



# Development of an Acid-Base E-Module Based on Guided Discovery Learning with Ethnoscience Content to Improve Literacy and Numeracy

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**Abstract:** This research aims to develop a chemistry learning e-module for acids and bases based on guided discovery learning, incorporating elements of ethnoscience to improve students' literacy and numeracy. The guided discovery learning approach was chosen to encourage students to actively construct knowledge through guidance, while the integration of ethnoscience aims to link chemistry concepts with local wisdom to increase student relevance and understanding. The research method used was Research and Development (R&D) with the 4D development model (Define, Design, Develop, Disseminate). The research instruments included an expert validation sheet, a student response questionnaire, and literacy and numeracy tests. The validation results indicated that the e-module was highly feasible in terms of content, presentation, and language. A limited trial demonstrated significant improvements in students' literacy and numeracy skills after using the e-module. Therefore, this e-module is effective as an alternative learning medium for contextual and meaningful chemistry learning.

**Keywords:** Acids-bases; E-module; Ethnoscience; Guided discovery learning; Literacy; Numeracy

## Introduction

Education is a key pillar in a nation's development. In Indonesia, the Independent Curriculum (Kurikulum Merdeka) has been introduced as an effort to improve the quality of learning in schools. The Independent Curriculum is an education policy aimed at giving schools and teachers the freedom to develop curricula tailored to student needs and local contexts (Tuerah & Tuerah, 2023).

Literacy and numeracy are key focuses in the development of the independent curriculum (Wahyudin et al., 2024). However, the 2022 results from the Programme for International Student Assessment (PISA) indicate that Indonesia is in the low-performance, high-equity quadrant. The average reading literacy score for Indonesian students is 359, and the average numeracy score is 366. These results are lower than the average score for OECD countries, which is 487 (OECD,

2023). Therefore, it is important to strive for the development of literacy and numeracy, especially in the field of science such as chemistry, because towards 21st century education, literacy and numeracy skills are important skills that students must have to be able to solve problems in everyday life by thinking critically and logically.

Chemistry is a field of science closely related to everyday life, especially for students (Waruwu & Sitinjak, 2022). However, many students struggle to understand chemistry because it tends to be abstract and complex (Basit et al., 2023). As a result, chemistry is often considered a difficult and boring subject, making it one of the least popular subjects among students (Muderawan et al., 2019).

One of the chemistry topics taught to students in the F phase of high school (SMA/MA) is acids and bases. This material is relevant to everyday life, as many materials in the surrounding environment are acidic or

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basic. By utilizing elements of local wisdom, students can learn through real-life examples, thereby increasing interest and motivation to learn.

Ethnoscience is a learning method that uses local knowledge as a source and object of learning, which can be integrated into contextually presented lessons (Lidi et al., 2022). Ethnoscience-based learning processes derived from local wisdom are crucial so that students can integrate indigenous knowledge from their communities into the science taught at school.

Interviews with teachers at SMAN 1 Solok, SMAN 2 Solok, and SMAN 1 Kubung revealed several problems. First, the student-centered learning process has not been optimally implemented. Second, teachers still lack the skills and expertise to utilize technology, which is essential in the 21st century. Third, the teaching materials used for acid-base topics have not been connected to local culture. Fourth, students have low motivation in learning chemistry, which makes it difficult for them to understand the acid-base material. According to the chemistry teacher, it is important and necessary to develop teaching materials that utilize technological advances with ethnoscience content in learning activities to better understand local culture, making learning contextual and relevant to them.

According to Hasibuan (2022), the concepts of local wisdom and independent learning share the same goal in Indonesian education: to provide educational institutions with the freedom to maximize student potential while adapting to their characteristics. Teaching materials equipped with ethnoscience-based learning models are necessary for students to gain a better understanding of chemical concepts and to gain an understanding of culture and its relationship to everyday life, thus fostering an understanding that chemistry is closely related to everyday life (Andayani et al., 2021).

A questionnaire completed by 97 students from SMAN 1 Solok, SMAN 2 Solok, and SMAN 1 Kubung showed that the teaching materials used consisted of 23.1% PowerPoint presentations, 37.9% printed books, 4.7% modules, 15.4% animated videos, 42.8% student worksheets, and 4.1% other teaching materials. The learning process is dominated by printed teaching materials, even though teaching materials are not limited to printed books and worksheets. Digital-based teaching materials, such as electronic ones, can also be used. Nowadays, electronic-based teaching materials, commonly known as e-books or e-modules, can be easily obtained with networked devices (Pratiwi et al., 2023). According to Rahayu & Solihat (2019), e-modules are learning resources focused on a specific topic and packaged in web format, allowing them to be studied anytime and anywhere via the internet or specific

websites. The development of e-modules requires innovation based on learning models.

Learning in the independent curriculum is implemented through various learning models that encourage students to actively discover concepts and be motivated to learn. One model used is guided discovery learning. Through guided discovery learning, students are guided to actively observe, express opinions, discuss, ask questions, and answer questions. The teacher acts as a facilitator to help students use previously learned ideas, concepts, and knowledge to acquire new knowledge (Anda, 2022).

