve web-based MLMs with the link www.tsmedia.web.id and materials according to suggestions given by experts.

4.2.5. Stage IV Implementation

The development model, which was evaluated to determine its feasibility and revised to perfect it, was then implemented in the classroom to determine its practicality and effectiveness through field trials. The website-based MLMS Physics field trial was revised based on the results of media expert validation, materials, and small group trials, and then continued with field trials. A trial was conducted during implementation. The samples used in the field trials were middle and high school students from the ICM. After completing the learning using website-based MLMS Physics, students and teachers were distributed field trial questionnaires to assess the development of website-based MLMS Physics learning resources.

4.2.6. Stage V Evaluation (Evaluation

An evaluation was conducted at the end of the program to determine its impact on student learning outcomes and the quality of learning at large. Therefore, in addition to providing advice to students and teachers, we assessed the feasibility of developing a web-based Physics MLMS. The next factor is the impact of effectiveness after using the web-based Physics MLMS, in this case, to improve student learning outcomes.

4.2.7. Validity of the Physics Learning MLMS

4.2.7.1. Material Validation Test

The material feasibility test was carried out by two material experts, the first material expert was Prof. Dr. Iwan Sugihartono, M.Si and Dr, Esmar Budi, M.T both work as physics lecturers at Jakarta State University. The feasibility test was conducted by administering a questionnaire with 21 questions covering basic competencies, development strategies, writing language, and consistency in writing. After the aspects tested or assessed were reviewed by the examiner, an assessment was conducted. The examiners also provided suggestions and opinions for improving the materials. The results of the material feasibility tests are listed in the following table.

Table 12. Material Expert Test Eligibility Results

Validator	Rated aspect (%)				Average (%)
	Feasibility of the content of teaching materials		Material Writing Language		
	Basic competencies	Content Delivery Strategy	Writing Language	consistency in writing usage	
I	87,50	85,71	85,00	87,50	86,36
II	93,75	96,43	95,00	95,83	95,45
Average (%)	**90,63**	**91,07**	**90,00**	**91,67**	**90,91**

Based on the table above, it can be concluded that this material received an average of 86.36%, so the overall presentation for the material feasibility test was 95.45%. 90.91 %. By obtaining this percentage, the suitability of the material is in the range of 76%-100%, based on the Likert scale, and the criteria are very good.

The suggestions provided by Validators I and II are as follows:

1) The writing symbols must be consistent and follow scientific rules.
2) Please clarify whether the conductor ball is solid or hollow.
3) In parallel capacitor plates, attention is paid to the positive and negative charges.
4) Add projects or practical activities for students.

4.2.7.2. Media Validation Test

The media suitability test was conducted by a media expert who worked as the Head of the ICT Division for Civil Scholars and one lecturer at Jakarta State University. Feasibility testing was conducted by administering a questionnaire with 20 questions covering multimedia presentation, reader comfort, website design, display consistency, and user-friendliness. After the aspects were tested, assessed, and reviewed by the examiner, an assessment was performed. The examiners also provided suggestions and opinions for improving the materials. The results of the media feasibility tests are listed in the following table.

Table 13. Media Expert Test Eligibility Results

Validator	Rated aspect (%)					Average (%)
	Presentation		Layouts		Use	
	Multimedia	Reader convenience	Website Design	Display consistency	User convenience	
I	90	83.33	83,33	75	90	**85.00**
II	80	83.33	75	87.50	85	**82,50**
Average (%)	**85**	**83.33**	**79,17**	**81.25**	**87,50**	**83.75**

Based on the table above, it can be concluded that this medium obtained an average of 85% for the feasibility test for the first examiner, while for the feasibility test for the second examiner, it was 82.50%. Therefore, the overall media feasibility test percentage was 83.75%. By obtaining this percentage, the suitability of the media was in the range of 76%-100%, based on the Likert scale, the criteria are very good.

The suggestions provided by Validators I and II are as follows:
1) Correct the size settings for videos, images and animations so that they are compatible on various devices
2) Improve the context of the narrator's voice (lots of noise) in the video
3) The color of the learning text has been corrected to just black
4) There are some bugs not syncing / not opening

4.2.8. Practicality of MLMS Physics Learning

Field trials of the website-based MLMS Physics, which were revised based on the results of validation by media experts and materials, followed by field trials, were carried out on small and large groups.

