



Development of an Intertextual-Based E-Module on Acid-Base Titration Concepts Integrating Science Process Skills

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Abstract

Students often experience difficulties in understanding chemistry due to their limited ability to connect macroscopic, submicroscopic, and symbolic representations, leading to misconceptions, particularly in acid-base titration. This issue is exacerbated by learning resources that predominantly emphasize symbolic aspects and do not adequately support the integration of multiple representations. To address these challenges, this study developed an intertextual-based e-module that integrates the three levels of chemical representation to support students' conceptual mastery and Science Process Skills (SPS). This study employed the ADDIE Instructional Model, which consists of five phases: analysis, design, development, implementation, and evaluation. Expert validation involving aspects of chemistry content, pedagogy, language, and media was conducted to assess the feasibility of the e-module. Inter-rater reliability (IRR) percentages were calculated for each aspect, showing high feasibility: content (66.67-100%), pedagogy (100%), language (100%), and media (100%). Feedback from experts was analyzed, and minor revisions were made to improve the quality of the e-module. These results indicate that the intertextual-based e-module is feasible and potentially effective for teaching acid-base titration concepts in high schools. This study contributes to chemistry education by highlighting the integration of intertextual approaches and Science Process Skills within an e-module as a potential way to address students' difficulties in understanding acid-base titration concepts.

How to Cite

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INTRODUCTION

One of the main difficulties in learning chemistry is students' limited ability to connect the three levels of chemical representation, namely macroscopic, submicroscopic, and symbolic, which are the basis of conceptual understanding (Johnstone, 1991; Gkitzia, Salta, & Tzougraki, 2020; Talanquer, 2020). The macroscopic level refers to chemical phenomena that can be observed directly, such as color changes, the formation of new substances, or the disappearance of substances. The submicroscopic level provides explanations at the particle level, where matter is described as atoms, molecules, and ions (Johnstone, 1991); this helps explain phenomena at the macroscopic level (Wu, 2003). These submicroscopic species are real but too small to observe, so chemists describe their characteristics and behavior using symbolic representations to construct mental models. The symbolic level involves the use of chemical symbols, formulas, and equations, as well as molecular structure images, diagrams, models, and computer animations to represent matter (Johnstone, 1991).

Research findings indicate that students who are able to connect the macroscopic, submicroscopic, and symbolic levels of chemical representation achieve a more complete understanding and long-term retention (Stieff, 2019), and similar results show that students who can link these three levels demonstrate better conceptual understanding, as they are able to visualize particle interactions in a phenomenon and interpret them into equations or diagrams (Schwedler & Kaldewey, 2020). The inability to connect these three levels leads to misconceptions, causing students to perceive chemistry as a difficult subject (Stieff et al., 2018). Similarly, other studies indicate that students' conceptual understanding is weak because chemistry is often presented merely as symbols, formulas, and equations rather than real-life phenomena (Baptista et al., 2019). Such misconceptions are also often found in the concept of acid-base titration (Supatmi et al., 2019; Widarti et al., 2017; Kumar, 2025).

One contributing factor is that most learning resources only emphasize symbolic aspects and fail to help students connect the three levels of representation (Thompson et al., 2023). In fact, connecting representations is essential for a more meaningful understanding of chemical concepts (Rau, 2015). An intertextual approach can be a solution because it coherently connects the three levels of representation (Johnstone, 1991; Lin & Wu, 2021). Intertextuality is the explicit

or implicit relationship that a text has with previous, contemporary, or even potential future texts (Bazerman & Pior, 2003). Texts are functional languages that can be read, written, or expressed through various media (Halliday and Hasan (1985) in Wu (2003)). These texts have meaningful relationships that shape comprehensive understanding in students. In chemistry, intertextuality is an approach to understanding chemistry that involves linking the three levels of representation in chemistry (macroscopic, submicroscopic, and symbolic) (Ryu, Nardo, & Wu, 2018).

