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Development of Smart Apps Creator-Based Interactive Chemistry Learning Media Integrated with Discovery Learning for Acid-Base Topics

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Abstract
This study aimed to develop Smart Apps Creator (SAC) based interactive chemistry learning media integrated with the Discovery Learning model for acid-base topics and to determine the validity and practicality. This study employed Research and Development (R&D) method with the 4D development model consisting of Define, Design, Develop, and Disseminate stages. The research participants included 3 expert validators, 2 chemistry teachers, and 36 students of class XI-7 at SMA Negeri 13 Medan. Data were collected through interview guidelines, expert validation sheets, and teacher and student response questionnaires. The results showed that the developed media obtained an overall validation score of 87%, consisting of 84% from material experts and 88% from media experts, indicating that the media was very feasible. Teacher and student responses reached 92% and 85%, respectively, indicating that the media was very practical for classroom implementation. Therefore, the developed learning media is considered valid and practical for acid-base instruction. However, further research is needed to examine its effectiveness in improving students' conceptual understanding and learning outcomes.

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INTRODUCTION

Advances in information and communication technology have significantly transformed various aspects of life, including education. The integration of technology into the learning process plays an important role in improving educational quality and supporting students in developing twenty-first-century competencies. Therefore, teachers are expected to integrate technology effectively into classroom instruction to create innovative, interactive, and student-centered learning environments (Husniyah et al., 2022) . The ability to integrate technology, pedagogy, and content knowledge is reflected in the *Technological Pedagogical Content Knowledge* (TPACK) framework, which emphasizes the selection of appropriate technologies to support effective learning processes (Suyamto et al., 2020).

Chemistry is a branch of science that involves the study of matter and its transformations at the macroscopic, submicroscopic, and symbolic levels. Due to the abstract nature of many chemistry concepts, students often encounter difficulties in understanding the subject matter. One topic that is frequently associated with learning difficulties is acid-base chemistry. Previous studies have reported that students experience misconceptions and difficulties in understanding acid-base theories, acid-base indicators, acid-base strength, and pH-related concepts (Ekawisudawati et al., 2021; Farizal et al., 2024). These difficulties may hinder students' conceptual understanding and academic achievement.

Based on interviews conducted with chemistry teachers at SMA Negeri 13 Medan, chemistry instruction is still predominantly delivered through lecture-based methods and printed textbooks. Although the school has established specific learning achievement targets, only approximately 40% of students have achieved the

expected level of mastery. Furthermore, students often experience difficulties in understanding abstract acid-base concepts. These findings indicate the need for innovative learning resources that can facilitate conceptual understanding and promote active student engagement.

One potential solution to address these challenges is the development of interactive learning media using Smart Apps Creator (SAC). Smart Apps Creator is a multimedia authoring application that enables the development of interactive learning media without requiring programming skills. The application supports the integration of various multimedia elements, including text, images, animations, audio, videos, and interactive quizzes, into a single learning platform (Rosdiana et al., 2024). Previous studies have demonstrated the educational potential of SAC-based learning media. Ghani & Maslikhah (2023) reported that SAC-based interactive learning media significantly improved students' learning outcomes, while Nuryandis et al. (2024) found that SAC-based media contributed to improvements in learning outcomes, learning motivation, and learning activities. These findings suggest that SAC has considerable potential to support students in understanding abstract chemistry concepts.

In addition to appropriate learning media, the selection of an effective instructional model is essential for achieving learning objectives. One instructional model that can be implemented is *Discovery Learning*. This student-centered model encourages learners to construct knowledge independently through exploration, investigation, data collection, data processing, verification, and conclusion drawing. Through these activities, students actively participate in the learning process and develop a deeper understanding of scientific concepts. Rahayu et al. (2025) demonstrated that Discovery Learning significantly improved students' cognitive learning outcomes. Biya et al. (2023) proved that Discovery Learning enhanced understanding of thermochemical concepts. Hasanah & Prayogo (2023) revealed that Discovery Learning increased learning achievement from 48% in Cycle I to 95% in Cycle II.

Several previous studies have explored the use of SAC-based learning media and the implementation of the *Discovery Learning* model in chemistry learning, demonstrating their potential to support student engagement and conceptual understanding. However, limited studies have integrated Smart Apps Creator-based interactive chemistry learning media with the *Discovery Learning* model specifically for acid-base instruction. Furthermore, research examining the validity and practicality of learning media that combine these two approaches remains scarce.