The development of an acid-base e-module based on guided discovery learning and ethnoscience is a highly potential teaching material for improving students' literacy and numeracy skills. Previous research by Rahmi & Yerimadesi (2022) demonstrated that an e-module on acid-base titration based on guided discovery learning was effective in improving student learning outcomes. Further research by Puspaningrum et al. (2022) demonstrated that the development of an e-module on multi-representation electrolyte-nonelectrolyte solutions integrated with ethnoscience was highly feasible, practical, and effective in improving conceptual understanding. This study demonstrates that developing e-module teaching materials that can be integrated into learning models and complemented with ethnoscience insights in chemistry learning can assist in the formation of a Pancasila Student Profile in accordance with the independent curriculum.

## Method

The type of research used in this study is development research, commonly known as Research and Development (R&D). R&D is a research method used to produce a specific product and test its effectiveness (Sugiyono, 2013).

The acid-base e-module was designed using the 4-D development model. The 4-D development model consists of four main stages: Define, Design, Develop, and Disseminate. The developed product was then tested for feasibility using validity, practicality, and effectiveness tests.

### *Research Procedure*

The research and development steps used a modification of the development model (Thiagarajan, 1974), known as the 4-D. The 4-D research procedure involves several stages. These stages are as follows.

#### *Define Stage*

The define stage involves analyzing and gathering learning needs related to the product to be developed.

Thiagarajan (1974) mentions five activities that can be carried out at the define stage, including:

#### *Front-end Analysis*

This analysis is conducted to identify and determine the underlying problems encountered in learning, thus underpinning the need for development. By conducting an initial analysis, researchers/developers obtain a factual overview and alternative solutions. This analysis is conducted through interviews with teachers and questionnaires completed by students related to learning problems and the teaching materials used in chemistry lessons. This can help in determining and selecting learning tools to be developed.

#### *Learner Analysis*

Learner analysis is the activity of identifying the characteristics of students targeted for learning tool development. These characteristics relate to academic ability, cognitive development, motivation, and individual skills related to the learning topic, media, format, and language.

#### *Task Analysis*

This analysis is conducted to identify the competencies that students must achieve to master the material being studied. This task analysis is guided by the independent curriculum, which contains learning outcomes (CP) and subject matter. Learning Objectives (TP) are then formulated for the material to identify the competencies that must be achieved after the learning process.

#### *Concept Analysis*

Concept analysis aims to determine the main concepts to be taught in the acid-base material, then arrange them hierarchically and present them in a concept analysis table.

#### *Specifying Instructional Objectives*

Learning objectives are formulated by reducing the learning outcomes to the learning objectives identified in the task analysis stage. The results of this learning objective analysis become the objectives to be achieved in the learning process. The results of this analysis will be used by researchers to determine what topics will be presented in the e-module.

#### *Design Stage*

The design stage aims to create an acid-base e-module based on guided discovery learning and ethnosience content that can be used in chemistry lessons. There are four steps in the design stage, including:

#### *Constructing Criterion-Referenced Test*

The test is the step that connects the define and design stages. In this stage, researchers will develop validation instruments to test the feasibility and effectiveness of the product and develop test instruments to assess students' process skills (Sugiyono, 2019).

#### *Media Selection*

This stage is conducted to identify learning media that are appropriate to the characteristics of the material. Media selection is based on the results of the concept analysis and task analysis of the characteristics of the students as product users. This is useful for helping students achieve the expected learning objectives and apply the concepts they have learned in real-world contexts.

#### *Format Selection*

Format selection is carried out to ensure that the developed e-module meets the needs of students and allows for the formulation of learning media, selected learning strategies, approaches, methods, and learning resources.

#### *Initial Design*

This stage is the overall design of the learning device that must be completed before the trial is conducted. This design includes various structured learning activities and the practice of different learning skills through teaching practices (microteaching).

#### *Development Stage*

The development stage is the realization stage of all components designed in the previous stage.

#### *Validity Test*

Before the trial is conducted, a validity test is conducted to determine the validity of the developed acid-base e-module. The validity test is conducted by experts to assess the product's feasibility based on the criticism, input, and suggestions provided. The acid-base e-module based on guided discovery learning with ethnosience content is assessed by material and media experts. Then, revisions are made. This revision stage aims to improve parts of the acid-base e-module based on guided discovery learning with ethnosience content that were deemed inappropriate by the validators before the trial. Revisions were stopped if the validator declared the developed acid-base e-module based on guided discovery learning and containing ethnosience valid.

### *Practicality Test*

This trial aimed to determine the practicality of the teaching materials in the form of an acid-base e-module based on guided discovery learning. This practicality test was conducted by administering a practicality test questionnaire to chemistry teachers and students.

### *Effectiveness Test*

The effectiveness test was conducted by testing two classes: one experimental class and one control class. The effectiveness test was also conducted by administering pretest-posttest questions to the experimental and control classes to determine students' literacy and numeracy.

### *Dissemination Stage*

Thiagarajan (1974) divided this stage into three activities: validation testing, packaging, diffusion, and adoption. Validation testing is the process of implementing the revised product during the development stage to the actual target audience. Packaging, diffusion, and adoption are the packaging of the teaching materials for dissemination for absorption and understanding by others on a large scale.

This stage involves using the developed tools on a broader scale, for example, in other classes, other schools, or by other teachers. Furthermore, research articles are published in indexed journals. This stage ensures that the resulting product can be utilized by others.