Interviews with chemistry teachers revealed that teaching about acid-base titration is still limited to strong acid-strong base titration. Time constraints and limited access to textbooks make it difficult for students to learn independently. This situation highlights the need for comprehensive, flexible, and accessible learning resources. E-modules are an alternative learning resource that meets these needs because they are self-directed and user-friendly (Kemendikbud, 2017). Several studies also show that the use of e-modules can improve the effectiveness of chemistry learning (Kuit & Osman, 2021; Mohd Hamid et al., 2021; Solomon et al., 2021; Osman & Lay, 2020; & Schettini et al., 2020; Holloway et al., 2024; Chongo et al., 2020; Apriwanda et al., 2021; Shobri et al., 2021).

In addition, the Indonesian curriculum emphasizes two main elements in chemistry learning: mastery of concepts and science process skills (SPS), which play a role in building student understanding (Kassaye et al, 2025). SPS is a set of cognitive and psychomotor skills used in the scientific investigation process (Özgelen, 2012), and is an essential component in science education (Yunaini et al, 2025). Experts generally classify Science Process Skills into two main categories: basic process skills and integrated process skills (Gizaw & Sota, 2023; Khan & Vanaja, 2019). Basic Science Process Skills are the foundation for more complex skills. Integrated Science Process Skills are more complex skills and are a combination of several basic skills (Gizaw & Sota, 2023). However, in reality, students' SPS is still relatively low (Derilo, 2019; Koomson et al., 2024).

There are two main approaches to developing SPS: teaching SPS explicitly and integrating SPS into content knowledge. The first approach focuses on designing specific scientific activities for each SPS component to help students understand the nature of science and how scientific knowledge is constructed. The second approach integrates SPS into science content through activity-based learning, enabling students to engage

in the scientific process while learning the subject matter. Of the two, the integrative approach provides a more meaningful context, as it simultaneously facilitates the development of SPS and conceptual understanding (Baydere et al., 2020). Therefore, integrating SPS into learning materials through e-modules is important to provide opportunities for students to engage in the scientific process while learning chemistry concepts.

Several studies have examined Science Process Skills (SPS) in chemistry learning and their integration across various teaching approaches (Artun et al., 2020; Baydere et al., 2020; Beichumila et al., 2022; Chen et al., 2024; Khamhaengpol et al., 2022; Ngozi, 2021; Nicol, et al., 2023). However, most studies have focused on implementation and effectiveness, while the development of e-modules that explicitly integrate SPS is still limited, particularly in the context of acid-base titration. Furthermore, previous studies that have developed e-modules on acid-base titration still have several limitations. The module developed by Afrisal Muslim (2022) combines macroscopic representations of laboratory experiments and symbolic representations through reaction equations, but does not cover submicroscopic aspects and the relationship between representation levels. Utami (2022) describes the macroscopic phenomena of titration experiments, but does not cover all types of titration or analyze the solution species at each stage of titration.

Therefore, there is still a research gap in the

development of an intertextual-based e-module on acid-base titration that comprehensively connects chemical representations and accommodates both concept mastery and scientific process skills. The objective of this study is to develop an intertextual-based e-module for the concept of acid-base titration that integrates three levels of chemical representation to support students' conceptual mastery and Science Process Skills (SPS).

METHOD

In this study, a qualitative approach is employed, and the module is developed by applying the ADDIE Instructional Model, which consists of five phases: analysis, design, development, implementation, and evaluation. Figure 1 shows the ADDIE Model. This model was selected because it provides structured guidelines for designing and developing a learning experience, which is a module in this study.

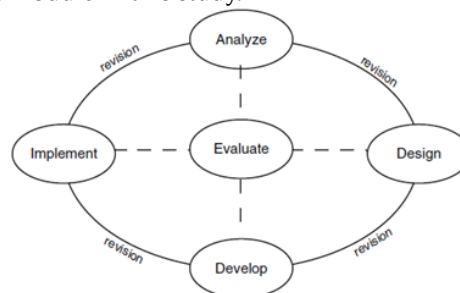


Figure 1. Core Elements of Instructional Design (Mariam & Nam, 2019)

Table 1. The application of ADDIE in an intertextual-based e-module on the 5E model

