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Development of a Contextually-Based Animated Video on Acid–Base Solutions Using Powtoon Web Application

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Abstract

Engaging and pedagogically relevant learning media are essential for improving students' conceptual understanding in chemistry, particularly on abstract topics such as acid–base solutions. This study aimed to develop a contextual animated video using the Powtoon web application to enhance student engagement and comprehension through real-life connections. The development followed the 4D model (Define, Design, Develop, Disseminate) and was conducted at a public senior high school in Yogyakarta. Participants included chemistry education lecturers (as media and content experts), high school chemistry teachers (for practicality evaluation), and 11th-grade science students (for readability testing). The animation incorporated core elements of contextual learning, such as inquiry, questioning, learning community, modelling, and reflection, to foster deeper understanding. Validation results indicated excellent quality, with ideal scores of 95% from media experts and 90% from content experts. Teachers rated the practicality at 92%, while students rated the video's readability at 95%. All evaluations were categorized as "very good." Quantitative data were analyzed descriptively using ideal percentage scores. These findings demonstrate that the developed animation is both pedagogically sound and technically effective in supporting student learning. This research contributes to the field of chemistry education by offering an accessible digital resource that supports contextualized instruction and increases student motivation and understanding of acid–base concepts.

Keywords: acid-base solution, contextual, PowToon, video animation

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1. Introduction

Educational technology is at the heart of student success in education (Mukhtar & Iskandar, 2011). Educational technology is a systematic tool to support the learning process, starting from conceptualizing the planning, implementation, and evaluation of the educational process using technological methods or tools (Ajizah & Munawir, 2021). Educational technology is needed to support the learning process's success, effectiveness, and efficiency (Salsabila et al., 2020). Zuhrieh in Ginting et al. (2020) also argues that educational technology can provide new nuances in presenting information that can change the learning climate in the classroom to become more exciting and meaningful. Technology use in education will improve several aspects, such as ease of access and sharing, increase students' interactive power and attractiveness and increase student interest in learning (Asiksoy & Ozdamli, 2017). Seeing the importance and many benefits of technology in education, a teacher should be able to use technology for learning purposes to Permendiknas No. 16 of 2007 concerning Academic Qualification Standards and Teacher Competencies (Mukaromah, 2020). However, in its implementation, teacher skills in utilizing

technology in the learning process are still minimal only 46% of teachers in Indonesia are familiar with technology (Prabowo et al., 2020).

Teachers' skills in utilizing technology can be improved by participating in technology-based learning media development training (Asmarani, 2014). With this training, it is hoped that teachers can develop various learning media using technology by the developments and demands of the times (Arsyad, 2013). Learning media are everything that is used to convey messages that can stimulate students' feelings, thoughts, will, and attention (Sapriyah, 2019). Learning media is needed in teaching and learning activities because it can help students improve understanding, present and excitingly convey material, and clarify information (Risnawati et al., 2018). Especially in the current era of the COVID-19 pandemic, which requires teachers to learn online to prevent the spread of the COVID-19 virus (Dewi, 2020). The continuity of the online learning process is strongly influenced by the use of learning media (Octavyanti & Wulandari, 2021). Based on research conducted by Kusuma et al. (2021), learning media in online teaching and learning has not been used optimally. Learning is still centered on the teacher as the only source of information and does not use engaging learning media, so the student's interest in participating is low (Zulkifli et al., 2021). In addition, learning resources during the pandemic are only in the form of summary materials made by the teacher without further explanation, so students find it difficult to study during the pandemic (Telepun, 2020). This statement is reinforced by the results of interviews with students who stated that the learning process still rarely uses media and only focuses on books that contain more information in the form of writing. Hence, it tends to be uninteresting. Therefore, appropriate and effective learning media are needed to attract students' attention (Adawiyah et al., 2021).