## **Result and Discussion**

The resulting product of the research is an acid-base e-module based on guided discovery learning with ethnoscience content to improve literacy and numeracy in high school (SMA/MA) students. The research was conducted as a research and development (R&D) study using a 4-D model consisting of define, design, develop, and disseminate. After completing the development stages, the validity, practicality, and effectiveness of the developed acid-base e-module were determined. The results are described as follows.

### *Define Phase Results*

In this stage, the researcher conducted a needs analysis by gathering as much information as possible. The goal was to obtain a general overview of the school, including an overview of learning methods and problems encountered in the classroom. There were five activities carried out at this stage.

### *Front-End Analysis*

The front-end analysis phase was conducted through literature review and interviews with Febrinar

Isnawati, S.Pd. (a teacher at SMAN 1 Solok), Marisha Arlen, S.Pd. (a teacher at SMAN 2 Solok), and Suci, S.Si., M.Pd. (a teacher at SMAN 1 Kubung). The main topics discussed in the interviews were classroom learning activities, media used, learning resources, and facilities used for the learning process.

Based on the initial analysis, information obtained indicated that the teaching materials used in schools were predominantly printed textbooks from publishers that had not yet been integrated with digital technology. The teaching materials used were not equipped with learning models, thus not facilitating student independent learning. Furthermore, students tended to still use lectures for chemistry material delivery, although some materials utilized discussion and question-and-answer methods.

A challenge encountered during the chemistry learning process for acids and bases is that students are unable to apply their acquired concepts to solve contextual problems related to acids and bases in everyday life.

Good teaching materials are those that can be used anytime and accommodate students with different learning styles. Therefore, this presents an opportunity to develop teaching materials using technology to stimulate learning interest and implement student-centered learning.

### *Learner Analysis*

The learner analysis stage is conducted to determine students' motivation and academic abilities, and to identify challenges they encounter during the learning process. This can be determined by distributing questionnaires to students. The questionnaires were completed by 12th-grade high school students from several schools that have studied acids and bases. The results of the student questionnaire analysis can be seen in Appendix 8. Based on the data analysis, it was found that: (a) the teaching materials used were not yet practical and had not been packaged in an attractive display, (b) the learning methods frequently used by teachers during the learning process were group discussions at 33.0%, lectures at 57.7%, and questions and answers at 9.3%, (c) the use of teaching material sources frequently used were power point at 23.1%, printed books at 37.9%, animated videos at 15.4% and LKPD at 14.8%.

Students are allowed to use smartphones to access digital technology-based teaching materials during their learning process. Nearly all students can operate smartphones, as evidenced by the results of a questionnaire distributed to students, which showed that 100% of students can operate smartphones. Smartphones can be utilized in the learning process as

an innovation due to technological advances, particularly in education (Puspitasari, 2019).

Based on data collected from the questionnaire distributed to students, it is clear that teaching materials must be tailored to the students' needs. Furthermore, the teaching materials used have not yet utilized technology as an innovation in learning. Consequently, the teaching materials must be in the form of electronic modules. The material used to develop this e-module is acid-base material.

#### *Task Analysis*

The task analysis phase aims to identify learning outcomes in the acid-base topic. The learning outcomes analyzed are those in Phase F, where students are required to be able to use acid-base concepts in everyday life. The learning objectives achieved after analyzing the learning outcomes are: (a) students will be able to explain acid-base theories according to Arrhenius, Bronsted-Lowry, and Lewis; (b) students will be able to identify several acid-base solutions using natural and artificial indicators; and (c) students will be able to calculate the degree of acidity (pH), degree of ionization, and acid-base equilibrium constant.

#### *Concept Analysis*

The concept analysis phase is conducted by tabulating important concepts in the acid-base topic to identify concept labels, concept definitions, concept types, characteristics, concept positions, facts, and principles. This concept analysis is organized into a concept map. A clear learning map can help students organize the information needed in the learning process, preventing misconceptions in the learning material (Aprillita et al., 2025). The results of the concept analysis can be seen in Appendix 2, and the concept map can be seen in Appendix 1.

#### *Formulating Learning Objectives (Specifying Instructional Objectives)*

The stage of formulating learning objectives (Specifying Instructional Objectives) involves developing a learning objective flow, derived from formulating the learning objectives. The flow of learning objectives for acids and bases is as follows: a) Students are able to explain the concepts of acids and bases according to the theories of Arrhenius, Bronsted-Lowry, and Lewis and their applications in everyday life; b) Students are able to identify several acid and base solutions using various indicators; c) Students are able to calculate the degree of acidity (pH), degree of ionization, and acid-base equilibrium constant. Learning objectives are used in the learning process to facilitate student mastery of the material, particularly in this case, acid-base material.

#### *Design Stage*

The second stage in the 4-D development model is the design stage. This stage aims to design an e-module based on guided discovery learning for acid-base material, tailored to the analysis results presented in the define stage. The following activities will be carried out in the design stage.

#### *Developing a Standard Test (Constructing a Criterion-Referenced Test)*

The development of a standard test at this stage consists of three parts: testing product feasibility, product practicality, and student understanding. The instrument used to test student validity and practicality is a questionnaire. Furthermore, to test student understanding, a test instrument in the form of 16 multiple-choice questions is used. This test aims to measure student understanding and learning outcomes in acid-base material.

