PUSTAKA DIDAKTIS
JURNAL MEDIA DAN MODEL PEMBELAJARAN
Vol.1, No.2 (January – 2026)
E-ISSN: 3110-1429
pp.80-88

Needs Analysis for Developing Interactive Digital Comics in the Acid–Base Topic for Grade XII Students at SMA Negeri 2 Siak Hulu

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Abstract
Education plays a strategic role in improving the quality of human resources, including through chemistry learning at the senior high school (SMA) level. Nevertheless, learning about acids and bases still faces various constraints, especially students' low motivation to learn and the limited availability of engaging, contextual learning media. This study aims to analyze the need for developing interactive digital comics as learning media for the acid–base topic in Grade XII. The study used a descriptive quantitative approach with a survey method. The participants included students and chemistry teachers at SMA Negeri 3 Siak Hulu. Data were collected through a needs analysis questionnaire that covered learning approaches, methods and models, learning motivation, and the need for digital learning media. The results show that the level of need for developing instructional tools is in the very high category, with an average percentage of 82.29%. The approach/method/model indicator obtained the highest percentage (85.42%), followed by student learning motivation (84.38%) and the need for digital learning media (77.08%). These findings indicate that interactive digital comics have the potential to become an effective alternative learning medium to enhance motivation and understanding of acid–base concepts. Thus, developing interactive digital comics is considered relevant and necessary as an innovation in chemistry learning media for Grade XII.

Article History
Received: January, 2026
Reviewed: January, 2026
Published: January, 2026

Key Words
Acid–base; chemistry learning; education; interactive digital comics; needs analysis.

How to Cite: Ani, F., Hidayati, N., & Yulis, P. A. R. (2026). Needs Analysis for Developing Interactive Digital Comics in the Acid–Base Topic for Grade XII Students at SMA Negeri 2 Siak Hulu. *PUSTAKA DIDAKTIS: Jurnal Media dan Model Pembelajaran, 1*(2). 80-88.

INTRODUCTION

Education, broadly defined, encompasses the entire continuum of human life processes that unfold continuously and cumulatively. It occurs not only within formal school settings but also in families, communities, and other social environments. Education is, therefore, a lifelong learning process through which individuals acquire knowledge, skills, values, and attitudes via lived experiences. Accordingly, education includes activities that positively influence individuals' cognitive, affective, and psychomotor growth and development (Pristiwanti et al., 2022). In this context, teaching may also be understood as an interactional process between educators and learners that can occur anytime and anywhere, is not confined to the classroom, and leverages a variety of available learning resources and media. With rapid advances in science and technology, education systems must adapt to contemporary changes, particularly the characteristics of learners in the digital era. Today's learners are highly familiar with digital technology, visual information, and interactive multimedia; therefore, strengthening the use of interactive multimedia in science learning, including the acid–base topic, has become increasingly relevant (Nirwesthi, 2025). Consequently, school learning processes should be designed innovatively to capture learners' attention, enhance learning motivation, and promote active engagement in understanding subject matter.

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At the secondary level, particularly in senior high school (SMA), chemistry plays a strategic role in cultivating learners' scientific thinking. Chemistry functions not merely as a collection of concepts and formulas, but also as a vehicle for developing critical thinking, problem-solving, and the ability to connect scientific ideas with natural phenomena and everyday life. Nevertheless, chemistry is often perceived as difficult by many learners. This perception is partly attributable to the abstract nature of many chemical concepts, the need for higher-order thinking, and the use of three levels of representation—macroscopic, microscopic, and symbolic. For this reason, instructional approaches that foreground multiple representations through interactive multimedia are important for bridging conceptual abstraction (Amiruddin et al., 2024). One chemistry topic that learners commonly find challenging is acids and bases. This unit includes various abstract concepts, such as acid–base theories (Arrhenius, Brønsted–Lowry, and Lewis), pH and pOH, degree of ionization, acid and base strength, and their applications in daily life (Chang & Goldsby, 2016). The conceptual complexity often makes it difficult for learners to understand relationships among ideas. As a result, acid–base learning tends to focus on memorizing formulas and calculation procedures rather than on deep conceptual understanding. This condition negatively affects learners' ability to solve contextual problems and real-world tasks related to acids and bases (Sari & Prasetyo, 2020).