The selection and use of appropriate and effective learning media dramatically affect learning (Lalian, 2018). Effective learning media can make students interested and make it easier to understand the material (Lestari & Projosantoso, 2016). One practical learning media that attract students' attention is animated video media (Pradilasari et al., 2019). Animated video media is audio- visual media that can simultaneously present images, text, and sound (Fadillah & Bilda, 2019). Animated videos can visualize concepts to students more efficiently and interactively to attract more students ' attention (Gowasa et al., 2019). This is by the results of research by Ibrahimi and Suryanti (2022), which revealed that learning media using animated videos made learning more effective and exciting. Another study by Isti et al. (2020) showed that learning media using animated videos could increase student motivation and learning outcomes. The research results reinforce this by Dewi and Kamaludin (2022) that animated video can be used as an alternative learning media in the classroom because it can attract attention and make it easier for students to understand the material. However, the existing learning videos have not been packaged attractively. In addition, some teachers still use animated video media in the learning process because they do not have adequate software, take a long time, and feel heavy if the software has to be paid for (Anggraini & Putra, 2021).

Teachers can use web apps to create animated videos in the learning process to make online animation videos that can be used independently and for free without having to install software on a computer (Wulandari et al., 2020). One of the web apps Animated video maker that is free and can be used without having to install it is PowToon (Kurniawati, 2020). PowToon is a web-based application that makes it easy for users to create animated videos (Puspitarini & Akhyar, 2019). The operation of PowToon is similar to PowerPoint, Prezi, or Impress, which uses slides to place images and text (Syafitri et al., 2018). The difference lies in the existing animated characters, where PowToon provides various types of animated characters that can be combined with sound or music that has been provided or through other external sources so that it can support the presentation of material to be more

interesting (Rioseco et al., 2017). Not only attractive, but another advantage that PowToon has is also that this application does not need to be installed on a computer. In addition, it can also be run offline in the form of videos, presentations, or PDF formats (Nurdiansyah et al., 2018).

Based on these many advantages, PowToon animation videos are suitable for learning media, especially for visualizing abstract concepts or topics (Ristiyani & Bahriah, 2016). Chemistry is one field of science with many abstract concepts and topics (Yosimayasari, 2021). Chemistry is one of the fields of science considered abstract and quite difficult for most students (Harta et al., 2020). Chemistry is considered difficult because it has a typical vocabulary. There are many theories, memorization, formulas, calculations, and abstract concepts (Andromeda et al., 2016). These difficulties cause many students to have difficulty learning chemistry (Jannah et al., 2019). One of the chemical materials considered difficult by students is a solution of acids and bases (Putri, 2014). Based on interviews with high school students at a school in Yogyakarta, it was found that students faced difficulties in understanding acid-base theories, distinguishing between strong and weak acids and bases, and calculating the pH of solutions. These findings are supported by the study conducted by Ekawisudawati et al. (2021), which revealed that 71.705% of students held misconceptions regarding acid-base theories, 76.36% had misconceptions about the strength of acids and bases, and 81.32% demonstrated misconceptions in the concept of pH calculation in acid-base solutions. In addition, many students find it challenging to understand the acid-base theory. The acid-base solution studies the development of acid-base theory, indicators of acid-base solutions, the concept of pH, the acid-base equilibrium constant (Ka/Kb), and the calculation of pH (Rositasari et al., 2014). Acid-base solutions contain many examples in real-life contexts that can increase the meaning of chemistry learning (Yunita, 2019). However, teachers often teach acid-base solution materials that only present theories conditioned to be memorized by students and only focus on calculating pH so that student's understanding of the topic of acid and base solutions is less than optimal (Andriani et al., 2019).

