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Development of an E-Module Based on the Scientific Approach for Acid-Base Topics Using Canva for Grade XI

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Abstract

Chemistry learning on acid–base topics remains challenging because instructional materials are often dominated by textbooks and conventional modules that provide limited interactivity, flexibility, and support for independent learning. This study aimed to develop a scientific-approach-based e-module for acid–base chemistry using Canva and to evaluate its validity and user responses. The study employed a Research and Development (R&D) design using a modified 4-D model comprising the define, design, and develop stages. Conducted from October 2025 to June 2026 at the Chemistry Education Study Program, Universitas Riau, with product trials at SMA Negeri 5 Pekanbaru and SMA Negeri 9 Pekanbaru, the study involved two material experts, one media expert, two chemistry teachers, three students in a one-to-one trial, and 20 students in a small-group trial. Data were collected through interviews, validation questionnaires, user-response questionnaires, and documentation and were analyzed using descriptive quantitative and qualitative techniques. The findings showed that the e-module achieved a material validation score of 96.37% and a media validation score of 100%, both categorized as valid. Teacher and student responses reached 96.65% and 90.69%, respectively, both categorized as very good. These findings indicate that the developed e-module is valid and practical as an independent learning resource for acid–base chemistry. The study contributes a scientific-approach-based digital teaching resource that can support more active, interactive, and flexible chemistry learning. However, broader effectiveness testing is required to determine its impact on learning outcomes across larger populations.

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Keywords: Acid–Base Chemistry; Canva; Digital Learning Materials; E-Module; Scientific Approach

INTRODUCTION

Advancements in education and digital technology necessitate teaching materials that do more than simply convey content; they must also foster student engagement, independence, and critical thinking skills (Sidiq & Najuah, 2020). Teaching materials that are systematically organized and engaging can facilitate a more conducive learning environment (Ritonga et al., 2022). In chemistry education, this need is particularly critical given the subject's abstract and hierarchical nature, which demands high-level reasoning. Consequently, teaching materials must be designed to help students construct concepts in a gradual and meaningful manner.

A module is a type of teaching material designed to enable independent study through a systematic arrangement of learning objectives, content, activities, exercises, and evaluations (Fuad et al., 2020). Technological advancements have driven the transformation of print modules into e-modules accessible via electronic devices and enriched with images, videos, animations, and interactive links (Izza et al., 2023). These characteristics make e-modules highly relevant for supporting learning flexibility and the integration of technology into the educational process.

Preliminary research involving interviews with chemistry teachers at SMA Negeri 5 Pekanbaru and SMA Negeri 9 Pekanbaru revealed that the teaching materials currently in use consist primarily of textbooks, student worksheets (LKM), and modules provided by the Ministry of Education and Culture (Kemendikbud). The use of modules remains relatively infrequent, and existing materials are perceived as lacking in terms of informativeness, interactivity, and flexibility. Teachers also noted that some students lack interest in chemistry but become more engaged when the material is supplemented with relevant videos and images. Furthermore, the scientific approach had not been specifically employed in the observed lessons. These conditions highlight the need for digital teaching materials that integrate content, scientific activities, and multimedia into a single learning resource.

The scientific approach positions students as active participants through a process comprising observing, questioning, gathering information (or experimenting), reasoning, and

communicating (Qolbi et al., 2025). This approach aligns with the characteristics of chemistry learning, as it guides students to connect phenomena, data, and concepts. The development of e-modules using the scientific approach has also yielded positive results across various chemistry topics. Asmiyunda et al., (2018) reported very high validity and practicality for a chemical equilibrium e-module, while Hasanah et al., (2021) demonstrated that a chemistry module based on the scientific approach achieved high feasibility ratings and excellent student responses.

Previous research also indicates that the use of digital media and Canva can enhance the appeal of instructional materials. Azizah & Ardhana, (2023) developed a web-based interactive e-module using the scientific approach, achieving 80% validity from subject matter experts, 95.65% from media experts, and 83.3% effectiveness. Yuliana et al., (2023) obtained an average validation score of 97.70% for an interactive chemistry e-module based on the scientific approach using Liveworksheets. Banawi, (2019) also demonstrated that a 3D Pageflip e-module utilizing the scientific approach for the topic of colloids achieved very high validity and practicality. Meanwhile, research on Canva indicates that the platform facilitates the presentation of instructional materials that are more visual, interactive, and aligned with digital learning needs (Anggraini & Isnawati, 2023).