Therefore, this study aimed to develop SAC-based interactive chemistry learning media integrated with Discovery Learning for acid-base topics, determine its validity based on expert validation, and determine its practicality based on teacher and student responses.

METHOD

This study employed a Research and Development (R&D) approach using the 4D development model (Thiagarajan et al., 1974), consisting of four stages: Define, Design, Develop, and Disseminate. The dissemination stage was implemented on a limited basis and did not include a full effectiveness test of the media on student learning outcomes.

Define

This phase aimed to identify problems in teaching and learning acid-base chemistry through needs analysis and a literature review. The needs analysis was conducted through interviews with chemistry teachers and students at SMA Negeri 13 Medan, along with an analysis of the Merdeka Curriculum, student characteristics, and the characteristics of acid-base material.

Design

This phase included selecting the development platform, choosing the format, designing the user interface using Canva, and creating initial drafts in the form of storyboards and flowcharts. The media was designed in Android application (APK) and Executable (EXE) formats, incorporating Discovery Learning syntax across six stages: stimulation, problem statement, data collection, data processing, verification, and generalization.

Develop

This phase included product creation, expert validation, and product revision. The product was developed using SAC as the primary platform, with visual design created in Canva.

Validation was conducted by three faculty members from Universitas Negeri Medan, comprising subject matter experts and media experts. The validators were selected based on their expertise in chemistry education and educational technology. Following validation, the product was revised based on the validators' suggestions and feedback.

Disseminate

Distribution was limited to two chemistry teachers and 36 students in Class XI-7 at SMA Negeri 13 Medan via a Google Drive link. The media was distributed in APK format for smartphone access and EXE format for laptop or computer access. After using the media, students and teachers completed response questionnaires to assess its practicality. This limited dissemination stage was not intended to test the effectiveness of the media on student learning outcomes.

Research Subjects and Instruments

The research subjects consisted of three faculty validators (subject matter and media experts), two chemistry teachers, and 36 students from Class XI-7 SMA Negeri 13 Medan. Data collection instruments included: (1) a subject matter expert validation sheet consisting of 41 items covering four aspects (content feasibility, presentation feasibility, language feasibility, and contextual assessment); (2) a media expert validation sheet consisting of 21 items covering three aspects (linguistic, software engineering, and visual display); (3) a teacher response questionnaire consisting of 16 items covering three aspects (appearance and user experience, practicality, and media content); and (4) a student response questionnaire consisting of 18 items covering six aspects (content, media, presentation, language, software, and efficiency). All instruments used a four-point Likert scale.

Data Analysis Techniques

Validity Analysis

The validity analysis used a four-point rating scale shown in Table 1.

Table 1. Expert Validation Feasibility Criteria

Assessment Criteria	Scale Value
Very Feasible	4
Feasible	3
Less Feasible	2
Not Feasible	1

Percentage of validity was calculated as formula below.

$$\%\ Validation = \frac{Total\ Score}{Maximum\ Score} \times 100\%$$

Results were interpreted according the categories in Table 2.

Table 2. Validation Percentage Categories

Category	Percentage
Not Feasible	0% - 40%
Less Feasible	41% - 60%
Feasible	61% - 80%
Very Feasible	81% - 100%

Practicality Analysis

The practicality analysis used a four-point rating scale shown in Table 3.

Table 3. Practicality Assessment Criteria

Assessment Criteria	Scale Value
Strongly Agree	4
Agree	3
Somewhat Agree	2
Disagree	1

Practicality percentage was calculated as:

$$\%\ Practicality = \frac{Total\ Score}{Maximum\ Score} \times 100\%$$

Results were interpreted using the categories in Table 4.

Table 4. Practicality Percentage Categories

Category	Percentage
Not Practical	0% - 40%
Less Practical	41% - 60%
Practical	61% - 80%
Very Practical	81% - 100%

RESULTS AND DISCUSSION

Result

Define

The needs analysis revealed that chemistry instruction at SMA Negeri 13 Medan is still dominated by conventional lecture-based approaches with textbooks as the primary learning resource. Interviews with teachers indicated that students experience difficulties understanding acid-base concepts, particularly concepts requiring visualization at macroscopic, submicroscopic, and symbolic representation levels. Student achievement data also showed that only approximately 40% of students met the expected learning mastery criteria. These findings indicate the need for interactive learning media to support chemistry instruction.