#### *Media Selection*

Media selection is the activity carried out to choose media that aligns with the characteristics and needs of Phase F high school/Islamic high school students. The learning media developed is electronic teaching materials in the form of an e-module based on guided discovery learning. The e-module was developed using guided discovery learning syntax, which is expected to guide students to be active in learning activities. The material presented in the e-module is presented in video and audio formats. Learning activities that utilize audio and video can alleviate boredom in understanding the material, thereby helping students improve their learning outcomes (Khairani et al., 2019).

#### *Format Selection*

The format selection stage aims to develop the learning media design, model selection, and learning approach. The format chosen for e-module development adheres to the writing structure established by the Ministry of National Education in 2008, namely: 1) cover, 2) introduction, 3) learning, 4) exercises, 5) self-assessment, 6) evaluation, 7) answer key, 8) glossary, 9) and bibliography. The e-module includes images, text, and videos to explain the content. Furthermore, the e-module incorporates a guided discovery learning syntax incorporating Minangkabau ethnoscience. The material contained in the e-module is linked to three cultures found in Minangkabau.

#### *Initial Design*

The e-module was designed using Canva and then converted using the Heyzine flipbook app. The material contained in the e-module is linked to Minangkabau culture.

*Development Stage*

After the e-module definition and design stages are completed, the next step is the development stage. The development stage involves several steps, including testing the validity, practicality, and effectiveness of the guided discovery learning-based e-module on acid-base material with ethnosience content for Phase F of Senior High School (SMA/MA). The development stages of the acid-base e-module that have been completed are as follows.

*Validity Test Results*

The validation step is carried out by an assessment by validators based on a questionnaire that has been created and adapted to the aspects of the e-module. The validators for this validity test consist of three chemistry lecturers and two chemistry teachers. The validity test consists of four aspects: content appropriateness, language, presentation, and graphics. The validation results are processed using the Aiken's V formula (Aiken, 1985). The results of the validation questionnaire assessment can be seen in Appendix 14. The data processing can be seen in Appendix 15. The results of the e-module validity data analysis can be seen in Table 1.

**Table 1.** Results of the E-Module Validity Data Analysis

Assessed Aspects	Value	Categories
Content Components	0.85	Valid
Language Components	0.88	Valid
Presentation Components	0.89	Valid
Graphic Components	0.87	Valid
Programming Aspects	0.89	Valid
Average	0.88	Valid

*Revision*

This stage aims to improve parts of the acid-base e-module based on guided discovery learning in accordance with the suggestions provided by the validator to perfect the developed e-module.

*Improved text color in the e-module*

Based on feedback from the validator, the text color in several sections of the e-module was deemed to lack contrast and make it difficult to read. Therefore, the text color was adjusted to better match the background and meet the principles of good readability.

*Practicality Test Results*

A practicality test of the Acids and Bases e-module based on Guided Discovery Learning with ethnosience content for Phase F of Senior High Schools (SMA/MA) was conducted to assess the practicality of the developed product. Practicality data were obtained through analysis of teacher response questionnaires to the e-module and questionnaire responses from 30 students at

SMAN 1 Solok. The results of the data processing from the practicality questionnaires administered to students and teachers. The results of the practicality analysis of the e-module obtained from 30 students are shown in Table 2.

**Table 2.** Results of the Practicality Analysis of the E-module by Students

Aspects Assessed	Value %	Categories
Ease of Use	85.3	Very Practical
Learning Time Efficiency	88.7	Very Practical
Benefits	87.1	Very Practical
Average Score	86.7	Very Practical

The results of the analysis of e-module practicality data obtained from three teachers can be seen in Table 3.

**Table 3.** Results of the analysis of e-module practicality data by teachers

Aspects Assessed	Value	Categories
Ease of Use	91.1	Very Practical
Learning Time Efficiency	93.3	Very Practical
Benefits	90.0	Very Practical
Average Score	91.5	Very Practical

These results indicate that the developed acid-base e-module received a positive response from students and teachers. This positive response from students can be seen from the percentage of correct answers. Based on the results of the practicality test, it can be concluded that the developed acid-base e-module based on guided discovery learning and ethnosience content is practical and can be used in the effectiveness phase.

*Effectiveness Test Results*

The effectiveness of the acid-base e-module based on guided discovery learning and ethnosience content in improving literacy and numeracy for high school (SMA/MA) students was assessed by comparing the learning outcomes of students in the experimental and control classes. Sampling was conducted using a cluster purposive sampling technique and analyzed using homogeneity and normality tests. The normality and homogeneity tests for determining the sample classes can be seen in Appendix 27 and Appendix 28. Based on this, class F.1.1 was selected as the experimental class and class F.1.2 as the control class.

The experimental class learned using the acid-base e-module based on guided discovery learning and ethnosience content, while the control class learned using conventional teaching materials. Effectiveness testing uses a learning outcomes test question instrument which includes 16 questions for literacy and numeracy tests. A pretest was given to students in both sample classes before learning began to determine the

students' initial abilities. Learning is carried out in each class according to the teaching materials that have been determined, then a posttest is carried out using the same questions.

The results of e-module testing on student literacy and numeracy can be seen in Appendix 29 and Appendix 30 and are summarized in Table 4.