Although prior research has developed e-modules based on the scientific approach for other chemistry topics and utilized various digital platforms, there remains scope to develop an e-module on acid-base chemistry specifically designed as a self-directed learning resource using Canva. The novelty of this research lies in the integration of acid-base content with the 5M stages of the scientific approach within an e-module designed using Canva, incorporating visual elements and videos. The developed content covers acid-base theories, acid-base indicators, and the degree of acidity (pH), featuring learning activities that guide students from the observation stage through to the communication of results. Based on these issues and gaps, this study focuses on developing an e-module based on the scientific approach for the topic of acids and bases, utilizing the Canva application for Grade XI high school (SMA/MA) students. The study aims to produce a valid and practical e-module and to describe teacher and student responses to the developed product. It is expected to provide a practical contribution by offering an alternative digital teaching resource, as well as an academic contribution by providing information on the development of chemistry e-modules that integrate the scientific approach with digital design.

METHODS

This study employs the Research and Development (R&D) method, aiming to produce and validate a teaching material product. The 4-D development model (Define, Design, Develop, Disseminate) was utilized but modified to conclude at the "Develop" stage, as the study focused on producing a valid product and assessing user response rather than conducting widespread dissemination. The implemented development stages comprised defining, designing, and developing.

The research was conducted from October 2025 to June 2026 within the Chemistry Education Study Program at the Faculty of Teacher Training and Education (FKIP), Universitas Riau. Product trials were carried out at SMA Negeri 5 Pekanbaru and SMA Negeri 9 Pekanbaru. The Define stage involved front-end analysis, learner analysis, task analysis, content structure analysis, concept analysis, procedural analysis, and objective analysis. The Design stage produced an initial e-module draft containing identification details, learning outcomes and objectives, a concept map, usage instructions, subject matter, 5M activities (Observing, Questioning, Collecting Information, Associating, Communicating), multimedia elements, exercises, evaluations, and a bibliography. The Develop stage encompassed expert validation, revisions, one-on-one trials, teacher response assessment, and small-group trials.

Research participants included three validators: two lecturers serving as subject matter experts and one lecturer as a media expert. The teacher response assessment involved two chemistry teachers, one each from SMA Negeri 5 Pekanbaru and SMA Negeri 9 Pekanbaru. One-on-one trials involved three Grade XI students selected based on heterogeneous ability levels (high, medium, and low). Small-group trials involved 20 Grade XI students 10 from SMA Negeri 5 Pekanbaru and 10 from SMA Negeri 9 Pekanbaru who had already studied the topic of acids and bases.

Data collection instruments consisted of interview guidelines, subject matter expert validation sheets, media expert validation sheets, teacher response questionnaires, one-on-one trial questionnaires, and student response questionnaires. Subject matter validation covered content suitability, scientific approach characteristics, language suitability, presentation, and graphic design. Media validation covered visual appearance/communication and software utilization. User feedback assessed content suitability, appeal, effectiveness, and practicality. Quantitative data were analyzed

descriptively using score percentages, while qualitative data consisting of comments and suggestions served as the basis for product revisions.

RESULTS

Validation of the e-module was conducted to determine the product's suitability in terms of content and media. Content validation was carried out in two stages, whereas media validation took place after the product had received feedback regarding its visual design and software usability. Table 1 presents the results of the content validation across five assessment aspects.

Table 1. E-Module Validation Results by Content Validators

Assessment Aspect	Validation I	Validation II	Criterion
Content suitability	87.50%	100%	Valid
Scientific characteristics	85.00%	97.50%	Valid
Language suitability	81.25%	96.87%	Valid
Presentation suitability	87.50%	100%	Valid
Graphic suitability	75.00%	87.50%	Valid
Overall average	83.25%	96.37%	Valid

Based on Table 1 e-module validation results by conten validator indicate that all aspects showed improvement during the second validation following revisions. The overall average increased from 83.25% in the first validation to 96.37% in the second, meeting the "valid" criterion. Improvements were observed in the following aspects: content suitability (from 87.50% to 100%), scientific characteristics (from 85.00% to 97.50%), language suitability (from 81.25% to 96.87%), presentation suitability (from 87.50% to 100%), and graphic suitability (from 75.00% to 87.50%). These data demonstrate that, following improvements based on the validator's feedback, all e-module assessment aspects achieved higher percentages in the second validation and met the "valid" criterion.