Design

During the design phase, storyboards and flowcharts were developed to guide the creation of the educational media. The media was designed with a predominantly blue-green color

scheme, incorporating text, images, instructional videos, animations, background music, and interactive quizzes. The sequence of material presentation was explicitly organized according to the six stages of Discovery Learning as follows. In the stimulation stage, students are presented with a short video of the acid rain phenomenon to arouse curiosity and motivate engagement with the material. In the problem statement stage, a guiding question is displayed to direct students toward identifying the relationship between acid-base properties and their real-world effects.

In the data collection stage, conceptual material on acid-base theories, indicators, and strength is presented through text, images, and animations covering all three levels of chemical representation—macroscopic, submicroscopic, and symbolic. In the data processing stage, embedded practice questions prompt students to analyze and apply the concepts they have encountered. In the verification stage, students check their answers against the provided solution and explanations. Finally, in the generalization stage, a summary is presented to help students consolidate and articulate the key principles they have discovered. The flowchart of the media structure is presented in Figure 1.

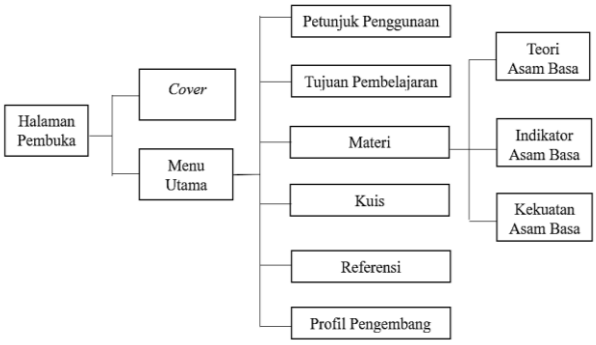

Figure 1. Structure of Learning Media Flow

Develop

At the development stage, an Android-based interactive chemistry learning media integrated with the Discovery Learning model was successfully developed using Smart Apps Creator (SAC). The developed media consists of several main components, including a cover page, main menu, learning objectives, user guide, learning materials, interactive quizzes, references, and developer profile. The learning materials cover acid-base theories, acid-base indicators, and acid-base strength concepts. Screenshots of the developed learning media are presented in Figure 2.

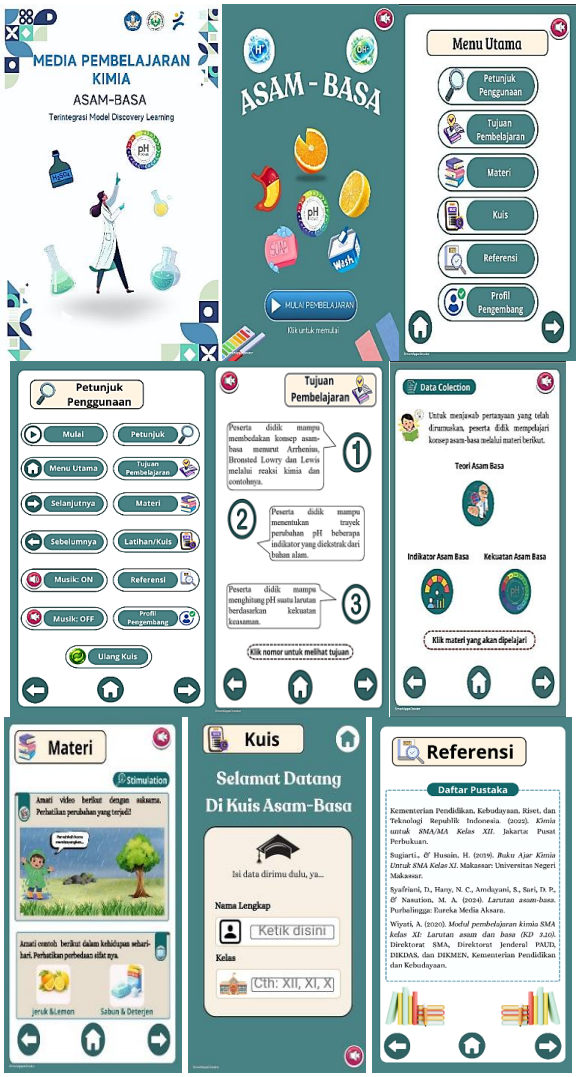

Figure 2. User Interface of the Developed SAC-Based Interactive Learning Media: (a) Cover Page, (b) Main Menu, (c) Learning Material Page, (d) Quiz Page, and (e) Reference Page

The developed media also incorporates an interactive quiz feature that provides immediate feedback after students complete the questions. This feedback helps students identify misconceptions, evaluate their level of understanding, and reflect on the concepts they have learned. By receiving direct feedback, students are encouraged to review and verify their answers, which is consistent with the verification stage of the Discovery Learning model. Consequently, the quiz serves not only as an assessment tool but also as a learning support feature that promotes conceptual understanding and self-directed learning.