Students' ignorance about the use of chemistry, especially in acid and alkaline solution materials in everyday life, causes students to get bored quickly and are not interested, resulting in low student learning outcomes (Rahardiana et al., 2015). Acid-base solution material taught by being linked in the context of everyday life can make students interested and motivated to learn it (Palisoa et al., 2018). The approach that connects learning material with its benefits in real life is termed the contextual approach (Apriadi, 2021). According to the Ministry of National Education in Suprihatiningrum (2014), the contextual approach is a learning concept that helps teachers relate the topics they teach to students' real-world situations and encourages students to make connections between their knowledge and its application in their lives as family and community members. If the contextual approach is combined with animated videos, it will undoubtedly provide a new nuance to the learning process in the classroom. Students are expected to be more motivated in learning and understand the learning material well (Paristiowati et al., 2017). However, based on the results of research conducted by Purwanto and Rizki (2015) shows that in the field, there are still not many learning media in the form of animated videos combined with a contextual approach.

Based on the description of the problem above, this study aims to develop an animated video of contextually charged acid- base solutions. The teacher can use the animated video as a learning medium in the classroom to make it easier for students to understand the relationship between acid- base solutions and everyday life. In addition, students are expected to be more motivated to study the material in acid-base solutions to improve their learning outcomes.

2. Research Method

This research uses Research & Development (R&D) research methods. R&D is a research method used to produce specific products and test the effectiveness of these products (Sugiyono, 2016). The product developed in this research is an animated video learning media with contextual content of acid-base solution material using the PowToon web apps. The development procedure uses the 4D development model proposed by Thiagarajan et al. (1974), which includes: (1) Define, (2) Design, (3) Development, and (4) Disseminate.

The defined stage is the first stage of research and data collection. The activities are needs, availability, curriculum, and material analysis. Needs and availability analyses were conducted through interviews with high school chemistry teachers. Curriculum analysis is carried out by identifying the competency standards that students must possess. Material analysis is done by determining the material to be taught and making a concept map to facilitate learning media development.

The design stage is the stage of designing the product to be developed. The activity is to determine the media used by the needs of the interview results, followed by compiling the format that must exist in the media to be developed. Next is the decomposition of the material or subject included in the media, the acid-base solution material. After that, the initial design for making animated video media using the PowToon web apps was made. In addition, the preparation of instruments is also carried out at this stage.

The development stage is a stage that aims to produce learning media that have been revised based on suggestions from experts. The steps include making the product according to the initial design at the design stage. Furthermore, the products that have been developed are consulted with the supervisor before being validated and assessed by experts. The experts used in this study are media and material experts to assess and provide input on the products that have been developed. Products revised and assessed by experts are then assessed and validated by four high school chemistry teachers (reviewers). Ten students of class XI majoring in Mathematics, and Natural Sciences respond to them.

The research instruments used in this study were product validation sheets, product quality assessment sheets, and student response sheets. Validation and product quality assessment was carried out using a Likert scale questionnaire, while student responses were obtained through a Guttman scale questionnaire.

The data analysis technique was carried out by changing the assessment data from media experts, material experts, and reviewers into qualitative assessment data based on the Likert scale with answer options Very Good, Good, Enough, Less, Very Less, which each option has a score of 5, 4, 3, 2, 1. Then the average value of each and all aspects of the assessment is calculated from the scores that have been obtained.

The score obtained is then converted into a qualitative value following the reference to change the score to a five-point scale, as shown in Table 1. The scores obtained were then converted into qualitative values based on a five-point scale, as shown in Table 1. This criterion allows for a more objective classification of assessment results based on the distribution of respondents' scores. Such a conversion model is a commonly used approach in instructional program evaluation, as described by Widoyoko (2009), because it reflects the data distribution and provides a more meaningful interpretation of the assessment outcomes.

Table 1. Ideal Assessment Criteria

Score Range	Category
Xi + 1.80 SBi < X	Very good
Xi + 0.60 SBi < X Xi + 1.80 SBi	Good
Xi - 0.60 SBi < X Xi + 0.60 SBi	Enough
Xi – 1.80 SBi < X Xi – 0.60 SBi	Less
X Xi – 1.80 SBi	Very less

Student response data is converted into quantitative data using the Guttman scale in the form of scores. The data converted into a score is then calculated as the percentage of the ideal product for each aspect and all aspects.