These issues indicate the need for innovation in developing instructional materials that can present acid–base concepts in a more concrete, engaging, and comprehensible manner. High-quality instructional materials should not only convey content but also facilitate meaningful learning experiences that enable learners to construct understanding. One alternative that aligns with learners' needs in the digital era is the interactive digital comic. Interactive digital comics integrate visual elements (images), narrative text, storylines, and digital interactivity features. This medium is advantageous because it can present content contextually and communicatively, thereby helping learners understand abstract concepts through visual illustrations and stories that are close to everyday life (Putra & Irawan, 2021). Consistent with this, the development of electronic chemistry comics on acid–base topics has been widely examined as a feasible and relevant medium for senior high school students, both as dedicated acid–base e-comics and as related chemistry learning comics (Halawa et al., 2022; Asmiarsih & Rusmini, 2019). Moreover, the formats of digital comics/e-comics are increasingly diverse; for example, the use of flipbook/3D page-flip applications for acid–base theory highlights that electronic comics can be designed to be more interactive and to support self-directed learning (Najul et al., 2023). In chemistry learning more broadly, comics have also been reported as a strategy to enrich concept representations and increase instructional attractiveness (Kurniawati et al., 2023). Interactive digital comics can therefore enable learners to study independently or with guidance while providing a more enjoyable learning experience.

A growing body of research shows that comics used as learning materials can increase motivation to learn, reading interest, and learners' active engagement in the learning process (Nugraha et al., 2020). Similar conclusions are reported in literature reviews on the implementation of digital comics in senior high school chemistry learning, which underscore the potential of digital comics as media that support engagement and conceptual understanding (Silalahi et al., 2023). Furthermore, digital comics can be designed to foster specific higher-order cognitive skills, such as training metacognitive skills through validated digital comics in other chemistry topics (Choiriyah & Hidayah, 2023), and strengthening chemical literacy via e-cartoon media in particular chemistry topics (Hasanah et al., 2024). Through compelling storylines and characters that resonate with learners' lives, acid–base

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concepts can be framed as contextual problems, helping learners connect theory to authentic applications; this approach is aligned with the development of digital comics based on instructional models such as PBL on acid–base materials, which positions contextual problems as learning triggers (Arham, 2025). Accordingly, interactive digital comics have the potential to address learners' difficulties in acid–based learning while improving the quality of chemistry instruction at the SMA level. Based on this rationale, a preliminary needs analysis is required to examine learning conditions, learner characteristics, and the need for appropriate learning media. Therefore, this study aims to investigate the needs of students and teachers as a basis for designing and developing effective, engaging learning media that align with learners' characteristics, with the expectation of improving students' conceptual understanding and learning outcomes in acids and bases. This emphasis is also consistent with broader e-comic development practices (Mujtahidin et al., 2024), which indicate that electronic comics can be adapted to different content areas and learner characteristics.

RESEARCH METHOD

This study was conducted at SMA Negeri 2 Siak Hulu in December 2025. The study employed a mixed-methods approach. According to Creswell and Plano Clark (2018), mixed methods is an approach that integrates the collection, analysis, and interpretation of quantitative and qualitative data within a single study or a series of studies. This integration is intended to complement and strengthen the findings, resulting in more valid and comprehensive evidence. Sugiyono (2021) likewise notes that mixed methods are used when researchers seek more complete, accurate, and in-depth data by combining the strengths of quantitative and qualitative methods within a single investigation.

The research participants comprised one Grade XII chemistry teacher and students from Grade XII-4. Data were collected using three instruments: (1) a needs analysis questionnaire with a five-category Likert scale (Tables 1 and 2), (2) a semi-structured interview guide (Table 3), and (3) an observation sheet for classroom learning processes. The questionnaire was used to identify students' needs related to the instructional content and the learning strategies employed. Interviews were conducted to obtain more in-depth information regarding students' learning constraints, the perceived utility of visual media, and input relevant to developing interactive digital comics. Classroom observation was conducted to document the learning situation directly, including the types of media used by the teacher and the level of student engagement during the learning activities. Quantitative data were analyzed using percentages, which were interpreted according to the categories shown in Table 4.

Table 1. Questionnaire Indicators for Needs Assessment

Aspect	Indicators
Digital-Based Learning	Media and other references used by the school
Learning Media	Designing and updating learning media
Comic Display and Features	Text readability; layout neatness; image quality; design consistency; color appearance and visual appeal
Learning Model	Learning methods and models
Development	Development of learning media

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Table 2. Indicators for the Semi-Structured Interview Guide

Aspect	Indicators
Curriculum	Type of curriculum used for chemistry learning at the school
Instructional Materials	Availability of instructional tools (lesson plans/RPP, modules, student worksheets/ LKPD) for the acid–based topic
Learning Media	Types of chemistry learning media used by the teacher
Learning Models and Methods	Learning models and methods used in the acid–base unit
Students	Students' level of participation in the chemistry learning process
Development of Chemistry Comics	Teachers' perspectives and expectations regarding the development of chemistry comics for the acid–base topic

Table 3. Response Options and Scores for the Student Needs Analysis Questionnaire

Response Option	Score
Yes	1
No	0

Table 4. Score Intervals and Categories for the Student Needs Questionnaire

Interval	Category
81%–100%	Strongly needed
61%–80%	Needed
41%–60%	Moderately needed
21%–40%	Less needed
0%–20%	Not needed

RESULT AND DISCUSSION

The classroom observations conducted at SMA Negeri 2 Siak Hulu were analyzed quantitatively to obtain data that are more objective and measurable. This analysis aimed to identify the observed aspects and determine trends or patterns emerging from them. The processed data were then presented in tables and diagrams to facilitate visualization and interpretation of the findings. Such a presentation is expected to provide a comprehensive overview and serve as a basis for decision-making and planning necessary follow-up actions. Based on this quantitative analysis, the observation results at SMA Negeri 2 Siak Hulu are presented in Table 5 and Figure 1.

