EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 11 Issue. 1, July 2026, pp 205-226
http://ejournal.uki.ac.id/index.php/edumatsains

Development of Google Sites–Based Interactive Learning Multimedia Integrating Problem-Based Learning (PBL) for Acid–Base Concept

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Article Info

Article history:
Received: April 28th, 2026
Revised: July 15th, 2026
Accepted: July 23rd, 2026
Available online: July 31st, 2026

https://doi.org/10.33541/edumatsains.v11i1.8122

Abstract

This research develops interactive learning multimedia based on Google Sites with *a Problem Based Learning* (PBL) model to improve students' understanding of acids and bases. Using a 4D (Define, Design, Develop, Disseminate) model, this media contains videos, images, simulations, interactive quizzes, and virtual experiments. The instruments include interviews, needs questionnaires, validation sheets, and limited trials. The research subjects consisted of expert lecturers, grade XI students, and chemistry teachers. The analysis was carried out descriptively, qualitatively, and quantitatively. The validation results showed that the media was very valid (material 90.79%, media 93.75%), with positive responses from students (90.1%) and teachers (97.6%). Thus, this medium is declared valid, practical, and effective for learning the chemistry of acid-base materials. This media is also designed to be easily accessible and used independently by students. Student involvement in problem-based activities is expected to improve critical thinking skills. The potential use of this medium is also open to other chemistry topics with relevant content adjustments.

Keywords: Interactive Multimedia, *Problem Based Learning*, *Google Sites*, Acids and bases, 4D.

1. Introduction

The rapid development of science and technology has an impact on the world of education, requiring the learning system to adapt to the digital era. 21st century learning emerged as a response to changes in society from the primitive, agrarian, industrial, to informative era marked by digitalization. This encourages all education stakeholders, including teachers, students, and parents, to master ICT skills (Susianti et al., 2024). Tony Wagner puts forward seven 21st century skills that are important to have, namely: (1) critical thinking and problem-solving, (2) cooperation and leadership, (3) adaptation and agility, (4) initiative and entrepreneurial spirit, (5) effective communication, (6) access and analysis of information, and (7) curiosity and imagination (Kurniawati et al., 2019).

One of the important competencies in 21st century education is problem-solving skills (Kurniawati et al., 2019). Santyasa (2008) stated that this ability is important for students because they will be easier to remember through examples and understand if given the opportunity to solve problems (Sulistyowati et al., 2012). Problem-solving skills are also relevant in everyday life because each individual is often faced with various challenges that require solutions (Adhyan & Sutirna, 2022). Meanwhile, Krulik and Rudnik call it a process of applying knowledge, skills, and understanding to solve problems in new situations (Alfiani & Rahayu, 2024).

Barrows (1980) asserts that "the problem-solving process is the core of a physician's professional performance and should be central to the educational process", signifying the importance of these skills in the entire educational process. He also stated that "the development of problem-solving skills is more important than the acquisition of factual knowledge", so that learning should not only focus on information transfer, but also encourage students to think critically and solve contextual problems actively (Barrows & Tamblyn, 1980).

Problem-solving skills in chemistry classes are still relatively low. Preliminary research shows that students experience difficulties such as: (1) being unable to relate chemical concepts when solving problems, (2) being less systematic and focusing only on the final result, and (3) weak understanding of chemical principles and rules. To overcome this, teachers need to dare to apply innovative learning methods to improve students' ability to solve problems (Rohayah, 2022).

Chemistry is a branch of science that is considered quite difficult and less popular with students because it is conceptual, abstract, and imaginary (Ristiyani & Bahriah, 2016). Chemistry covers a wide range of topics such as atomic structure, chemical bonds, colloids, chemical equilibriums, redox reactions, acid-bases, and hydrocarbons. According to (Handayani et al., 2019), the highest difficulty is found in the buffer solution material, such as the properties, capacity, mechanism, and pH of the buffer solution. Difficulties also arise in early concepts such as the Bronsted-Lowry ionization reaction, acid-base strength, stoichiometry, pH, equilibrium constants, and equilibrium shifts.

Acid and base materials are found in KD 3.10 and 4.10 class XI SMA IPA, covering acid-base theory, solution deposition, and titration. According to Fajrin et al. (2020), students experienced difficulties in all acid-base sub-materials, with an average difficulty of 47%. The highest difficulty is found in the calculation of the pH of acid and alkaline solutions.

The difficulty of students in understanding acid-base material requires teachers to be more creative in developing learning, both through teaching materials, media, and learning models. Therefore, supporting teaching materials are needed so that the delivery of material is more effective and students' tasks are more directed. Teachers need to have creativity and sensitivity to the surrounding phenomena. Suradi (2021) stating that teachers must be creative in creating interactive media so that learning goals are achieved and students can understand the material more easily.

Learning needs to be designed to be engaging and not boring for students. To optimize the learning process, learning resources and media are needed that help students understand and visualize concepts. According to Ismail (2020) One way to reduce learning difficulties is to utilize adequate learning facilities, infrastructure, and media.