**Table 4.** Literacy and Numeracy Ability Test Scores

Class	N	Pretest Average	Posttest Average	N-Gain Average	Categories
Experiment	30	55	89	0.76	High
Control	30	51	83	0.66	Medium

Based on Table 4, the N-Gain values for the experimental and control classes were 0.76 and 0.66, respectively, indicating that the average N-Gain values for both classes were considered high and moderate. The data shows that the N-Gain value for the experimental class was higher than the control class, indicating a difference before and after treatment. According to (Kristalia, 2021), the difference in the average N-Gain values between the control and experimental classes indicates a difference between the sample and experimental classes.

#### Discussion

The definition stage aims to identify and analyze fundamental problems in the field and find solutions to these problems. The results of the definition stage indicate that the teaching materials used in schools are mostly printed textbooks published by publishers. Digital technology has not been integrated with the subject matter. Furthermore, the learning model used is unstructured, resulting in teacher-centered learning that tends to focus on lecture methods. This results in students being less actively involved and experiencing difficulty connecting chemistry concepts, particularly acid-base concepts, to real-life contexts. This obstacle suggests that effective teaching materials must bridge theory with practice and engage students. According to Iranda & Darmana (2024), the lack of contextual and interactive teaching materials leads to students' lack of engagement in chemistry learning.

Selecting teaching materials that are appropriate to student characteristics is a strategic step in improving conceptual understanding and achieving learning objectives. According to Sagala (2013), teaching materials developed based on student needs and learning styles can increase active engagement and facilitate independent learning.

The analysis shows that students are permitted to use smartphones at school. Therefore, the use of electronic learning materials is an appropriate solution. E-modules enable a more flexible, independent, and interactive learning process and can accommodate various student learning styles. Features in e-modules, such as animations, simulations, interactive exercises, and digital quizzes, can strengthen the visualization of

acid-base concepts and facilitate understanding (Arsyad, 2017). The teaching materials are complemented by learning models to enhance the learning process.

This study aims to develop an acid-base e-module based on guided discovery learning with an ethnoscience content to improve student literacy and numeracy. The developed e-module is designed to encourage student participation in activities involving exploration, observation, and independent discovery of concepts. By using the guided discovery learning model, students not only passively receive information but also engage in the process of asking questions, investigating, and drawing conclusions, thus enabling active interaction between students and the learning materials. E-modules are effective in fostering active learning because they facilitate critical thinking and contextual problem-solving (Fadhilah & Yerimadesi, 2025).

In this design stage, the module is designed in accordance with the learning outcomes and objectives in line with the Merdeka Curriculum. The acid-base e-module, based on guided discovery learning and containing ethnoscience, is designed to improve students' literacy and numeracy.

The use of e-modules in learning not only increases flexibility and interactivity but also enhances students' literacy and numeracy skills (Sape et al., 2024). The integration of technology through e-modules allows students to access materials independently, visualize information better, and practice critical thinking skills through context-based practice problems.

The developed acid-base e-module is complemented by ethnoscience content drawn from the local wisdom of the people of West Sumatra, enabling students to understand chemical concepts in real-life contexts close to their culture. Some forms of ethnoscience integrated into this module include: the process of making gulo saka (traditional brown sugar), which involves pH changes during the heating and thickening of palm sap; The dyeing process for Minangkabau woven fabrics uses natural dyes with acidic or basic properties as color indicators; and the land preparation and cultivation of Solok rice paddies, which are related to regulating soil pH to support optimal plant growth.

The integration of ethnoscience aims not only to explain the concepts of acids and bases scientifically, but also to foster students' awareness of cultural values and local knowledge, and to increase their interest in learning through familiar and relevant contexts. This approach aligns with the research findings of Febrina et al. (2025), which showed that developing ethnoscience-based e-modules can improve scientific literacy and student engagement in learning. Therefore, these e-modules support the implementation of the Independent Curriculum, which prioritizes differentiated, contextual learning, and is based on the Pancasila student profile. The developed acid-base e-module was then tested for validity, practicality, and effectiveness to perfect the product.

Based on the validity test results, the average validation score obtained for the content component assessment was 0.85, categorized as valid. Therefore, the acid-base e-module developed based on guided discovery learning aligns with the Learning Outcomes (CP) and Learning Objectives (IP) of the Merdeka Curriculum. The images and videos used are relevant to the acid-base material and are scientifically sound. The motivation and problem-solving presentation, questions provided on data processing, exercises, and evaluations guide students in discovering concepts, thereby improving their literacy and numeracy skills. This aligns with the theory that content validity indicates a product developed in accordance with the curriculum and based on strong theoretical rationale (Apriani et al., 2020).

Based on the validity test results, the average score for the language component assessment was 0.88, categorized as valid. This indicates that the acid-base e-module developed based on guided discovery learning uses good, easy-to-understand, simple, and clear Indonesian. One characteristic of e-modules is that they are user-friendly. Furthermore, the text, images, and videos are clearly legible. This aligns with the statement that the indicators assessed by validators in terms of language include readability, clarity of information, adherence to correct Indonesian language rules, and effective and efficient language use.