ADDIE Phase	Activity
Analysis	Interviews with high school chemistry teachers to assess the availability and utilization of teaching materials and resources in schools. Analysis of students' misconceptions related to acid-base titration concepts based on various literature articles, and analysis of existing acid-base titration e-modules to identify their strengths and weaknesses. Literature analysis on concept mastery, scientific process skills, and three levels of chemical representation for the concept of acid-base titration from five General Chemistry textbooks.
Design	Identifying and analyzing the learning objectives (TP) and learning objective flows (ATP) from the curriculum to ensure alignment with concept mastery and science process skills. This stage also involved designing multiple representations for the e-module content, creating the module outline, and preparing for expert validation instruments.
Development	The creation of an intertextual-based e-module using the Canva platform by connecting macroscopic, submicroscopic, and symbolic representations of chemical phenomena.
Evaluation (Expert Validation)	Formative evaluation was conducted through expert validation involving specialists in content, pedagogy, language, and media to assess the feasibility and quality of the developed e-module. Suggestions from experts were used to revise and improve the product prior to implementation.

The research was limited to the Development stage due to time constraints of the study. Accordingly, the evaluation in this research was conducted through expert validation despite the absence of an implementation stage. In the ADDIE model, evaluation can be carried out in both formative and summative forms. Formative evaluation occurs at every stage of the development process, whereas summative evaluation is typically conducted after implementation through field testing using criterion-referenced instruments to obtain user feedback (Mariam & Nam, 2019).

The instrument used in this study was the e-Module validation sheet instrument (Agree/Disagree). The subjects of this study consisted of seven expert validators. The feasibility of the content and pedagogy aspects was evaluated by three experts in chemistry education. The language aspect was assessed by two experts, comprising one expert in Indonesian language and one in chemistry education. Meanwhile, the media aspect was evaluated by two experts, consisting of one expert in visual communication design and one in chemistry education.

Data were collected using an expert validation sheet covering aspects of content, pedagogy, language, and media. The validation sheet included assessment indicators and a final validation decision. In validation process, the developed e-module was first reviewed by validators, who assessed each indicator by marking whether the criteria were met. The validators also provided written comments and suggestions for improve-

ment on specific parts of e-module. In addition, direct discussions were conducted with validators to obtain further feedback and clarification.

The collected data were analyzed descriptively based on the validator's assessment. To determine the consistency of expert judgments across indicators, Inter-Rater Reliability (IRR) in the form of percentage agreement was calculated. The IRR indicates the degree of agreement among validators. A higher IRR value indicates greater consistency in expert evaluations. In addition, data in the form of written comments and suggestions from validators were analyzed descriptively to identify aspects that required revision.

RESULT AND DISCUSSION

Development of an Intertextual-Based E-Module for the acid-base titration concept

Referring to Learning Outcomes (CP) in the Indonesian curriculum, four Learning Objectives (TP) and Learning Objective Flow (ATP) have been identified. Based on these objectives, the e-module is organized four learning units: (1) principles of acid-base titration, (2) strong acid-strong base titration, (3) weak acid-strong base titration, and (4) weak base-strong acid titration.

Students' misconceptions about the concept of acid-base titration were identified through a literature review. This step is essential to prevent misconceptions during the development of the e-module and to ensure that the developed e-module so does not cause new misconceptions.

Table 2. Intertextual-Based E-Module Outline for Learning Unit 2

Phase	Activity	Chemical Representation	Science Process Skills (SPS)
Engage	Students were given probing questions to connect their prior knowledge of the basic principles of titration with the differences in acid-base properties, thus fostering curiosity about the different types of acid-base titrations.	Macroscopic	
Explore 1	Students were asked to predict the appropriate indicator for a strong acid-strong base titration based on their prior knowledge. Students watched a learning video showing the titration process of HCl with NaOH. Through the video, they observed how the titration was performed, the color changes of the indicator, and the recording of the titrant volume in the burette. Students also uploaded their observations via a prepared Google Form.	Macroscopic	Predicting, Observing
Explain 1	Students were guided to analyze the titration volume data in a table and calculate the concentration of the HCl solution.	Macroscopic & Macroscopic-Symbolic	Processing Data