An effective learning medium is interactive multimedia, which is a combination of text, images, graphics, sounds, animations, videos, and interactions packaged in digital form to convey messages (Munir, 2013). Interactivity is the main advantage of multimedia, because it creates two-way communication, increases creativity, and allows feedback from users, so that the learning process becomes more dynamic (Munir, 2013).

Interactive multimedia is a learning medium that contains content such as text, images, graphics, animations, sounds, and interactive applications with menus that can be accessed to display certain information (Akbar, 2016). If developed and used appropriately, interactive multimedia provides great benefits for teachers and students, such as making learning more interesting, interactive, time-efficient, improving the quality and attitude of learning, and allowing flexible learning at any time (Munir, 2013). Its use has been proven to be quite effective in improving learning outcomes (Kenneth, 2019). and problem-solving skills (Lestari, 2021; Sari 2022).

Google Sites is one of Google's products that can be used to create web-based interactive multimedia. The platform is easy to use, even by new users, and is capable of recording various activities such as attendance lists, materials, and tasks (Hadidi & Setiawan, 2021). Research by Sari and Suswanto (2017) and Ridoh (2020) It also shows that web-based learning media is effective and efficient in improving student learning outcomes. Therefore, Google Sites can be used by teachers to package learning materials, especially in chemistry learning.

Google Sites has been widely developed as a web-based learning medium in various educational contexts. Hartari and Putra (2025) have reported that Google Sites is valid, practical, and effective in improving students' learning outcomes, learning motivation, and learning engagement. In addition, most studies have focused on evaluating the feasibility and effectiveness of the developed media rather than exploring how the media can facilitate higher-order thinking skills. Consequently, the potential of Google Sites as an interactive multimedia platform to support students' problem-solving skills has not been fully explored, particularly in chemistry learning.

Furthermore, studies integrating Google Sites with student-centered learning models remain limited. Most existing Google Sites-based learning media primarily function as repositories for learning materials, assignments, and assessments. Although Yanto and Waskito (2023) have incorporated multimedia elements, few have integrated a complete learning process that combines interactive multimedia, virtual laboratory activities, structured worksheets, and the syntax of Problem-Based Learning (PBL) into a single web-based platform. This indicates a research gap in the development of learning media that not only delivers content but also systematically guides students through the process of solving contextual chemistry problems.

In order for multimedia to support students' problem-solving abilities, it needs to be integrated with the model's syntax Problem Based Learning (PBL). The syntax of PBL includes: (1) Orientation of students to problems, (2) Organizing students to learn, (3) Guiding individual/group experiences, (4) Developing and presenting the results of the work, and (5) Analyzing and evaluating the process of solving (Sumartini) (2022). According to Arends (2008), PBL is designed to help students develop their thinking, problem-solving, and intellectual skills.

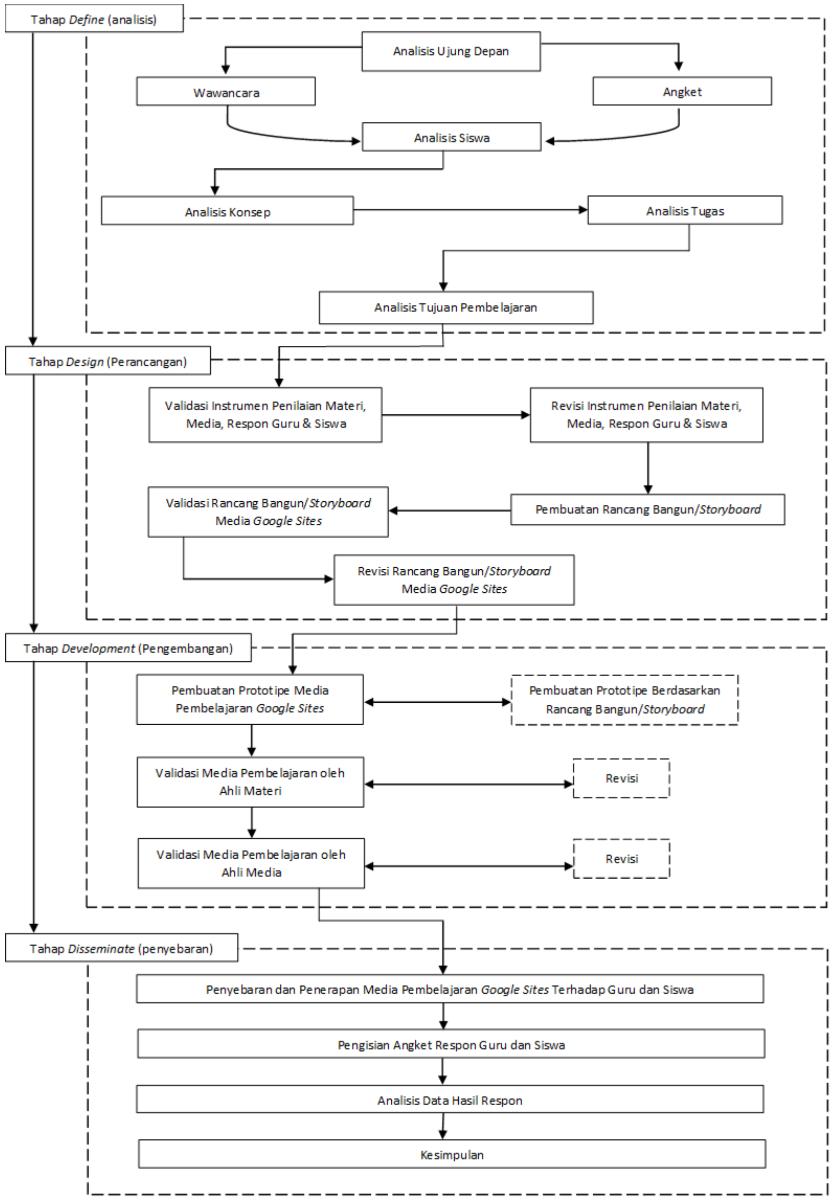
Therefore, this study develops Google Sites-based interactive multimedia integrated with the Problem-Based Learning (PBL) model for acid-based learning in senior high school. The developed media combines learning materials, instructional videos, interactive exercises, virtual laboratory simulations, student worksheets, and evaluation activities within a single web-based platform. By integrating these learning components with the stages of PBL, this study is expected to provide a more meaningful learning experience while facilitating students' problem-solving skills in learning acid-base concepts.