4.2.8.1. Small Group Trials

After the web-based Physics MLMS was declared to have passed the material expert and media expert feasibility test, this physics MLMS was first tested on a small group by giving a 34-item questionnaire to 17 respondents. The questionnaire items included the content of teaching materials (material), the language in which the material is written, multimedia presentation, web design, use/access and benefits. The results of the small-group test are shown in the following table:

Table 14. Small Group Test Results

No	Aspect	Average score (%)	Interpretation
1	Material Content	89.22	Very good
2	Writing Language	87.50	Very good
3	Multimedia Presentation	84.19	Very good
4	Web Design	85.00	Very good

5	User Ease	80.51	Very good
6	Benefit	91.47	Very good
	Overall average	**86.32 (Very good)**	

The table above shows that the aspects of material content, writing language, multimedia presentation, web design, user friendliness, and benefits received scores of 89.22%, 87.50%, 84.19%, 85%, 80, 51%, and 90.47 %, respectively, which are included in the very good category. The average score was 82.67. This is in accordance with Sugiyono (2017), who states that a Likert scale with a score of 76–100% is in the very good category.

4.2.8.2. MLMS Physics field test for teachers and students

After the web-based Physics MLMS passed the feasibility test for material and media experts and was tested on small groups, it was deemed suitable for use and field testing in several schools around South Tangerang for teachers and students.

The recruitment of professional teachers for the web-based MLMS Physics feasibility test was distributed into 42 questions. The questionnaires were distributed to professional teachers at SMAS Insan Ilmu Madani (I), SMAI Alzahar BSD Selatan (II), SMAN 9 Tangerang (III), and SMAS Insan Rabbany (IV). The results are presented in the following table:

Table 15. Eligibility Test Questionnaire Results from Professional Teachers

Category	**Indicator to be assessed**	**Professional Teacher Respondents**				**Average (%)**	**Interpretation**
		I	II	III	IV		
Feasibility of the content of teaching materials	basic competencies	93.75	93,75	87,50	93,75	92,19	Very good
	Delivery Strategy	96,43	92,86	92,86	85,71	91,96	Very good
Material Writing Language	Writing Language	85	90	75	95	86,25	Very good
	Consistency in the Use of Written Language	91,67	95,83	75	95,83	89,58	Very good
Presentation	Multimedia Presentation	90	80	75	90	81,67	Very good
	Reader Convenience	75	75	75	83,33	77,78	Very good
Layouts	Web Design	75	75	75	75	75	Good
	Display Consistency	75	81,25	75	87,5	81,25	Very good
Usage/access	User Ease	80	75	80	80	78,75	Very good
Average Score						**84,82**	**Very good**

Based on the data above, of all the indicators proposed, only one was in the good category, and the rest were very good. The indicators that were declared good are regarding web design with a percentage of 75%, and the indicators that were declared very good were basic competence, delivery strategy, writing language, consistency in the use of writing language, multimedia presentation, reader comfort, display consistency, and user friendliness, with percentages of 92.19 %, 91.96 %, 86.25 %, 89.58 %, 80.00 %, 77.78 %, 81.25 %, and 78.75 %, respectively. On average, from the feasibility test of professional teachers, a score of 84.82% was obtained in the very good category. This is in accordance with Puspasari and Puspita (2022), who stated that a Likert scale with a score of 76–100% is in the very good category.

The questionnaires resulting from student responses regarding website-based MLMS Physics contained 34 questions. A response questionnaire regarding the use of the web-based Physics MLMS was distributed to several schools, including SMAS Insan Ilmu Madani and SMAN 9, South Tangerang. The results of the questionnaire are presented in the following table:

Table 16. Results of Questionnaire Responses from Students

No	Aspect	Average score (%)	Interpretation
1	Material Content	82,20	Very good
2	Writing Language	79,91	Very good
3	Multimedia Presentation	79,97	Very good
4	Web Design	79,44	Very good
5	User Ease	78,37	Very good
6	Benefit	80,00	Very good
Overall average		**79,98 (Very good)**	

The above data show that the indicator aspects assessed for material content, writing language, multimedia presentation, web design, ease of use, and benefits had average scores of 82.20%, 79.91%, and 79.97, respectively. %, 79.44%, 78.37, and 80%. On average, based on the results of the student questionnaire responses, a score of 79.98% was obtained in the very good category. This is in accordance with Puspasari and Puspita (2022), who stated that a Likert scale with a score of 76–100% is included in the very good category.

4.3. Discussion

The development of this web-based Physics Learning MLMS, is named tsmedia because it is web-based, with the web address: www.tsmedia.web.id. Product development was conducted using the Research and Development (R&D) research method with the Analyze, Design, Development, and Evaluation (ADDIE) model. The ADDIE model is a systematic learning design model as the procedural aspect of the systems approach has been realized in many methodological practices for the design and development of texts, audiovisual materials and computer-based learning materials (Zamsiswaya, Syawaluddin, & Syahrizul, 2024). With this development model, we feel that we can have more freedom and direction, allowing developers to design learning solutions that are in accordance with the analysis results of the study. This design can be adapted to learning styles, content, and student needs.