Table 5. Results of the Student Needs Analysis Questionnaire (SMA Negeri 2 Siak Hulu)

Needs Analysis Indicator	Percentage
Learning Media	86.25%
Approaches, Methods, and Models	81.67%
Motivation	100%
Mean	89.31%

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E-ISSN: 3110-1429
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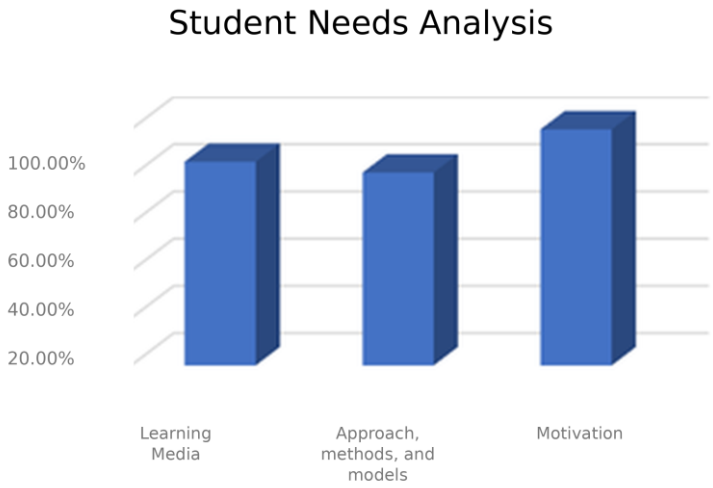

Figure 1. Results of the Student Needs Analysis Questionnaire

Based on Table 5, the needs related to learning media, approaches, methods, learning models, and chemistry learning motivation yielded mean percentages in the 'strongly needed' category. To obtain a deeper understanding of these needs, the study was followed by an interview with the chemistry teacher at SMA Negeri 2 Siak Hulu. The interview aimed to explore information on curriculum implementation, learning tools, the learning media used to date, student characteristics, learning models and methods, and the teacher's views on developing a chemistry magazine as a learning medium. The teacher interview results are presented in Table 6.

Table 6. Teacher Interview Results

No.	Question	Response
1.	Which curriculum is used in teaching and learning?	Merdeka Curriculum.
2.	How do you conduct apperception/activation of prior knowledge in class?	Before starting the lesson, I ask questions about the previous material.
3.	Do you use a learning model during instruction? If yes, which model/method do you use?	Yes. The model is Project-Based Learning (PjBL).
4.	Do you usually do an ice-breaker before starting the lesson?	Not always at the beginning; sometimes in the middle and at the end of the lesson.
5.	Do you instruct students to form several groups?	Yes.
6.	Do you use learning media in the learning process? If yes, what media do you use?	Yes; LKPD (student worksheets), PPT, and teaching aids.
7.	Do students discuss with group members to complete the LKPD assigned by the teacher?	Yes.
8.	Do you circulate to observe and assess students' attitudes during discussion?	Yes.

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No.	Question	Response
9.	Do you help students find solutions when they have difficulty completing tasks?	Yes.
10.	Do students present the results of their discussions?	Yes.
11.	Are students allowed to ask questions?	Yes, always.
12.	Are students allowed to answer?	Yes.
13.	Do you provide students with appreciation and recognition?	Yes, always.
14.	In your view, which learning materials are relatively difficult for students to understand?	Calculation-based topics such as Ksp, buffer solutions, acid–based, and the mole concept.
15.	What causes those topics to be difficult for students to understand?	Students say chemistry is difficult, especially calculation-based chemistry.
16.	Do you experience constraints in using media? If yes, what constraints do you usually face?	No constraints in using learning media.
17.	What kinds of learning media should be further developed to improve learning quality?	Media such as comics, magazines, and an LMS.
18.	What is your opinion if a new, more interesting product, such as a chemistry comic, were developed?	Outstanding; very good for advancing students' chemistry learning.
19.	Do students reflect on the learning that has been carried out or provide conclusions?	Yes, because reflection is important.
20.	Do you reinforce the material learned?	Yes.
21.	Do you give individual assignments to students?	Yes.
22.	Do you inform students about the material to be learned in the next meeting?	Yes.
23.	Do you end and close the lesson with a prayer together?	Yes, the lesson must end with a prayer.