Subsequently, media validation was conducted to evaluate the e-module's visual appearance and the use of software in product development. The results of the media validation are presented in Table 2.

Table 2. E-Module Media Validation Results

Assessment Aspect	Percentage	Criterion
Appearance	100%	Valid
Software utilization	100%	Valid
Overall average	100%	Valid

Based on the E-module media validation results in Table 2, the visual design aspect achieved a score of 100%, while the software usability aspect also achieved 100%. The overall average for media validation reached 100%, meeting the validity criteria. Feedback from the media validator included suggestions to add navigation images, video playback icons, and instructions for using the e-module on laptops and smartphones. After incorporating this feedback, the product was deemed valid in terms of media aspects. Overall, the validation results show that the e-module received a score of 96.37% from the content validator and 100% from the media validator. The validation data indicate that all assessment aspects met the validity criteria.

Teacher feedback was obtained from two teachers who evaluated the e-module based on content suitability, appeal, effectiveness, and practicality. The results of the teacher feedback are presented in Table 3.

Table 3. Teachers' Responses to the E-Module

Assessment Aspect	Percentage	Criterion
Content Suitability	100%	Excellent
Attractiveness	93.75%	Excellent
Effectiveness	92.85%	Excellent
Practicality	100%	Excellent
Overall Average	96.65%	Excellent

Source: Processed data, 2026

Data in Table 3 teachers' responses to the e-module indicate an average response rate of 96.65% for the e-module, placing it in the "very good" category. The content suitability and practicality aspects each achieved a score of 100%, while the appeal and effectiveness aspects scored 93.75% and 92.85%, respectively. Teachers also noted that the e-module is suitable for classroom instruction under teacher supervision and can be utilized by students for independent study at home. Feedback provided by the teachers suggested using a wider variety of materials for the acid-base indicator practical activities.

A small-group trial was conducted with 20 students from SMAN 5 and SMAN 9. Student responses were evaluated based on appeal, effectiveness, and practicality. The evaluation results are presented in Table 4.

Table 4. Student Responses in the Small-Group Trial

Assessment Aspect	SMAN 5	SMAN 9	Average	Criterion
Attractiveness	90.83%	88.33%	89.58%	Excellent
Effectiveness	94.00%	88.50%	91.25%	Excellent
Practicality	92.50%	90.00%	91.25%	Excellent
Overall average	92.44%	88.94%	90.69%	Excellent

Source: Processed data, 2026

Based on Table 4 student responses in the small-group trial, which details student responses from the small-group trial, the overall average response rate was 90.69%, falling into the "very good" category. The appeal aspect scored an average of 89.58%, while the effectiveness and practicality aspects each scored 91.25%. During the one-on-one trials, students reported that the e-module was easy to understand and accessible via the internet and digital devices. Students also provided feedback regarding the use of images and videos within the e-module; one suggestion was to include additional examples of pH calculation problems.

The developed e-module is a digital teaching resource based on the scientific approach, covering the topic of acids and bases for Grade XI high school students (SMA/MA or equivalent) and created using the Canva application. The product is designed as a self-study resource featuring an engaging visual layout and a variety of learning activities. The e-module incorporates the five stages of the scientific approach: observing, questioning, gathering information/experimenting, reasoning, and communicating.



Figure 1. E-Module Cover

The e-module cover features the topic (acid-base chemistry), developer details, the institution's logo, and illustrations related to chemistry learning. The design employs a color palette of dark blue, yellow, and white, incorporating chemistry-themed visual elements. It is

designed to be visually appealing and to stimulate students' interest in the material. The cover's appearance is also one of the components evaluated for attractiveness in the student response instrument.

The e-module content is systematically organized, comprising usage instructions, an introduction, module details, learning outcomes, learning objectives, a concept map, learning activities, practice questions, an evaluation section, and a bibliography. The core material is divided into three learning activities: (1) acid-base theories, (2) acid-base indicators, and (3) degree of acidity (pH).