2. Methods

The research method used in this research is research and development, aiming to produce a product, validate, and test its effectiveness (Sugiyono, 2013). This method was chosen because the research aims to develop learning media. The development in this study is in the form of a website that focuses on acid-base materials. The research model used in this study refers to the 4D development model (Define, Design, Development, and Disseminate).

The 4D development model consists of 4 stages, namely Define, Design, Development, Disseminate. This model is suitable for beginners such as students who are working on a thesis because the stages are easier to understand and systematic (Thiagarajan, Semmel, & Semmel, 1974).

Picture 1. Research Scheme



3. Result and Discussion

This research aims to develop a chemistry learning website based on Problem Based Learning (PBL) using Google Sites on acid-base materials, with a 4D development model (Define, Design, Development, Disseminate) from Thiagarajan et al. The method used is Research and Development (R&D). The following is presented the results of the website development process.

3.1 Define

At the definition stage, the researcher carried out a number of activities, including: end-to-end analysis, student analysis, concept analysis, task analysis, and learning objective analysis.

Front-end analysis is a needs analysis obtained from teachers and students with the aim of identifying and determining the main problems faced in chemistry learning. The purpose of this activity is to collect information related to the needs of teachers and students in learning. According to Afifulloh & Cahyanto (2021), front-end analysis is an important part of identifying aspects relevant to learning. In this process, the researcher conducts a needs analysis through interviews with teachers and the distribution of questionnaires to teachers and students.

The analysis of teacher needs is carried out through direct interviews with chemistry teachers to understand the views of the modules to be developed and the curriculum used. The results of the interviews show that the commonly used learning media include worksheets, PowerPoint, quizzes, and YouTube. Despite knowing Google Sites as an educational platform, teachers rarely use it directly in learning. This is reinforced by the student questionnaire, where 86% stated that they have never used Google Sites-based audio-visual learning media.

Table 1. Student Needs Analysis Table

No.	Question Indicator	Percentage	Category
1.	I have a hard time understanding chemistry	78%	Strongly agree
2.	I have a hard time understanding acid-base material	73%	Agree
3.	I often use textbooks to understand chemistry materials	77%	Strongly agree
4.	Chemistry books have an attractive look	67,6%	Agree
5.	The display in the chemistry book made it easier for me to understand chemistry material	61%	Agree
6.	I often use computers/laptops/smartphones to make it easier for me to understand chemical materials	79,4%	Strongly agree
7.	I like learning media where there are pictures to explain the concept of the material	81,9%	Strongly agree
8.	I like learning media where there are videos to explain the concept of the material	86,3%	Strongly agree

9.	I like learning media where there are animations to explain the concept of the material	84,3%	Strongly agree
10.	I like learning media where there is a virtual lab to explain the concept of the material	80,4%	Strongly agree
11.	I love learning media that comes with columns to collect assignments and exercises.	78,9%	Strongly agree
12.	I am interested in learning media that provides video games related to learning materials as entertainment	80,9%	Strongly agree
13.	I need a learning medium in which there are practice questions and how to solve them	84,8%	Strongly agree
14.	I need a digital learning medium that can	82,8%	Strongly agree
	used anywhere independently		
15.	I already know web-based interactive multimedia and have used it	60,8%	Agree
16	I am interested in using interactive websites that contain text, videos, entertainment, and virtual labs to help me understand the material	83,8%	Strongly agree
Average		77,56%	

Second, analysis of student characteristics, this is carried out through the analysis of the results of the needs questionnaire which is distributed in the form of *Google Form*. Based on the results of the questionnaire, an overview was obtained of several characteristics of students at SMA Nusantara Plus, namely that most students have difficulty understanding chemistry materials, including the topic of acid-base, because of the unattractive appearance of textbooks. Conform to Lumadya & Wiyarsi (2024), many students experience misconceptions on the concepts of acid-base, pH, and ion balance in solution.