From the quantitative data derived from the student needs analysis questionnaire at SMA Negeri 2 Siak Hulu, the mean level of need for developing instructional tools was 89.31%, which falls into the very high category. More specifically, the learning motivation indicator showed the highest percentage (100%), indicating that students strongly need more engaging learning experiences to increase their learning involvement. The learning media indicator reached 86.25%, reflecting a strong need for innovative learning media that align with the characteristics of chemistry content. The approaches, methods, and learning models indicator was 81.67%, which also remains high. These findings underscore the urgent need to develop interactive digital learning media—particularly in the form of digital comics—to support more effective, contextual, and meaningful chemistry learning. This conclusion is consistent with prior studies that report that digital media play an important role in helping learners understand abstract chemistry concepts, while improving motivation and learning outcomes.

The interview with the chemistry teacher indicated that classroom instruction has implemented the Merdeka Curriculum with the Project-Based Learning (PjBL) model. Learning activities began with apperception by posing questions related to the previous

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material to activate students' prior knowledge. In practice, the teacher organized students into discussion groups, employed learning media such as student worksheets (LKPD) and PowerPoint (PPT) slides, and facilitated group discussion through to student presentations of their work. The teacher also actively circulated in the classroom to observe, guide, and assess students' attitudes and participation during the learning process.

The teacher reported that several chemistry topics remain difficult for students to understand, particularly quantitative problem-solving topics such as the mole concept, Ksp, buffer solutions, and acid–base. In the acid–base unit, students often struggle to understand acidity (pH), acid and base strength, ionization reactions, and the application of pH calculations across contexts. These difficulties are reinforced by students' perceptions that chemistry is a complex subject—especially when mathematical calculations are involved—which may reduce self-confidence and learning motivation. This finding aligns with Chang (2019), who argues that acids and bases are abstract chemical concepts because they require the simultaneous use of macroscopic, microscopic, and symbolic representations and thus benefit from visual media support. In addition, Treagust and Chandrasegaran (2020) note that students' difficulties in chemistry often arise from a lack of instructional media that can bridge abstract concepts into more concrete, comprehensible forms.

Regarding the use of learning media, the teacher did not report any substantial technical constraints. However, the teacher considered that the media used thus far remain insufficiently varied and have not fully increased students' interest in difficult topics such as acid–base. The teacher therefore suggested developing more innovative media, such as learning comics, educational magazines, and learning management systems (LMS) platforms. The teacher expressed strong support for developing an interactive chemistry comic as a new learning medium. This medium was viewed as potentially supporting students' contextual understanding of acid–base concepts through visualization, storyline, and real-life examples. This view is supported by Trisniningsih et al. (2021), who reported that interactive learning media can significantly improve conceptual understanding and learning outcomes. Likewise, Sinaga and Simbolon (2021) found that attractive learning media can foster an enjoyable learning atmosphere and enhance students' motivation to learn. In sum, the interview results indicate that developing interactive digital comics for the acid–base unit is highly necessary to address students' learning difficulties, enhance motivation, and improve the quality and outcomes of chemistry learning in schools.

CONCLUSION

Based on the needs analysis questionnaire, teacher interview, and classroom observation, it can be concluded that Grade XII students at SMA Negeri 2 Siak Hulu still experience difficulties in understanding acid–base material, particularly in conceptual understanding and calculations. The abstract nature of the material and the predominance of conventional instruction mean that students' understanding, motivation, and participation have not yet developed optimally. The questionnaire results indicate a very high need for the development of learning media, especially interactive digital media that can increase learning motivation and support the visualization of chemical concepts. The teacher also emphasized that current learning media remain insufficiently varied and have not fully attracted students' interest in complex topics such as acid–base. Therefore, the development of interactive digital comics for the acid–base unit is considered highly necessary as an alternative solution to present content in a more engaging, contextual, and comprehensible manner, and as an effort

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to improve the process and outcomes of chemistry learning for Grade XII students at SMA Negeri 2 Siak Hulu.

RECOMMENDATIONS

Teachers are encouraged to use interactive digital comics in acid–base learning to make the material more engaging and easier for students to understand. Further studies are needed to test the effectiveness of this medium in other chemistry topics.

ACKNOWLEDGMENTS

The researchers express their deepest respect and sincere gratitude to the chemistry teachers at SMA Negeri 2 Siak Hulu for their time, support, and intellectual contributions based on classroom learning experiences. The input and information provided played an important role in strengthening the foundation and depth of this study. The researchers also thank all students at SMA Negeri 2 Siak Hulu for their active participation in completing the needs analysis questionnaire. Their involvement was a key factor supporting the smooth implementation and completion of this study.

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