Phase	Activity	Chemical Representation	Science Process Skills (SPS)
Elaborate 1	Students were given data from a titration experiment of H_2SO_4 with NaOH and then asked to analyze and calculate the concentration of the H_2SO_4 solution based on this data.	Macroscopic & Macroscopic-Symbolic	Processing Data
Explore 2	Students were presented with probing questions regarding indicator selection in a strong acid-strong base titration to foster curiosity and encourage thinking.	Macroscopic	
	Students are presented with a strong acid-strong base titration curve and observe the pH changes at the start of the titration, before, during, and after the equivalence point.	Macroscopic & Macroscopic-Symbolic	Observing
Explain 2	Explain indicator selection on the vertical portion of the curve and describe the species present in the solution at each stage of the titration of HCl by NaOH	Macroscopic, Submicroscopic & Submicroscopic-Symbolic	
Elaborate 2	Students are presented with a strong base-strong acid titration curve.	Macroscopic & Macroscopic-Symbolic	Observing, Communicating
	Students analyze the titration curve and are asked to describe the species present in the solution at each stage of the titration and determine the appropriate indicator.		
	Students are given feedback by discussing the species present in the solution at each stage of the titration of a strong base by a strong acid and determining the appropriate indicator.	Macroscopic, Submicroscopic, Macroscopic-Symbolic, & Submicroscopic-Symbolic	
Summary	Presents a summary of the lesson content.		
Evaluate (Formative Test 2)	This section contains a written formative test that assesses students' mastery.		
Feedback	The results determine whether students are ready to proceed to the next learning unit or repeat the current learning unit.		

Based on the analysis of learning objectives and identified misconceptions, an intertextual-based e-module outline was then developed for each learning unit. The outline for Learning Unit 2 (strong acid-strong base titration) is presented as a representative example, as shown in Table 2.

This e-module is intertextual, meaning that its structure is formed by linking three levels of representation, starting from the macroscopic level, then the sub-microscopic level, and the

symbolic level. The five latest editions of the General Chemistry textbook were analyzed to identify the three levels of representation used. The results of this analysis then became the basis for designing the three levels of representation that will be presented in the e-module. To illustrate how the intertextual approach is implemented in the e-module, an example from Learning Unit 1 (principles of acid-base titration) is presented in Figure 2.



Figure 2. Integration of macroscopic, submicroscopic, and symbolic representations in the intertextual-based e-module (Learning Unit 1: Principles of Acid-Base Titration)

The developed e-module is an intertextual-based module, thus aligned with constructivist theory. The Learning Cycle 5E model was selected to guide the design of the e-module. Learning activities in the e-module were structured according to the 5E syntax in each learning unit, although the phases are not explicitly shown in the module. The 5E learning cycle consists of five phases: Engage, Explore, Explain, Elaborate, and Evaluate (Ruiz-Martín & Bybee, 2022). In Learning Unit 1, the Engage phase begins by reminding students of the acid-base material they have learned previously and asking provocative questions to stimulate curiosity and activate their prior knowledge. This phase is followed by the Explore phase, which involves watching a video of the HCl-NaOH neutralization experiment, allowing students to observe the phenomenon directly and build a foundation for concept development. This phase also serves as a macroscopic representation. In the Explain phase, students are given a submicroscopic explanation of acid-base reactions, complete with illustrations to help them understand the process. In the Elaborate phase, students are encouraged to apply the concepts learned in a new context, namely the reaction between $\text{Mg}(\text{OH})_2$ and HCl. The Evaluate phase is conducted through a formative test that measures students' conceptual understanding. This 5E cycle is also applied to Learning Units 2, 3, and 4, with some stages repeated as needed for the topic, ensuring gradual and repeated learning and also reinforcing students' mastery of the concepts.