Instead, they are interested in digital media that contains images, videos, animations, virtual labs, as well as features such as practice questions, assignment columns, and educational games that can be accessed flexibly. Students are also interested in interactive websites that contain materials, exercises, and virtual labs, in line with Squirt (2023) which states that website-based learning media can help students.

Third, concept analysis is a crucial step in designing meaningful chemistry learning, as it helps to understand the structure and relationships between concepts. According to Herron (1977), concept analysis includes definitions, labels, attributes, types, positions in the hierarchy of knowledge, as well as examples and non-examples. A systematic understanding of these elements allows for a more directed, logical, and appropriate delivery of material for students' cognitive abilities.

Table 2. Concept Analysis Table

Elements of Analysis	Description	
Concept Labels	Acids and Bases	
Concept Definition	An acid is a substance that in solution releases H^+ ions and has a pH of less than 7. A base is a substance that in solution releases OH^- ions and has a pH of more than 7. This definition can be explained based on the theories of Arrhenius, Brønsted-Lowry, and Lewis according to the level of cognitive development of the student.	
Concept Type	Abstract concepts with concrete examples. The concept of acids and bases is abstract because it involves the ionization and transfer of protons or electrons that cannot be observed directly, but examples of substances such as vinegar or soap are easily recognizable in everyday life.	
Concept Attributes	**Critical Attributes:**	• Acid releases H^+ • Release language OH^- • Have a pH of < 7 (acidic) or > 7 (alkaline) • Indicates the color change indicator • Engage in neutralization reactions
	Variable Attributes:	• Acid/alkaline strength • Concentration of solution • Color and smell of substances
Concept Position	**Superordinates:**	Electrolyte and non-electrolyte solutions, chemical reactions
	Coordinates:	pH, indicator, titration
	Subordinate:	H^+ and OH^- ions, indicator color change, neutralization reaction
Example	**Acids:** HCl, H_2SO_4, CH_3COOH, Citric Acid **Base:** NaOH, KOH, NH_4OH, soapy water	
Non Examples	Pure water (neutral), sugar solution (non-ionized), oil (nonpolar), alcohol (does not produce H^+/OH^-), NaCl (is not acidic or alkaline in pure water)	

Fourth, task analysis is carried out with the aim of developing materials in designing Google Sites-based learning media on acid-base topics. Based on the results of the initial analysis, it is known that the curriculum used is the 2013 Curriculum. This is in line with Yolanda (2021) who stated that Google Sites can be used as a self-study resource that helps students. According to Islanda and Darmawan (2023), Google Sites allows the presentation of material in the form of text, images, videos, and practicum simulations, and has advantages such as ease of use, data efficiency, and light memory usage.

Fifth, the analysis of learning objectives was carried out to determine the focus of the research with several limitations: the learning media was developed using google sites and intended for grade XI high school students, the material developed was the topic of acid-base, the approach used was *Problem Based Learning* (PBL), and testing was carried out at SMA Nusantara Plus Ciputat. These restrictions ensure the focus and relevance of the data in accordance with the media development objectives.

3.2 Design

After the analysis stage, the research is continued to the design stage which focuses on the development of electronic modules. This process includes designing materials, validating materials, validating student response questionnaire instruments, and revising materials and instruments.

3.2.1 Validation of material assessment instruments, media, student and teacher responses

In the initial design stage, the researcher validated the assessment instrument which included material, multimedia, and student and teacher responses. This instrument is adapted from Sriadhi (2019) and Rati (2022). Conform to Pribowo (2018), the validation instrument functions to assess the level of media feasibility based on certain criteria.

In the material domain assessment instrument, the aspects assessed include information guides, multimedia content/materials, *Problem Based Learning* (PBL), and evaluation. In the domain of multimedia construction, the assessment aspects include information guidance, program performance, systematicism, aesthetics and design principles, and PBL. Meanwhile, the student and teacher response questionnaire assessed aspects of information guidance, content, evaluation, media design and facilities, as well as pedagogical effects.

Table 3. Research Instrument Validation Table

No.	Rated instruments	Validator	Score	Percentage	Criterion
1.	Content/Material Assessment Instruments	Validator 1	1	94%	Worth Using
		Validator 2	1	100%	Worth Using
2.	Multimedia Construction Assessment Instrument	Validator 1	1	96%	Worth Using
		Validator 2	1	76.2%	Worth Using
3.		Validator 1	1	91.3%	Worth Using

	Student & Teacher Response Test Questionnaire	Validator 2	1	95.2%	Worth Using

3.2.2 Design/*storyboard creation*

In designing media based on *Google Sites*, the next step is to compile a Design/Storyboard that contains acid-base material. This storyboard will be a guide in the development of learning media.