In the first learning activity, the e-module covers the evolution of acid-base theories, specifically the Arrhenius, Brønsted-Lowry, and Lewis theories. The material is presented following the stages of the scientific approach and is supplemented by instructional videos and practice questions. The second learning activity focuses on acid-base indicators both natural and synthetic including color changes in acidic and basic environments; this section also includes videos and practice questions. Meanwhile, the third learning activity addresses the concept of pH, the relationship between pH and pOH, and calculations involving H^+ and OH^- ion concentrations, accompanied by videos and practice questions.

Visually, the e-module incorporates illustrations, images of chemical phenomena in everyday life, instructional videos, information boxes, and interactive activities. Students are encouraged not merely to read the material but also to observe phenomena, answer questions, conduct analyses, and communicate their reasoning. For instance, one page presents the Arrhenius theory, featuring an image of the scientist, reaction equations, an illustration of the ionization process, and examples of real-life applications.



Figure 2. Content Display Of The E-Module On The Topic Of Acid-Base Theory

Figure 2 displays a section of the e-module covering the Arrhenius acid-base theory. The e-module pages feature an engaging visual layout that combines text, images of the scientist, illustrations, and chemical reaction equations to help students grasp the concepts more concretely. The material begins by introducing Svante Arrhenius, the scientist who developed the acid-base theory, followed by an explanation that acids are substances that produce H^+ ions, while bases produce OH^- ions in aqueous solution.

To clarify the concepts, the e-module presents the example of an HCl reaction in water, illustrating the formation of H^+ and Cl^- ions. Particle illustrations of the solution are also used to help students connect reaction equations to the state of substances at the microscopic level. Additionally, a section highlighting key information links the Arrhenius theory concepts to the primary components of acidic and basic solutions. This presentation combining textual explanations, images, reaction equations, and illustrations is intended to facilitate a gradual understanding of acid-base concepts and boost student interest in the subject matter.

DISCUSSION

Research results indicate that the development of an e-module based on the scientific approach covering acid-base topics and created using Canva yielded a product that meets feasibility criteria. During the definition stage, it was found that existing teaching materials relied heavily on textbooks and modules containing only content explanations and practice questions, thereby failing to fully facilitate active and independent learning. Furthermore, students struggled to grasp abstract acid-base concepts and relate them to everyday phenomena. These conditions provided the basis for developing an e-module that integrates content, scientific activities, and multimedia elements.

During the content validation stage, improved ratings across all aspects demonstrated that revisions based on validator feedback successfully refined the product. Improvements focused on aligning content with Learning Outcomes; linking association activities to observational findings; ensuring the correct use of chemical symbols, notation, and punctuation; clarifying video usage instructions; and balancing text with illustrations. Regarding content feasibility, for instance, examples of acid-base concepts applied in daily life were added to strengthen the link between the material and the students' real-world

contexts. This aligns with the view of Magdalena et al., (2020) that teaching materials should adopt a contextual approach to connect content with students' actual experiences.

Revisions also reinforced the application of the scientific approach within the e-module. Activities involving observing, questioning, gathering information, associating, and communicating were structured to ensure greater continuity. The association stage was revised to ensure that students' analytical activities directly related to information obtained in the preceding stage. Consequently, the e-module's activity structure does not merely present scientific stages in isolation but links them within a cohesive learning flow.

Regarding language, refinements were made to chemical symbols, notation, and punctuation usage. In terms of presentation, improvements included adding video playback instructions to provide students with clearer guidance when using supplementary media. Finally, regarding graphic design, revisions involved adding relevant illustrations and adjusting the layout of pages that were previously dominated by text. The improvements resulted in higher ratings during the second validation. The media validation also indicated that the visual design and software usability met the feasibility criteria. Despite receiving maximum ratings, the validators provided suggestions specifically regarding the addition of navigation graphics, video playback icons, and usage instructions for both laptops and smartphones to further refine the product's usability prior to user testing.