Based on the results of the validity test, the average score obtained in the presentation component assessment was 0.89 with a valid category. This shows that the acid-base e-module based on guided discovery learning that was developed has been systematically compiled in accordance with the module compilation guidelines by the Ministry of Education and Culture in 2017. In addition, the acid-base e-module based on guided discovery learning that is presented is in accordance with the syntax in the guided discovery learning model modified into several stages, namely (1) motivation and problem presentation (motivation and

problem presentation), which is a step to observe by reading and understanding the problems presented; (2) data collection (data collection), which is a step to collect and obtain information from several sources; (3) data processing (data processing), which is a step to solve problems, answer questions and find concepts from the material being studied; (4) verification (proof), which is a step to prove the temporary hypothesis; (5) closure (closing), which is a step to conclude the learning material (Yerimadesi et al., 2019). Based on the graphical component, an average score of 0.87 was obtained, categorizing it as valid. This indicates that the developed e-module is presented in an attractive manner, indicating that its design and presentation are engaging. An attractive e-module display can increase student motivation in learning activities (Febrianto & Kurniawati, 2023).

Based on the validity test results, the average score for the programming aspect was 0.89, categorizing it as valid. This indicates that the developed acid-base e-module, based on guided discovery learning, has a balanced composition of text, images, and video; it is easy to use, has easy-to-understand instructions, a moderate file size, and is efficient.

Based on Table 4, the overall validity test for the guided discovery learning-based acid-base e-module obtained an average Aikens' V of 0.88, with a valid category for all aspects assessed by the validator. Therefore, the developed guided discovery learning-based acid-base e-module can be declared valid and can proceed to the next stage.

The practicality of the e-module was measured by administering a practicality questionnaire to three Phase E chemistry teachers and 30 students at SMAN 1 Solok. A product is considered practical if teachers or representatives of the target user group can easily use the product as expected (Plomp & Nieveen, 2008). The practicality of an e-module can be assessed based on aspects of ease of use, efficiency of learning time, and the benefits of the product developed by users, both students and teachers (Karmila & Abidin, 2023; Maskar & Dewi, 2020).

Based on the ease use aspect, the acid-base e-module based on guided discovery learning by teachers and students obtained average practicality scores of 91.1% and 85.3%, respectively, categorized as very practical. This indicates that the designed e-module has easy-to-understand instructions, clear presentation of materials, images, and videos, understandable language, and clear and easy-to-read fonts. This ease of use is related to the module's language being clear and easy for students to understand, as well as the clear and simple material contained within the module (Yani & Yerimadesi, 2023).

Regarding the efficiency of learning time, the practicality percentages of the acid-base e-module by teachers and students were 93.3% and 88.7%, respectively, categorized as very practical. This indicates that learning using e-modules can make learning time more effective. This demonstrates that the learning process using e-modules is more efficient and allows students to learn at their own pace (Asmiyunda et al., 2018).

The practicality of the acid-base e-module, according to teachers and students, was 90% and 87.1%, respectively, categorized as very practical. This indicates that learning using e-module materials can improve understanding and engage students actively in learning. Furthermore, e-module materials are supported by systematic learning steps to guide students in discovering concepts (Alvi & Yerimadesi, 2022; Ellizar et al., 2018).

The overall average practicality scores based on teacher and student responses were 91.5% and 86.7%, respectively, categorized as very practical. This indicates that using the acid-base e-module based on guided discovery learning facilitates student understanding of acid-base material, makes learning time more effective, and engages students actively in learning. According to Sukardi (2012), teaching materials are considered practical when they facilitate teachers' teaching and facilitate students' understanding of the material.

Based on the research that has been conducted and based on the validity and practicality analysis data that has been analyzed, the acid-base e-module based on guided discovery learning that has been developed can be declared valid and practical.

## Conclusion

Based on the research conducted, it can be concluded that the acid-base e-module based on guided discovery learning and ethnoscience content developed is valid, highly practical, and effective in improving student learning outcomes in the high category. The acid-base e-module based on guided discovery learning and ethnoscience content can be used to improve the literacy and numeracy of high school (SMA/MA) students. The acid-base e-module based on guided discovery learning and ethnoscience content is a teaching material worthy of consideration by high school (SMA/MA) teachers and prospective teachers for implementation in schools, as it has been proven valid, practical, and effective based on research results. This acid-base e-module based on guided discovery learning and ethnoscience content can also help students apply their concepts to solve contextual problems, thus making learning more applicable. This is because

students not only learn chemical theory but also connect it to problems they encounter in everyday life.

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## Author Contributions

### Conflicts of Interest

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## References

- Aiken, L. R. (1985). Three Coefficients for Analyzing the Reliability and Validity of Ratings. *Educational and Psychological Measurement*, 45(1), 131–142. <https://doi.org/10.1177/0013164485451012>
- Alvi, N. V., & Yerimadesi, Y. (2022). Effectiveness of the Acid-Base E-Module Based on Guided Discovery Learning on the Students Learning Outcomes of Class XI Students at SMAN 7 Padang. *Pancaran Pendidikan*, 11(2), 1–8. <https://doi.org/10.25037/pancaran.v11i2.387>
- Anda, H. A. (2022). Pengaruh guided discovery terhadap keterampilan proses dan pemahaman konsep dari tingkat keterampilan berpikir siswa sma. *SECONDARY: Jurnal Inovasi Pendidikan Menengah*, 2(3), 385–397. <https://doi.org/10.51878/secondary.v2i3.1430>
- Andayani, Y., Anwar, Y. A. S., & Hadisaputra, S. (2021). Pendekatan Etnosains dalam Pelajaran Kimia Untuk Pembentukan Karakter Siswa: Tanggapan Guru Kimia di NTB. *Jurnal Pijar Mipa*, 16(1), 39–43. <https://doi.org/10.29303/jpm.v16i1.2269>
- Apriani, N. W. R., Doyan, A., Sridana, N., & Susilawati, S. (2020). The validity of Physical Learning Device Based on Discovery Learning Model Assisted by Virtual Laboratory. *Jurnal Penelitian Pendidikan IPA*, 6(2), 132–135. <https://doi.org/10.29303/jppipa.v6i2.413>
- Aprillita, G., Maharani, P. D. S., Wulandari, P., Zuhrah, S. N., Zaini, M., Putra, A. P., Fajeriadi, H., Lestari, A., & Rahmi, B. (2025). Pengaruh metode peta konsep pada hasil belajar dan berpikir kritis peserta didik mata pelajaran biologi. *Journal of Bio-Creaducation*, 2(1). Retrieved from <https://ppjp.ulm.ac.id/journals/index.php/bioc>