This lesson also covers several science process skills (SPS). In learning units 1 and 2, the SPS aspect that appears is observing. Learning

Unit 3 covers a broader range of SPS, experimenting, observing, data processing, inferring, and reporting, through a practicum on determining the acetic acid concentration in market vinegar. Students follow a guided procedure, analyze the resulting data, and submit their conclusions via a provided link. In Learning Unit 4, the SPS of constructing a graph is emphasized as students complete titration data and generate a weak base-strong acid titration curve. Figure 3 presents examples of learning activities designed to facilitate science process skills, specifically observing and constructing graphs.

The developed e-module is presented in an electronic format that can be accessed anytime and anywhere through internet-connected devices, such as smartphones and computers, thereby supporting flexible learning. In addition, the e-module utilizes various interactive features, including embedded videos, Google Forms, quizzes and polls, and interactive links that allow users to navigate content easily. Figure 4 shows examples of these interactive features in the e-module.

Furthermore, all essential learning materials are comprehensively presented in the developed intertextual-based e-module, eliminating the need for students to seek additional information from external sources. To anticipate student questions, optional supplementary materials are also provided. These materials can be accessed based on student needs and are not mandatory. This module includes additional content related to determining the pH range of acid-base indicators to support deeper understanding. Figure 5 presents this supplementary material in the e-module.



Figure 3. Examples of learning activities facilitating science process skills (observing and constructing graphs) in the e-module

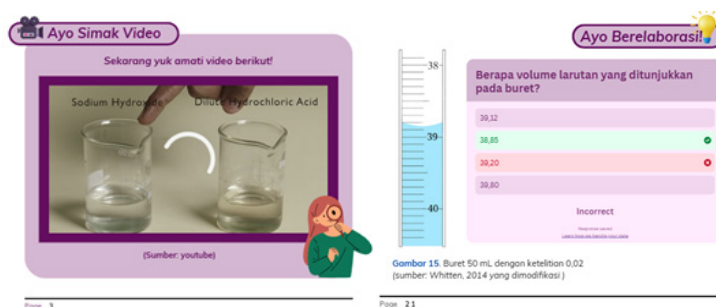


Figure 4. Examples of interactive features in the e-module

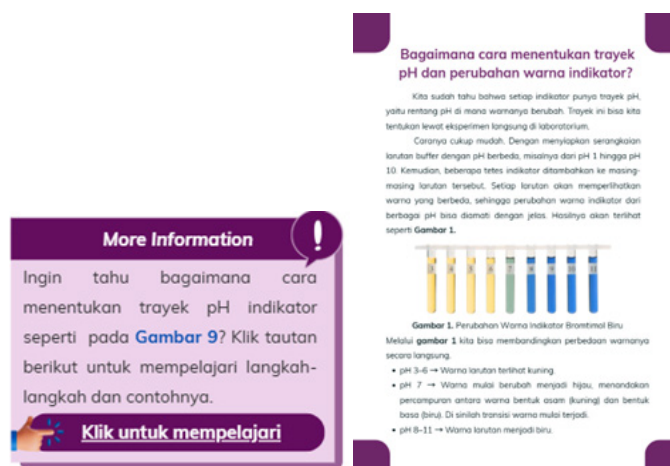


Figure 5. Supplementary material provided in the e-module

Validation of Intertextual-Based E-Modules for the Acid–base Titration Concept

Validity is a crucial aspect in determining the feasibility of an e-module to be implemented in the teaching and learning process. Therefore, this e-module is validated to determine the feasibility of the intertextual-based e-module for the acid–base titration concept developed. The e-module validity is evaluated in several aspects, including e-module content, pedagogy, language, and media.

The content aspect is a key component in e-module development because it plays a role in

presenting material that is accurate, relevant, and in accordance with learning objectives. Furthermore, pedagogical, language, and media aspects are also essential to ensure that the e-module is not only conceptually correct but also effectively used in the learning process. The assessment results are presented in the form of an inter-rater reliability (IRR) percentage, which indicates the level of agreement between validators regarding the quality of the developed e-module. Table 3 shows the results of the intertextual-based e-module validation on the content aspect.