Subject Matter Expert Validation

Subject matter expert validation was conducted by three validator faculty members who completed an evaluation questionnaire

consisting of 41 items covering four aspects. The results are presented in Table 5.

Table 5. Recapitulation of Subject Matter Expert Validation Results

Aspect	Average	Percentage	Category
Content Feasibility	3.40	85%	Very Feasible
Presentation Feasibility	3.33	83%	Very Feasible
Language Feasibility	3.44	86%	Very Feasible
Contextual Assessment	3.30	82%	Very Feasible
Overall Average	**3.37**	**84%**	**Very Feasible**

Based on Table 5, the overall average score for subject matter expert validation was 3.37, with a feasibility percentage of 84%, categorized as Very Feasible. The language feasibility aspect received the highest percentage (86%), indicating that the language used is communicative and appropriate for high school students. The contextual assessment aspect received the lowest score (82%), indicating that the material has been connected to real-world situations such as the acid rain phenomenon.

Media Expert Validation

Media expert validation was conducted by three validator faculty members who completed an evaluation questionnaire consisting of 21 items covering three aspects. The results are presented in Table 6.

Table 6. Recapitulation of Media Expert Validation Results

Aspect	Average	Percentage	Category
Linguistic	3.67	92%	Very Feasible
Software Engineering	3.62	90%	Very Feasible
Visual Display	3.43	86%	Very Feasible
Overall Average	**3.57**	**88%**	**Very Feasible**

Based on Table 6, the overall average score for media expert validation was 3.57, with a feasibility percentage of 88%, categorized as Very Feasible. The linguistic aspect received the highest score (92%), indicating that the language used in the media is clear, precise, and communicative. The software engineering aspect (90%) indicates that inter-page navigation is smooth and the media can be accessed offline.

Table 7. Overall Recapitulation of Validation Results

Type of Validation	Average	Percentage	Category
Subject Matter Validation	3.37	84%	Very Feasible
Media Validation	3.57	88%	Very Feasible
Average Overall	**3.47**	**87%**	**Very Feasible**

Based on Table 7, the overall average validation score is 3.47, with 87% categorized as Very Feasible, indicating that the developed media meets the validity criteria in terms of both content and media quality.

Disseminate

The dissemination stage was conducted on a limited scale involving two chemistry teachers and 36 students of class XI-7 at SMA Negeri 13 Medan. The learning media was distributed in APK format through a Google Drive link. After using the media, teachers and students completed response questionnaires to evaluate the practicality of the developed product.

Teacher Responses

Teacher response assessment was conducted by two chemistry teachers who completed a questionnaire consisting of 16 items covering three aspects. The results are presented in Table 8.

Table 8. Recapitulation of Teacher Response Results

Assessment Aspect	Percentage	Category
Appearance & User Effects	93%	Very Practical
Practicality	90%	Very Practical
Media Content	94%	Very Practical
Average Overall	**92%**	**Very Practical**

Based on Table 8, the overall teacher response score was 92%, categorized as Very Practical. The media content aspect received the highest score (94%), indicating that the material presented is well-aligned with the learning needs for acid-base topics.

Student Responses

Student response assessment was conducted by 36 students who completed a questionnaire consisting of 18 items covering six aspects. The results are presented in Table 9.

Table 9. Recapitulation of Student Response Results

Assessment Aspect	Percentage	Category
Content	86%	Very Practical
Media	80%	Very Practical
Presentation	89%	Very Practical
Language	88%	Very Practical
Software	82%	Very Practical
Efficiency	88%	Very Practical
Average Overall	**85%**	**Very Practical**

Based on Table 9, the overall student response score was 85%, categorized as Very Practical. The presentation aspect received the highest score (89%), indicating that the visual design was engaging. The media aspect received the lowest score (80%), which, while still Very Practical, suggests that some interactive features may benefit from further refinement in future development.