- o/article/view/14118
- Arsyad, A. (2017). *Media Pembelajaran*. Jakarta: PT Raja Grafindo Persada.
- Asmiyunda, A., Guspatni, G., & Azra, F. (2018). Pengembangan e-modul kesetimbangan kimia berbasis pendekatan saintifik untuk kelas XI SMA/MA. *Jurnal Eksakta Pendidikan (JEP)*, 2(2), 155–161. <https://doi.org/10.24036/jep.v1i2.50>
- Basit, D. A., Muslim, B., & Saridewi, N. (2023). Pengaruh Model Problem Based Learning Berbasis Etnosains Terhadap Hasil Belajar Siswa pada Materi Laju Reaksi. *SPIN Jurnal Kimia Dan Pendidikan Kimia*, 5(1), 75–90. <https://doi.org/10.20414/spin.v5i1.6907>
- Ellizar, E., Hardeli, H., Beltris, S., & Suharni, R. (2018). Development of scientific approach based on discovery learning module. *IOP Conference Series: Materials Science and Engineering*, 335, 12101. <https://doi.org/10.1088/1757-899X/335/1/012101>
- Fadhilah, N., & Yerimadesi, Y. (2025). Validitas Dan Praktikalitas E-Modul Interaktif Asam Basa Berbasis Guided Discovery Learning Untuk Fase F SMA. *SCIENCE: Jurnal Inovasi Pendidikan Matematika Dan IPA*, 5(2), 918–927. <https://doi.org/10.51878/science.v5i2.5712>
- Febrianto, Y., & Kurniawati, D. (2023). Pengembangan e-LKPD Terintegrasi STEM-PjBL pada Materi Asam Basa Kelas XI SMA Menggunakan Flip PDF Professional Software. *Entalpi Pendidikan Kimia*, 31–39. <https://doi.org/10.24036/epk.v4i2.314>
- Febrina, W., Yelianti, U., & Wicaksana, E. J. (2025). Pengembangan E-Modul Pembelajaran Berbasis Etnosains Pembuatan Batik Jambi pada Kurikulum Merdeka untuk Meningkatkan Keterampilan Literasi Sains Siswa SMA:(Development of E-Module Learning Based on Ethnoscience Making Jambi Batik in Independent Curriculum. *BIODIK*, 11(02), 332–340. <https://doi.org/10.22437/biodik.v11i02.44105>
- Hasibuan, H. A. (2022). Peran Modul Berbasis Kearifan Lokal Untuk Mendukung Pendidikan Merdeka Belajar. *Seminar Nasional Pendidikan Dasar*, 1(1), 1–10. <https://doi.org/10.34007/ppd.v1i1.201>
- Iranda, R. P., & Darmana, A. (2024). Pengembangan Bahan Ajar Kimia Terintegrasi Model Pembelajaran Process Oriented Guided Inquiry Learning. *Didaktika: Jurnal Kependidikan*, 13(4), 4777–4786. <https://doi.org/10.58230/27454312.1081>
- Karmila, M., & Abidin, Z. (2023). Pengembangan E-Modul Berbasis PBL dengan Media Wepik Terhadap Peningkatan Kemampuan Literasi Sains dan Numerasi Siswa MA. *Jurnal Ilmiah Wahana Pendidikan*, 9(22), 611–626. <https://doi.org/10.5281/zenodo.10129984>
- Khairani, M., Sutisna, S., & Suyanto, S. (2019). Studi meta-analisis pengaruh video pembelajaran terhadap hasil belajar peserta didik. *Jurnal Biolokus*, 2(1), 158–166. <https://doi.org/10.30821/biolokus.v2i1.442>
- Kristalia, A. Y. (2021). Efektivitas E-Modul Larutan Elektrolit Dan Nonelektrolit Berbasis Guided Discovery Learning Terhadap Hasil Belajar Siswa Kelas X. *Jurnal Pendidikan Kimia Undiksha*, 5(2), 54–59. <https://doi.org/10.23887/jjpk.v5i2.37910>
- Lidi, M. W., Wae, V. P. S. M., & Kaleka, M. (2022). Implementasi Etnosains dalam Pembelajaran IPA untuk Mewujudkan Merdeka Belajar di Kabupaten Ende. *OPTIKA: Jurnal Pendidikan Fisika*, 6(2). <https://doi.org/10.37478/optika.v6i2.2218>
- Maskar, S., & Dewi, P. S. (2020). Praktikalitas dan efektifitas bahan ajar kalkulus berbasis daring berbantuan geogebra. *Jurnal Cendekia*, 4(2), 888–899. Retrieved from <https://www.academia.edu/download/71483917/197.pdf>
- Muderawan, I. W., Wiratma, I. G. L., & Nabila, M. Z. (2019). Analisis faktor-faktor penyebab kesulitan belajar siswa pada pelajaran kimia. *Jurnal Pendidikan Kimia Indonesia*, 3(1), 17–23. <https://doi.org/10.23887/jpk.v3i1.20944>
- OECD. (2023). *Programme for International Student Assessment (PISA) 2022 Result*. Retrieved from <https://shorturl.asia/bRmad>
- Plomp, T., & Nieveen, N. M. (2008). *Educational Design Research, Part A: An intruduction*. Retrieved from <https://shorturl.asia/MkUtG>
- Pratiwi, W., Hidayat, S., & Suherman, S. (2023). Pengembangan E-Modul Berbasis Heyzine Di Gugus Menes. *VOX EDUKASI: Jurnal Ilmiah Ilmu Pendidikan*, 14(1), 156–163. <https://doi.org/10.31932/ve.v14i1.2173>
- Puspaningrum, A. K., Sumarni, W., & Sudarmin. (2022). Desain E-Modul Larutan Elektrolit-Nonelektrolit Multirepresentasi terintegrasi Etnosains untuk Meningkatkan Pemahaman Konsep. *Journal of Chemistry In Education*, 1(2252), 15–21. Retrieved from <https://lib.unnes.ac.id/50716/>
- Puspitasari, A. D. (2019). Application of Physics Learning Media Using Printed Modules and Electronic Modules for High School Students. *Journal of Physics Education*, 7(1), 17–25. Retrieved from <http://journal.uin-alauddin.ac.id/index.php/PendidikanFisika>
- Rahayu, J., & Solihatin, E. (2019). Pengembangan Modul Pembelajaran Online Pada Mata Pelajaran Kimia. *Jurnal Ilmiah Wahana Pendidikan*, 5(1), 13–28.