Table 3. Percentage inter-rater reliability for the e-module content aspect

No	Assessment Criteria	Indicators	Agree	Disagree	IRR (%)
1	Alignment with the Learning Outcomes (CP) of Phase F in the Merdeka Curriculum	The presented material comprehensively encompasses all topics related to Acid–Base Titration as specified in the Phase F Learning Outcomes (CP) of the Merdeka Curriculum, which are further operationalized in the ATP.	3	0	100%
2	Accuracy and correctness of the concept	The concepts and definitions presented are precise and do not allow for multiple interpretations.	3	0	100%
		The material is consistent with widely accepted chemical principles.	3	0	100%
		The explanation integrates the three levels of chemical representation, namely macroscopic (phenomenological), submicroscopic (particle-level explanation), and symbolic (chemical symbols and equations).	3	0	100%
3	Accuracy of illustrations	Submicroscopic illustrations are consistent with phenomena observed in laboratory settings or everyday life.	3	0	100%
		The intended meaning of the illustrations is clear and interpretable.	3	0	100%
		The illustrations are supported by coherent and explicit verbal explanations.	2	1	66.67%
4	Accuracy of symbols	Chemical symbols and notations are presented accurately in accordance with standard scientific conventions.	3	0	100%
5	Currency of references	The references utilized are current and relevant to recent developments in the field.	2	1	66.67%
6	Organization of material and assessment tasks	The instructional material facilitates students' conceptual understanding.	3	0	100%
		The practice questions support the development of conceptual comprehension.	2	1	66.67%
		The assessment tasks effectively measure students' abilities and understanding.	3	0	100%
		The questions promote higher-order thinking, particularly analytical skills.	2	1	66.67%
		The tasks stimulate the development of students' science process skills.	2	1	66.67%
7	Contextual relevance	The material is presented in alignment with relevant contexts and appropriate illustrations within the domain of chemistry	3	0	100%

The validation results indicate that the developed e-module demonstrates a high level of content feasibility, as reflected by the dominance of high IRR values across indicators. The strong agreement among validators implies that the integration of multiple chemical representations and the alignment with the Merdeka Curriculum have been appropriately implemented, which are critical in supporting meaningful conceptual un-

derstanding in chemistry learning. However, several indicators with lower agreement highlight specific areas for improvement. These include the need to strengthen the connection between visual representations and their explanatory text, ensure the use of more up-to-date references, and further optimize tasks that promote science process skills.

The pedagogical aspect is essential in ensuring that the e-module is not only conceptually accurate but also instructionally effective in facilitating meaningful learning. This aspect focuses on how the material is structured, sequenced, and

delivered to support students' understanding, engagement, and independent learning. The results of the pedagogical validation are presented in Table 4 using inter-rater reliability (IRR) to reflect the level of agreement among validators.

Table 4. Percentage inter-rater reliability for the e-module pedagogy aspect

No	Assessment Criteria	Indicators	Agree	Disagree	IRR (%)
1	Alignment with the E-Module Structure	The learning objectives are clearly stated.	3	0	100%
		The introductory section is complete.	3	0	100%
		The core content section is comprehensive.	3	0	100%
		The closing section is complete.	3	0	100%
		Conceptual explanations (structuring of content) are systematically presented.	3	0	100%
		Instructions for completing tasks are clear.	3	0	100%
		The summary section is clearly presented.	3	0	100%
		The glossary provides clear definitions of terms used within the e-module.	3	0	100%
2	Sequence and systematic organization of concepts	Concepts are presented in a logical and coherent sequence.	3	0	100%
		Concepts are organized progressively from concrete to abstract.	3	0	100%
		Concepts are structured from simple to more complex levels.	3	0	100%
		Each concept builds upon prior knowledge, enabling meaningful conceptual understanding.	3	0	100%
3	Practice exercises and summative assessment	Practice exercises (formative) are provided at the end of concept discussions to assess students' conceptual understanding.	3	0	100%
		Summative evaluation tasks are provided at the end of the learning unit to measure overall comprehension.	3	0	100%
4	Student engagement in independent learning	The presentation of material is designed to support students' active engagement, both mentally and emotionally, in independent learning.	3	0	100%
		The material delivery is structured to motivate students to actively participate in the learning process.	3	0	100%
5	Coherence between sub-sections/ paragraphs	The presentation of content across sub-sections is coherent and sequential.	3	0	100%
		The connections between sentences or lines reflect a clear and logical flow of ideas.	3	0	100%
6	Meaningfulness and clarity of content	The material conveys clear and meaningful messages to support students' understanding	3	0	100%
7	Motivation enhancement	The material includes elements that describe expected learning outcomes and achievements, aimed at fostering students' learning motivation.	3	0	100%