The initial stage of design is the preparation of materials, which is done by collecting sources from books, journals, articles, and other references. The preparation of website pages is adjusted to the learning stages using the model Problem Based Learning (PBL). The website consists of a home page, materials, PBL case studies, virtual labs, practicums, and about the author. This structure supports learning flexibility while maintaining regularity (Herwina, 2021).

The material pages on the website are separated from the PBL model so that students can understand the concept of acid-base independently first. This approach is in accordance with Kalyuga (2011) and Irwansyah & Retnowati (2019), which emphasizes the importance of reducing cognitive load by avoiding split attention and redundancy effects, especially for students with limited initial knowledge.

Multimedia in this study integrates acid-base material with a student-centered PBL model and authentic problem solving (Barret, 2017). Reading materials are focused on real cases, such as the use of acid-base in households or industries. This is in line with Suginem (2021), which states that PBL encourages student-centered exploration, investigation, problem-solving, and evaluation to increase interest in learning.

This website is designed using Canva to create an attractive and easy-to-understand visual look. Conform to Princess (2024)Canva supports visual learning through intuitive design, font variation, and color, making it effective for creating posters, infographics, and presentations. In addition to designing materials with Canva, the selection of case studies is also crucial in the development of this website. Case studies from Mufhtih et al. (2021) It is used because it is relevant to daily life, such as the application of acid-base in industry and households, thus stimulating students' critical thinking.

To improve the quality of learning, the questions are improved to be more challenging and based on real situations. Conform to Ardianti et al. (2021), PBL links learning to real-world problems to develop critical thinking skills, helping students connect theory with practice more effectively. After improvising questions and strengthening PBL, the PHET virtual laboratory was used for interactive experiments without physical tools. PHET helps to understand the concept of acid-base safely and practically. In line with research Rizaldi et al. (2020) and (Muyasaroh et al., 2025) These simulations are effective in visualizing complex concepts, increasing understanding, interest, and motivation to learn, and providing a real laboratory-like experience.

To make learning more effective, PHET practicum modules are structured with step-by-step instructions to help students connect theory and practice. This module encourages observation, data-driven decision-making, and critical thinking. Defianti et al. (2021) states that PHET and structured practicum procedures enrich the learning experience and enhance understanding of acid-base concepts through hands-on exploration.

3.2.3 Design/*storyboard validation*

After the design is prepared, validation is carried out to ensure that the teaching materials have a clear structure and are in accordance with the learning objectives. Storyboards include visual, text, and interactive elements, structured around learning design principles to be engaging and easy to understand.

The validation involved two subject matter experts who assessed the storyboard on a Likert scale without a 'hesitation' category to improve clarity (Kurnianto & Kharisudin (2022). The validation results showed an average score of 94.2% (Very Feasible), signifying the chemistry content in the storyboard-based storyboard Google Sites ready to be further developed.

Table 4. Design Validation Table

Plan to Build *Google Sites Learning Media*	**Expert Validators**	
	Validator 1	**Validator 2**
Design and Build Materials	196	211
Total Percentage	90.75	97.7%
Total Average	94.2%	
Criterion	Highly Worth It	

3.3 Development

The development phase in creating Google Sites-based learning media includes design, validation, and revision. Its main focus is media creation, content validation and construction, and improvement based on validation results to ensure its quality and fit for learning objectives.

3.3.1 Prototyping *Google Sites Learning Media*

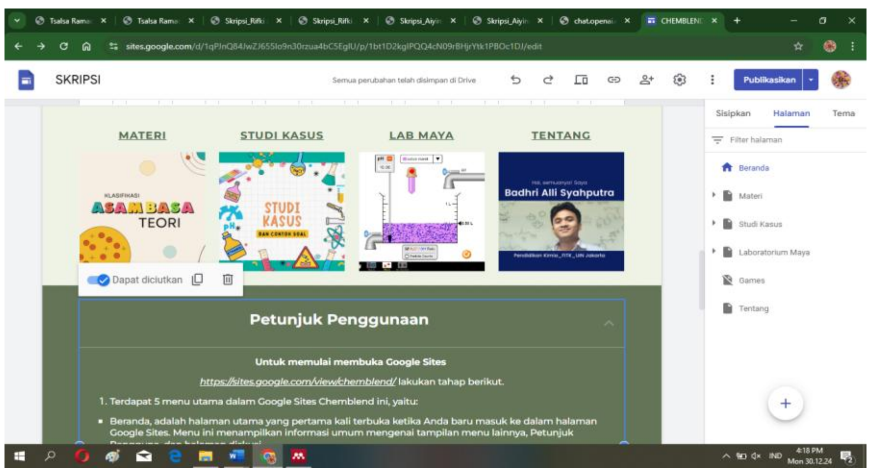
In the development stage, Google Sites-based learning media includes five main sections: 1) home, 2) materials, 3) case studies, 4) virtual labs, and 5) about authors. Each section is designed to be attractive and easy to use. The following is a view of the developed learning media.