User feedback indicates a positive reception of the e-module. Teachers rated the module highly in terms of content suitability, appeal, effectiveness, and practicality. Student trials showed that the e-module was usable, comprehensible, and accessible via digital devices. Students responded positively to the use of images and videos, although they suggested adding example problems involving pH calculations. Small-group trials also yielded results in the "very good" category. These findings align with previous research on the development of modules and e-modules based on the scientific approach. Regarding content suitability, studies by Yuliana et al., (2023), Hasanah et al., (2021), and Azizah & Ardhana, (2023) reported scores of 98.00%, 93.33%, and 80%, respectively. The current study achieved a higher content suitability score during final validation compared to those three studies. This difference can be attributed to the product revision process guided by validator feedback specifically, aligning the material with Learning Outcomes and incorporating real-life contexts.

Regarding the scientific approach characteristics, the study by Aprilia & Wardana, (2024) achieved a score of 100%, whereas the current study achieved 97.50% during final validation. Although the percentage was slightly lower, the results confirm that the stages of the scientific approach were successfully integrated into the e-module. Variations in results may stem from differences in product characteristics, subject matter, and the assessment instruments used in each study. In terms of language, this study achieved a score of 96.87%, compared to 93.33% in the study by Tri & Yulian, (2018), indicating a high level of language quality in the e-module.

Regarding graphic design, this study achieved a score of 87.50% following revisions, whereas Lestari et al., (2021) achieved 83.99%. The results demonstrate an improvement in visual quality following the addition of illustrations and layout enhancements. These findings align with Mukarromah & Andriana, (2022), who explain that incorporating visual elements into teaching materials helps clarify information and boost student engagement. Lavtania et al., (2021) also indicate that effective design and layout contribute to the validity of the product. User feedback further reinforces these earlier research findings. The teachers' positive response to the e-module is consistent with the findings of Erlangga & Dwiningsih, (2024) regarding interactive chemistry e-modules, while the results concerning the implementation of the scientific approach align with Hapsari et al., (2019). Regarding practicality, the results also concur with April et al., (2025), showing that a practical e-module can support the learning process and foster student learning independence.

The research findings have implications for the development of digital teaching materials in chemistry education, specifically regarding the topic of acids and bases. The developed e-module goes beyond merely providing content and exercises; it integrates the stages of the scientific approach observing, questioning, gathering information, associating, and communicating. This integration offers teachers an alternative way to provide teaching materials that support student learning activities in a more structured manner. The use of Canva and multimedia elements provides an alternative method of presenting material that is accessible via digital devices. Images, videos, illustrations, navigation features, and usage instructions are integral to the product design, facilitating the e-module's use both inside and outside the classroom. Teacher feedback indicates that the e-module is suitable for use with teacher guidance or as a resource for independent study at home. This aligns with Baroroh et al., (2024), who explains that the use of technology in education offers flexibility in accessing learning resources.

Another implication relates to the presentation of abstract acid-base concepts. The inclusion of illustrations, videos, and real-life application examples provides a more diverse range of representations for delivering the material. Manurung, (2020) explain that multimedia in digital learning materials can support students' attention, motivation, and understanding. Thus, the developed e-module can serve as an alternative digital learning resource for teaching acid-base concepts at the high school (SMA/MA) level. This study has several limitations. First, while the development utilized the 4-D model, the research was conducted only up to the third stage Define, Design, and Develop meaning the Disseminate stage was not extensively carried out. Second, user testing was conducted on a limited scale, involving two teachers and a specific group of students; consequently, the feedback received may not fully reflect the acceptance of the e-module among a broader population. Third, the study focused primarily on the product's validity and user response, without extensively testing the impact of the e-module on improving learning outcomes or specific skills through an experimental design.

CONCLUSION

This research produced an e-module based on the scientific approach covering acid-base topics, created using Canva for Grade XI high school students (SMA/MA or equivalent). The product was developed following the Define, Design, and Develop stages of the 4-D model. Validation results yielded an average score of 96.37% for content and 100% for media, both falling into the "valid" category. Teacher feedback (from two teachers) reached 96.65%, while student feedback (from 20 students in a small-group trial) reached 90.69%; both were rated as "excellent." These findings indicate that the e-module is suitable and practical for use as an independent learning resource. The research contributes by providing an alternative digital teaching material that integrates acid-base content, the 5M scientific approach, and visual/multimedia elements into a single product. Future research should extend development to the Disseminate stage, involve a larger sample, and conduct effectiveness testing via an experimental design to determine the impact of the e-module on conceptual understanding, learning independence, motivation, and chemistry learning outcomes.

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