This research begins by carrying out an analysis to identify problems in research and the needs of students and educators in learning physics, knowing what problems in the field are felt by students and physics teachers, in addition to seeing the potential that can be developed from students, physics teachers, and schools. From a literature study regarding the problems that occurred, it was concluded that there was a need to develop a web-based MLMS product for physics learning in high schools. During the design and development stage, the product development process was pushed to carry out revisions based on the findings of the validator team, expert validators, and media validators. products that matched the needs analysis of the study.

The web-based physics learning MLMS product, with the name tsmedia learning with the address www.tsmedia.web.id, is novel in several ways, including:

4.3.1. Interesting multimedia integration

This product integrates various media, including text, images, videos, animations, and virtual labs, into one platform to explain physics concepts in learning, starting with an interesting introduction that explains problems in everyday life packaged in videos or simulations. The content is made short and clear to explain concepts accompanied by systematic and easy-to-digest mathematical explanations and ends with practice questions equipped with discussions that are easy to understand and equipped with a video version (YouTube) so that you can repeat or save. This can help students organize the learning process independently, in accordance with the Cognitive Theory of Multimedia Learning, or Cognitive Theory of Multimedia Learning, developed by Jenlink (2019) as a theoretical framework for understanding how people learn through the use of media. This theory is based on the understanding that humans have limited cognitive systems and that effective multimedia learning takes advantage of these limitations.

4.3.2. Record student progress

Student progress is well stored, making it easier for teachers to track and evaluate the extent to which students have achieved an understanding of physics concepts.

4.3.3. Structured and tiered learning

The tsmedia MLMS system requires that you be able to go through each subchapter before moving on to the next subchapter so that students can go deeper and understand the concepts of that subchapter, and teachers can check and determine the extent of students' understanding.

4.3.4. Virtual PhET lab with Student Worksheets

The MLMS is equipped with an open-source virtual lab with Student Worksheets so that, while surfing the virtual lab, students can systematically process data and analyze physical variables related to these concepts. This helps students construct an understanding of the concepts of influential physical variables, which is in accordance with the theory of constructivism, in which individual students have previous knowledge and understanding that shapes their understanding of new information. They use frameworks of thought, schemes, or concepts that they have previously developed to interpret and relate to new information they encounter (Piaget, 1973).

4.3.5. Wide accessibility

Web-based physics learning MLMS products can be accessed easily anytime and anywhere from various types of devices (HP, iPad/Tablet, laptop/PC) and operating systems (Windows, Android, iOS, or MacOs) simply by opening a browser and typing the address. tsmedia learning (www.tsmedia.web.id) and connected to the Internet.

4.3.6. Record progress that is easy to print

All student progress can be easily printed, providing authentic evidence as the basis for the assessment process in physics learning.

5. Conclusion

5.1. Conclusion

Based on the problem formulation and research results described above, the following conclusions can be drawn:

1. The needs of high school teachers and students in the South Tangerang city area, based on the analysis results, show that teachers and students need the development of a web-based Multimedia Learning Management System (MLMS) for physics learning.
2. This study presents a prototype of a web-based MLMS development model for physics learning that integrates various media, including text, images, videos, animations, and virtual labs, on one platform to explain physics concepts.
3. The validity of the web-based Physics MLMS, on static electricity and dynamic electricity, is suitable for use as learning multimedia based on the validation results of material experts and multimedia experts as well as the results of field trials in the very good category,
4. The practicality of web-based MLMS in physics learning, based on the results of small group and large group trials obtained in the very good category, these respondents assessed the suitability of the material content, writing language, multimedia presentation, web design, ease of use, and benefits of the web-based MLMS.
5. The effectiveness of developing a web-based MLMS for physics learning can improve high school physics learning outcomes in the discussion of static and dynamic electricity is proven.

5.2. Suggestion

This study offers several suggestions for future improvements, including the following:

1. Further research is needed to determine the effectiveness of using web-based MLMS as an online learning medium to increase students' knowledge competencies.
2. It can continue to be developed not only in web form but also in applications based on Android OS or iOS systems.
3. In carrying out research planning, starting from needs analysis to the implementation stage of development results, it is necessary to pay attention to the timeline, as well as to predict problems that may arise when conducting research so that it can be timely and prepared for problems that have been predicted so that in the future, it will provide better results. maximum.

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