3.3.1.1 Home Page

Creating interactive multimedia based on *Google Sites* starts with designing a compelling home page using Canva's design, containing a title, Basic Competency (KD), and learning objectives.

Picture 2. Home Page (1)

Picture 3. Home Page (2)



The Home page comes with instructions for use and a discussion column. Instructions help students understand how to use interactive multimedia, while discussion columns become a space for interaction between students and teachers.

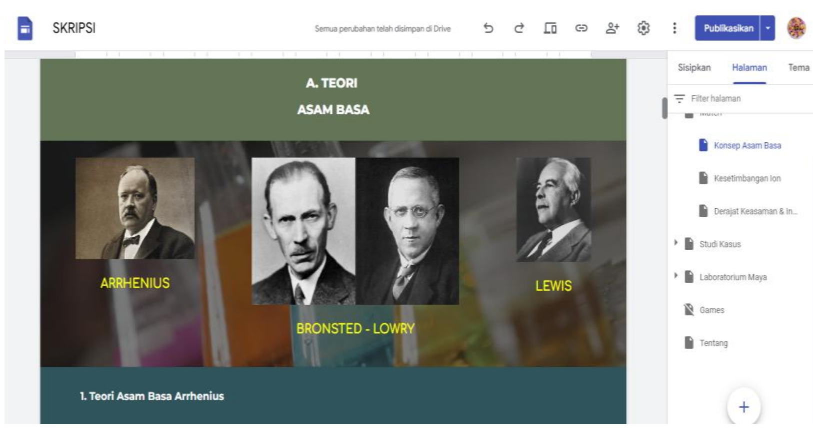
3.3.1.2 Material Page

This page consists of one main page and three subpages. The main page of this learning material includes an introduction to the material, basic competencies and indicators of the material to be studied.

Picture 4. Material Pages (1)

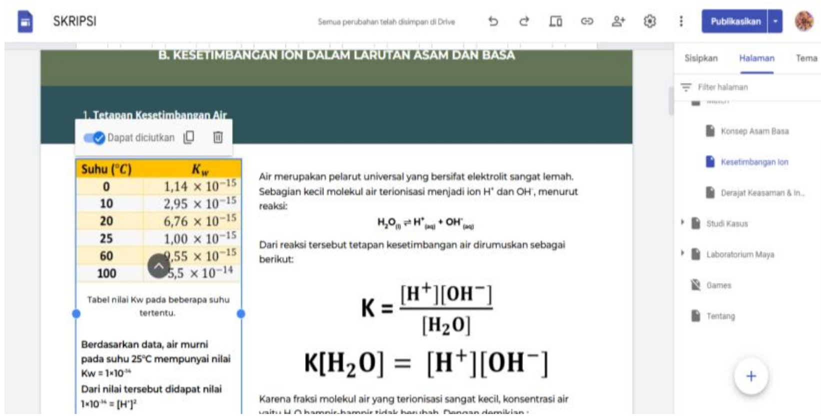
The "Concept of Acid-Base" subpage contains the theories of Arrhenius, Bronsted-Lowry, and Lewis, along with examples of formulas and analysis of their limitations. At the end of the page, there is a learning video with interesting explanations, complete with playback sounds and images.

Picture 5. Subpage: Concept of Acid-Base



The sub-page "Ion Equilibrium in Acid-Bases" discusses the process of ion equilibrium in acidic and alkaline solutions, complete with examples of pH calculations and equilibrium constants (Ka and Kb). The analysis also includes factors that affect equilibrium, such as concentration and temperature.

Picture 6. Sub Page: on Equilibrium



The sub-page "Acidity Degree and Acid-Base Indicator" discusses the concept of pH as a measure of acidity degree and its use in determining the acidic or alkaline properties of a solution, complete with an example calculation. In addition, various indicators of acid-base and color changes that occur in certain pH ranges are explained.

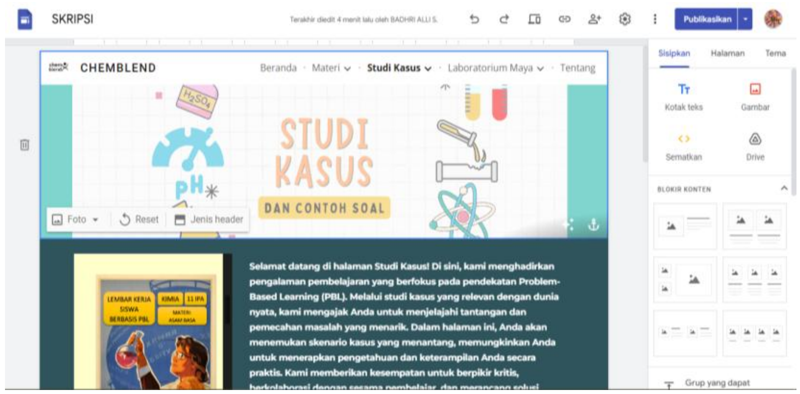
Picture 7. Subpage Acidity Degree & Acid-Base Indicator

3.3.1.3 Case Study Page

The "Case Study" page presents the application of the concept of acid-base in everyday life through real case studies. Users can understand acid-base reactions as well as their applications, supported by *Problem Based*

Learning (PBL)-based worksheets to analyze and solve problems in a practical way.