Discussion

Validity of the Developed Media

The results showed that the Smart Apps Creator (SAC)-based interactive chemistry learning media integrated with the Discovery Learning model achieved an overall validity score of 87%, which falls into the Very Feasible category. This result indicates that the developed media meets the required standards in terms of content suitability, presentation, language, software engineering, and visual communication. The high validity score is associated with the integration of multimedia elements, including text, images, animations, videos, audio, and interactive quizzes, which were systematically designed to support the learning objectives of acid-base topics. The media was also developed based on the stages of the Discovery Learning model, ensuring alignment between learning activities and instructional objectives.

These findings are consistent with previous studies reporting that Smart Apps Creator can be used to develop valid and feasible chemistry learning media (Ghani & Maslikhah, 2023; Nuryandis et al., 2024). The integration of various multimedia features enables learning content to be presented in a more interactive and engaging manner, thereby supporting students in understanding chemistry concepts that are often considered abstract. Acid-base topics in particular require students to connect three levels of chemical representation: macroscopic phenomena (e.g., the color change of an indicator), submicroscopic processes (e.g., the ionization of acid and base particles), and symbolic notation (e.g., chemical equations and pH values). By combining visual animation, simulation, and text-based explanation within a single application, SAC-based media can present these three levels simultaneously, which is difficult to achieve through conventional textbooks alone. This is consistent with Hutasoid (2023), who found that SAC-assisted interactive multimedia was rated as feasible because it helps bridge abstract chemical representations through visual and animated content.

Practicality of the Developed Media

The practicality results further demonstrated that the developed media received highly positive responses from both teachers and students. Teacher responses yielded a score of 92%, while student responses reached 85%, both categorized as Very Practical. These findings indicate that the media is easy to use and can be implemented effectively in classroom learning activities. The high practicality score is supported by the user-friendly interface, clear navigation system, and accessibility of the application through Android devices, in line with Nursalimah & Sutisna (2024), who reported that SAC-based Android media was considered practical because of its ease of use and accessibility. These features enable students to access learning materials anytime and anywhere, thereby supporting flexible learning experiences.

Another factor contributing to the practicality of the media is the incorporation of the Discovery Learning model. Through stages such as stimulation, problem statement, data collection, data processing, verification, and generalization, students are encouraged to participate actively in constructing their understanding of acid-base concepts, consistent with Rahayu et al. (2025) and Biya et al. (2023), who found that Discovery Learning-based media supported active student engagement. Furthermore, the interactive quiz feature provides immediate feedback, allowing students to identify misconceptions, evaluate their understanding, and review concepts that require further study. This feature supports independent learning and aligns with the verification stage of Discovery Learning.

Limitations and Future Research

Despite the positive validity and practicality results, this study has several limitations. The dissemination stage was conducted on a limited

scale involving only one class and two chemistry teachers at a single school, so the findings cannot yet be generalized to broader or more diverse classroom contexts. In addition, the study focused solely on the validity and practicality of the developed media and did not evaluate its effectiveness in improving students' learning outcomes or conceptual understanding. Therefore, future studies are recommended to investigate the effectiveness of the media through experimental or quasi-experimental research designs involving larger and more diverse samples.

CONCLUSION

Based on the research findings and discussion, the following conclusions can be drawn: 1) The interactive chemistry learning media based on Smart Apps Creator (SAC) integrated with the Discovery Learning model for acid-base topics is valid based on expert validation, with an overall average score of 3.47 (87%), categorized as Very Feasible. Subject matter expert validation yielded 84% and media expert validation yielded 88%. The developed media meets the validity criteria in terms of both content and media and is suitable for use in chemistry instruction, and 2) The media is practical based on teacher and student responses. Teacher responses yielded 92% and student responses yielded 85%, both categorized as Very Practical. The media is considered engaging and easy to use in the acid-base learning process. However, the effectiveness of the media on student learning outcomes still requires testing in future research.

RECOMMENDATION

Based on the research findings, the following recommendations can be made: 1) For teachers: SAC-based learning media integrated with Discovery Learning may be used as an alternative medium to support chemistry instruction on acid-base topics. 2) For future researchers: A quasi-experimental or experimental design is recommended to test the effectiveness of the media on students' conceptual understanding, critical thinking skills, and learning outcomes. Wider trials across different schools are also encouraged. 3) For media developers: Future development may expand to other abstract chemistry topics, improve the interactivity of simulations, add usability testing, and incorporate accessibility improvements.

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