The validation results demonstrate a very high level of agreement across all pedagogical indicators, indicating that the e-module has been designed with strong instructional quality. This suggests that the structure, organization, and delivery of the material are well-aligned with principles of effective learning design.

The language aspect plays an important role in ensuring that the e-module content is clearly communicated and easily understood by students. This aspect was evaluated based on the appropriateness, clarity, consistency, and comprehensibility of the language used. The results of

the language validation are presented in Table 5 using inter-rater reliability (IRR).

The validation results indicate a very high level of agreement across all language indicators. This reflects that the material has been communicated in a way that is both understandable and pedagogically effective. The strong agreement among validators implies that the use of standard Indonesian, consistent terminology, and correct spelling contributes to minimizing ambiguity and potential misconceptions in learning chemistry concepts.

Table 5. Percentage inter-rater reliability for the e-module language aspect

No	Assessment Criteria	Indicators	Agree	Disagree	IRR (%)
1	Appropriateness of language use	The language used adheres to the rules of standard Indonesian.	2	0	100
		Punctuation is applied in accordance with standard Indonesian conventions.	2	0	100
		The language used is communicative and effective.	2	0	100
		Sentences are constructed clearly and do not lead to ambiguity or multiple interpretations.	2	0	100
2	Accuracy of spelling	Spelling conforms to the Enhanced Indonesian Spelling System (EYD).	2	0	100
3	Standardization of terminology	The terminology used is consistent with the Kamus Besar Bahasa Indonesia (KBBI).	2	0	100
4	Consistency in the use of terms and symbols	Terms and symbols used to represent concepts are applied consistently throughout the material.	2	0	100
5	Clarity and comprehensibility of messages and information	Information, usage instructions, learning objectives, and learning procedures are presented clearly.	2	0	100
		Messages and information are conveyed using simple and accessible language.	2	0	100
		The language used facilitates ease of understanding.	2	0	100
6	Appropriateness of language to students' developmental level	The language used is appropriate to students' level of emotional development.	2	0	100
		The language encourages students to engage in critical thinking.	2	0	100
		Concept explanations are aligned with students' level of intellectual development.	2	0	100
		Summative evaluation tasks are provided at the end of the learning process to assess students' conceptual understanding	2	0	100

The validation results indicate a very high level of agreement across all language indicators. This reflects that the material has been communicated in a way that is both understandable and pedagogically effective. The strong agreement

among validators implies that the use of standard Indonesian, consistent terminology, and correct spelling contributes to minimizing ambiguity and potential misconceptions in learning chemistry concepts.

Table 6. Percentage inter-rater reliability for the e-module media aspect

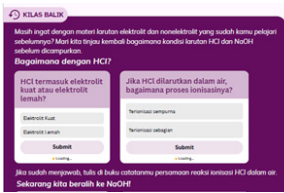
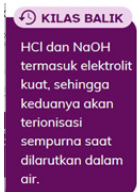
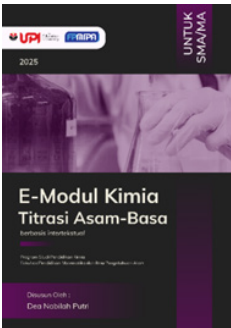
No	Assessment Criteria	Indicators	Agree	Disagree	IRR (%)
1	Font proportion and typography	The title font size is more prominent than the body text.	2	0	100
		The font sizes used are proportional and well-balanced.	2	0	100
		The typeface (font) used is clear and legible.	2	0	100
		Variations in font styles (bold, italic, and capitalization) are applied appropriately and not excessively.	2	0	100
2	Proportion of images and videos	The colors of images used in the e-module contrast appropriately with the background.	2	0	100
		The images are clear and of good quality (not blurred).	2	0	100
		The presentation of images and videos is proportional and well-balanced within the layout	2	0	100
3	Color proportion	The text color contrasts clearly with the background.	2	0	100
		The overall color composition is balanced and visually appropriate.	2	0	100
4	Consistency of layout elements	The placement of layout elements (titles, subtitles, text, images, image captions, and page numbers) is consistent across all sections of the e-module.	2	0	100
5	Paragraph separation	Paragraphs are clearly and appropriately separated to enhance readability	2	0	100
6	Integration of media and text	Images and videos are presented in a coherent and integrated manner with the accompanying text.	2	0	100
7	Audio quality in videos	The audio in the videos does not interfere with or distract from the learning process.	2	0	100
8	Attractiveness of visual media	The images and videos included in the e-module are engaging and visually appealing.	2	0	100