Picture 8. Case Study Page



3.3.1.4 Virtual Lab Page

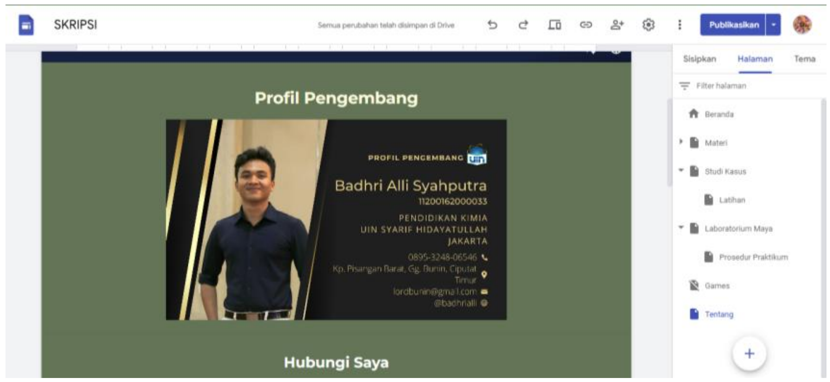
The "Virtual Laboratory" page presents a virtual acid-base practicum equipped with Basic Competencies (KD) and achievement indicators. Users are guided with clear practicum procedures through PHET interactive simulations, allowing experiments without physical equipment.

Picture 9. Virtual Lab Page

3.3.1.5 About Author Page

The "About the Author" page contains background information, the purpose of the writing, and the author's motivation in developing the website. This page introduces the author to the user and describes the experiences and expectations for the development and positive impact of this learning medium.

Picture 10. About Author Page



3.3.2 Validation of learning media by material experts and media experts

The next step after the preparation of the material is to validate the material based on the instrument that has been determined. In this study, material validation was carried out using instruments from Sriadhi (2019) and Rati (2022).

Table 5. Material Validation Table

No.	Aspects	Expert Validator Lecturer		Total Percentage	Category
		Validator 1	Validator 2		
1.	Guidelines and Information	87.5%	93.75%	90.63%	Highly Worth It
2.	Multimedia Content/Materials	85%	95%	90%	Highly Worth It
3.	Problem Based Learning (PBL)	90%	100%	95%	Highly Worth It
4.	Evaluation	85%	90%	87.5%	Highly Worth It
Percentage		**86.88%**	**94,69%**	**90.79%**	**Highly Worth It**

The next stage in this study is to validate the media. This validation process was carried out by media experts using assessment instruments from Sriadhi (2019) and Rati (2022).

Table 6. Media Validation Table

No.	Aspects	Expert Validator Lecturer		Total Percentage	Category
		Validator 1	Validator 2		
1.	Guidelines and Information	100%	87.5%	93.75%	Highly Worth It
2.	Program Performance	91.7%	87.5%	89.6%	Highly Worth It
3.	Systematics, Aesthetics, and Design Principles	96.2%	92.3%	94.25%	Highly Worth It
4.	Problem Based Learning (PBL)	100%	95%	97.25%	Highly Worth It
Percentage		**96.98%**	**91.25%**	**93.71%**	**Highly Worth It**

3.4 Disseminate

The next step is the implementation of Google Sites-based learning media *for* students and teachers. This process is carried out by distributing response questionnaires to teachers and students to find out the responses or reactions to the learning media that has been developed.

3.4.1 Test Student and Teacher Response

Google *Sites-based learning media* that has been developed and validated by experts is then tested on students. This trial involved 59 students from class XII of MIPA at SMA Nusantara Plus. The purpose of this trial is to find out the students' responses to the learning media that has been developed.

Table 7. Student Response Test Table

No.	Aspects	Average percentage	Criterion
1.	Guidelines and Information	92.11%	Highly Worth It
2.	Multimedia Content/Materials	89.99%	Highly Worth It
3.	Evaluation	88.16%	Highly Worth It
4.	Media Design and Facilities	90.01%	Highly Worth It
5.	Pedagogical Effect	90.24%	Highly Worth It
Average		**90.1%**	**Highly Worth It**

After the implementation to the students, the next step is to test the implementation to the teacher. This limited trial involved one teacher from SMA Nusantara and one teacher from SMA Darussalam. The purpose of this trial is to find out the teacher's response to the electronic module that has been developed.