3. Result and Discussion

Result The research resulted in a product in the form of an animated video containing contextual content on acid-base solution material using the PowToon web apps. The instructional media developed in this study were validated by subject matter experts and media experts to evaluate content quality and technical aspects. Subsequently, the media received feedback from high school chemistry teachers to assess its practical implementation in classroom settings, and from students to evaluate readability and comprehension of the video content.

This study employed the 4D development model, which consists of four main stages: Define, Design, Develop, and Disseminate (Thiagarajan, et al., 1974). However, the research was limited to the *Develop* stage. This limitation was made because the primary objective of the study was to produce and evaluate the initial feasibility of the instructional media through expert validation and limited user testing. Additionally, constraints related to time, resources, and the overall scope of the research were considered as rational factors for limiting the process to this stage.

3.1. Define

The define stage begins with conducting a needs analysis, availability analysis, curriculum analysis, and material analysis. Analysis of needs and availability was conducted through interviews with four high school chemistry teachers and ten high school class XI students. This interview aims to find out the problems and products needed in schools. The results of the interviews were then studied to determine the product needed. Based on interviews with high school chemistry teachers, it was found that the implementation of learning on acid and base solutions was still using conventional methods such as lectures and had not used learning media. Students also said that the learning process on acid-base solution material only listened to the teacher explaining the material contained in the textbook and working on questions that made students bored. Students feel more enthusiastic if they learn to use media and are associated with everyday life. Therefore, it takes exciting learning media and can increase students' interest in learning. At this stage, the curriculum and materials analysis is done to make it easier when inserting material into the media. The researcher arranges the concept of the material that will be included in the video by the applicable curriculum. Furthermore, the material that has been determined is made into learning objectives and concept maps so that the material is more focused. The material used in this study is an acid-base solution.

3.2. Design

Step taken at the design stage is to determine the media according to the interview results. Based on the interview results, it was decided to develop PowToon animated video media with contextual content on acid-base solutions. The next activity is the preparation of the format. The formats contained content on acid-base solutions. The next activity is the preparation of the format. The formats contained in the video include opening, characteristics of the contextual approach (finding, asking, learning community, modeling, reflection), and closing. After that, the collection and decomposition of the acid-base solution material will be inserted into the media. The material collection is done by looking for learning resources from textbooks and YouTube. The next stage is to make an initial design of an animated video using the PowToon web apps. The initial design was made by making scripts and animation layouts in the form of sketches and then recording the sound. Next, the video is produced by inserting animation and other components into the PowToon slide, as seen in Figure 1. Subsequently, the videos were edited using the CapCut application to enhance them with background music, stickers, and pre-recorded voiceovers, as shown in Figure 2.