- Retrieved from <https://jurnal.peneliti.net/index.php/JIWP/artic le/view/71>
- Rahmi, S., & Yerimadesi. (2022). Efektivitas E-Modul Titirasi Asam Basa Berbasis Guided Discovery Learning terhadap Hasil Belajar Siswa Kelas XI di SMAN 7 Padang. *Jurnal Pendidikan Mipa*, 12(3), 431–436. <https://doi.org/10.37630/jpm.v12i3.633>
- Sagala, S. (2013). *Konsep dan Makna Pembelajaran*. Bandung: Alfabeta.
- Sape, H., Sambara, P. M., & others. (2024). Penggunaan E-Modul Interaktif dalam Meningkatkan Kemampuan Literasi Siswa. *Jurnal Pendidikan Dan Pembelajaran*, 4(2), 101–106. <https://doi.org/10.62388/jpdp.v4i2.522>
- Sugiyono. (2013). *Metode Penelitian Kombinasi (Mixed Methods)*. Bandung: CV. Alfabeta.
- Sugiyono. (2019). *Metode Penelitian Kualitatif, Kuantitatif dan R&D*. Bandung: Alfabeta.
- Sukardi. (2012). *Evaluasi Pendidikan Prinsip dan Operasionalnya*. Jakarta: Bumi Aksara.
- Thiagarajan, S. (1974). Instructional Development for Training Teachers of Exceptional Children: A Sourcebook. *Council for Exceptional Children*, 22091. Retrieved from <https://eric.ed.gov/?id=ED090725>
- Tuerah, R. M., & Tuerah, J. M. (2023). Kurikulum Merdeka dalam Perspektif Kajian Teori: Analisis Kebijakan untuk Peningkatan Kualitas Pembelajaran di Sekolah. *Jurnal Ilmiah Wahana Pendidikan*, 9(19), 979–988. <https://doi.org/10.5281/zenodo.10047903>
- Wahyudin, D., Subkhan, E., Malik, A., Hakim, M. A., Sudiapermana, E., LeliAlhapip, M., Nur Rofika Ayu Shinta Amalia, L. S., Ali, N. B. V., & Krisna, F. N. (2024). Kajian Akademik Kurikulum Merdeka. In *Pusat Kurikulum dan Pembelajaran Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan*. Retrieved from <https://archive.org/details/kajian-akademik-kurikulum-merdeka/page/n1/mode/2up>
- Waruwu, A. B. C., & Sitinjak, D. (2022). Penggunaan Multimedia Interaktif dalam Meningkatkan Minat Belajar Siswa pada Pembelajaran Kimia. *Jurnal Pendidikan Mipa*, 12(2), 298–305. <https://doi.org/10.37630/jpm.v12i2.589>
- Yani, S. H., & Yerimadesi, Y. (2023). Validitas dan Praktikalitas Modul Reaksi Kimia Berbasis Guided Discovery Learning Terintegrasi Etnosains untuk Fase E SMA. *Jurnal Pendidikan Mipa*, 13(2), 436–444. <https://doi.org/10.37630/jpm.v13i2.986>
- Yerimadesi, Y., Kiram, Y., Lufri, L., Festiyed, F., & Guspatni, G. (2019). Validity and practicality of guided discovery learning models for chemistry learning in senior high school. *Journal of Physics: Conference Series*, 1317(1). <https://doi.org/10.1088/1742-6596/1317/1/012149>