Table 8. Teacher Response Test Table

No.	Aspects	Average percentage	Criterion
1.	Guidelines and Information	100%	Highly Worth It
2.	Multimedia Content/Materials	97,92%	Highly Worth It
3.	Evaluation	91,67%	Highly Worth It
4.	Media Design and Facilities	97,22%	Highly Worth It
5.	Pedagogical Effect	100%	Highly Worth It
Average		**97,6%**	**Highly Worth It**

In this study, there are several aspects that are assessed. These aspects include the Guidance and Information aspect, the aspect of Multimedia Material, the aspect of Evaluation, Media Design and Facilities, and the aspect of Pedagogical Effects. By testing these aspects to students and teachers, researchers can obtain relevant data to evaluate and improve previously developed learning media.

The Guide and Information aspect includes clarity of instructions for the use of learning media, intuitive navigation structure, and the integration of the information presented. This aspect received an assessment score of 92.10% from students and 100% from teachers.

The Multimedia Material aspect assesses the suitability of the content with the curriculum, the accuracy of information, and the effectiveness of the use of multimedia elements such as text, images, audio, and video in supporting concept understanding. The material presented must be interesting and fun so that students stay motivated. In addition, the material needs to be arranged as optimally as possible to support good learning outcomes and achieve learning objectives (Sunarti, 2021). This aspect received an assessment score of 89.98% from students and 97.92% from teachers.

The developed multimedia was designed by integrating the syntax of the Problem-Based Learning (PBL) model into the learning process. Students begin learning by identifying contextual problems related to acid-base phenomena encountered in daily life. They are then guided to formulate problems, collect relevant information from the learning materials provided in Google Sites, conduct virtual laboratory activities using PhET simulations, discuss possible solutions through student worksheets, and finally evaluate the obtained solutions. The integration of these activities enables students not only to understand theoretical concepts but also to develop systematic problem-solving skills throughout the learning process.

The Evaluation aspect focuses on the quality of the evaluation instruments available in the learning media, including the suitability of practice questions, quizzes, and feedback given to students to support the understanding of the material. Learning evaluations that are compiled in a systematic, directed, and in accordance with quality standards can play an important role in improving student learning outcomes (Iskandar & Rasmitadila, 2024). This aspect received an assessment score of 88.15% from students and 91.67% from teachers.

The Design and Media Facilities aspect assess the layout, color selection, typography, and user interface so that the learning media is attractive and easy to use. In addition, this aspect also includes ease of access and media compatibility with various devices. The main challenge in the development of interactive learning media does not only lie in the use of advanced technology. Researchers need to ensure that the media developed is aligned with the learning objectives and the material being taught. Each interactive element should be designed to support the achievement of learning objectives as well as assist students in achieving expected competencies (Utomo, 2023). This aspect gets an assessment score of 90% from students and 97.22% from teachers.

In classroom implementation, the developed media is intended to be used as the main learning platform during acid-base instruction. Teachers act as facilitators by guiding students through each stage of the PBL process embedded in Google Sites. Students can access learning materials, videos, virtual laboratory simulations, worksheets, and evaluation activities sequentially according to the PBL stages. This implementation allows learning to become more student-centered while encouraging active participation, collaboration, and independent problem-solving.

The Pedagogical Effect aspect measures the extent to which learning media can increase student engagement, encourage critical thinking, and support the model Problem Based Learning (PBL) effectively. The use of learning media in the teaching and learning process can develop new interests and desires, motivate and even bring psychological influence on learning (Wulandari et al., 2023). This aspect received an assessment score of 90.24% from students and 100.00% from teachers.

This high score indicates that students perceived the multimedia elements to be relevant and helpful in understanding abstract acid-base concepts. The integration of videos, interactive images, and virtual laboratory simulations enabled students to visualize microscopic chemical processes that are difficult to observe directly. Furthermore, embedding these multimedia components within the PBL stages encouraged students to explore information independently before proposing solutions to contextual problems.

4. Conclusion

This research aims to develop Google Sites web-based learning media that is integrated with *the Problem-Based Learning* (PBL) model on acid-base materials. Based on the results of the research that has been submitted, the development of this media is carried out using a 4D model which consists of the following stages:

1. **Define:** At this stage, a need analysis was carried out to identify the importance of developing Google Sites web-based learning media that is integrated with PBL on acid-base materials to support the learning process.

2. ***Design*:** This stage includes designing acid-base materials, creating web display and structure designs on Google Sites, and drafting questionnaire instruments to measure student and teacher responses.

3. **Develop:** At this stage, the learning media is validated by two subject matter experts and two media experts. The validation results showed that the feasibility of the material reached 90.79% with the category "Very Feasible," while the feasibility of the media obtained 93.75% with the same category. Therefore, this learning media is declared feasible to be implemented.

4. ***Disseminate*:** The Google Sites web-based learning media was applied to two chemistry teachers and 59 grade XI students at SMA Nusantara Plus Ciputat. The results of the students' responses showed a feasibility rate of 90.1%, while the teacher's response reached 97.6%, both in the category of "Very Feasible." Based on the results of the trial, this learning media received a positive response from all participants, and no revisions were considered necessary.

5. Aknowledgments

We thank you for your invaluable support and to the research school for providing the resources. We also thank all parties who made this research possible.

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