The media aspect is essential in supporting the visual delivery of content and enhancing students' learning experience. This aspect was evaluated based on visual design, layout consistency, media integration, and overall attractiveness. The results of the media validation are presented in Table 6 using inter-rater reliability (IRR).

The validation results indicate a very high level of agreement across all media-related indicators, suggesting that the visual design of the e-module is highly appropriate and supportive of the learning process. This reflects that the e-module

has been developed with careful consideration of visual communication principles. Overall, the findings indicate that the developed e-module is suitable for use in learning and has met the expected criteria in terms of content, pedagogy, language, and media aspects. The experts agreed that the e-module is feasible for implementation, with several revisions required to further enhance its overall quality. These improvements are based on the suggestions provided by the experts, which are presented in the following section.

Table 7. Expert Feedback and E-Module Revisions

Aspect	Expert Feedback	Initial Version	Revised Version
Chemistry Content	To strengthen the relationship between the three levels of representation in the concept of neutralization reaction, expert 1 suggested adding an explanation of the meaning of $\text{NaCl}_{(\text{aq})}$ as a submicroscopic-symbolic aspect.	There is no explanation of the meaning of the symbolic writing of $\text{NaCl}_{(\text{aq})}$.	In the submicroscopic part of the NaOH and HCl reaction, an explanation was added that the meaning of $\text{NaCl}_{(\text{aq})}$ is that the Na^+ and Cl^- ions are in solution, and no bonds are formed between them. New bonds will form when the solution is heated, leaving behind solid NaCl crystals.
Pedagogy	The “ <i>Kilas Balik</i> ” feature was supposed to help students recall previous material, but in the initial version it was too long and felt like relearning.		
Language	Inconsistencies in terminology and spelling were identified, including mismatches between glossary definitions and the explanations in the main text.	The term “ <i>titik eivalen</i> ” was used inconsistently, and the e-module used the term “ <i>titran</i> ”.	The spelling was standardized to “ <i>titik ekuivalen</i> ” in accordance with chemistry literature and KBBI. Then the terminology was corrected by replacing “ <i>titran</i> ” with “ <i>analit</i> ” to maintain consistency with the material and standard chemistry references.
Media	Correction of title capitalization and repositioning of the phrase “ <i>Berbasis Intertekstual</i> ” to clarify that it refers to the e-module.		

The final version of this intertextual-based e-module is formatted as an interactive website, using the Canva platform. This e-module is considered stand-alone, meaning it can be used independently without relying on other learning media. It can be used without requiring additional support from other sources or media, either during the learning process or when completing the assignments.

All the material students need is presented comprehensively within the developed e-module, eliminating the need for students to seek additional information outside the e-module. Furthermore, this e-module is equipped with learning videos that can be played directly within the module. Each question is accompanied by ans-

wers or feedback, and answer keys are provided for practice questions and formative tests. Based on the results of the validation and revision that has been carried out, this e-module is considered feasible.

CONCLUSION

The developed intertextual-based e-module on acid-base titration concepts demonstrates a high level of feasibility across content, pedagogy, language, and media aspects. The validation results indicate strong agreement among experts, suggesting that the e-module is reliable and suitable for learning, with several minor revisions recommended to further improve its overall quality.

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