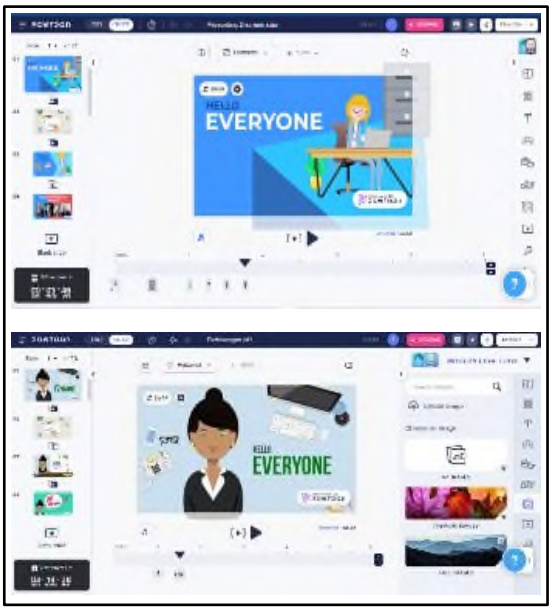


Figure 1. The Video Creation Process in Powtoon

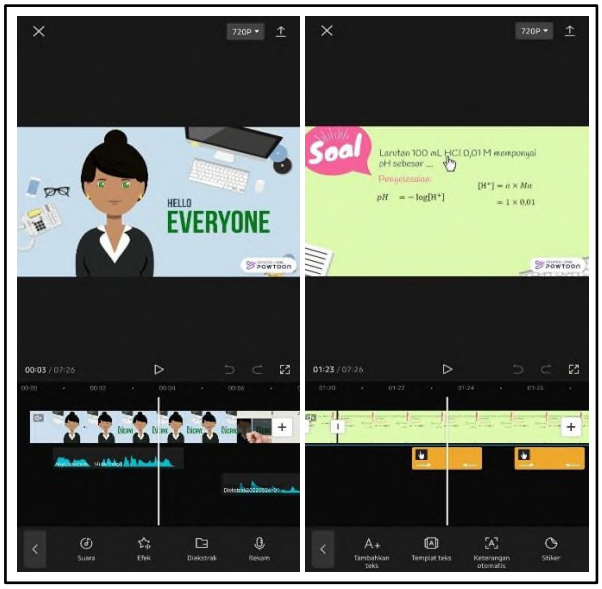


Figure 2. Video Editing Process in Capcut

The final output consisted of a series of six PowToon animated videos focused on contextually enriched acid-base content, each ranging from 2 to 8 minutes in duration. Each video follows a structured format that includes an opening, the key elements of a contextual approach (such as inquiry, questioning, learning community, modeling, and reflection), and a closing. The introduction includes a greeting, the title of the lesson, and the author's name, as depicted in Figure 3.

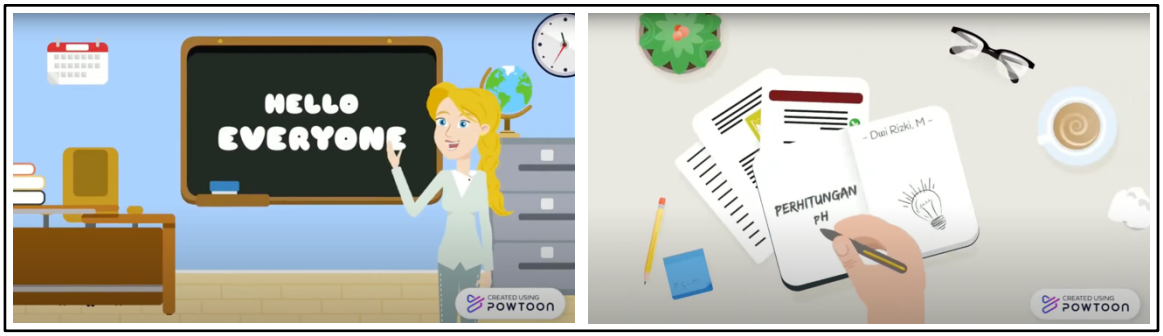


Figure 3. The Opening Part of the Video

The characteristics of the contextual approach consist of finding, asking, community learning, modeling, and reflection. The video is packaged to display the five characteristics of the contextual approach. The finding characteristic is made by asking students to try to determine the pH of an acid-base using biological indicators so that students can find and classify the surrounding materials themselves, which are classified as acids and bases. This process aims to help students recognize that knowledge is not solely acquired through memorization but also through self-discovery and active engagement. The benefit of the application of finding characteristics is that students' memories of the knowledge they acquire can last longer because students understand through the process of finding and applying (Nengsi et al., 2021).

Examples of how these contextual characteristics are visually represented in the video are shown in Figure 4.

Figure 4. Characteristics of Founding on Video

The second characteristic is asking. Asking is essential in learning to gather information and measure students' abilities (Yuniarto, 2020). Several questions are shown in the video to arouse students' attention and response, as shown in Figure 5.

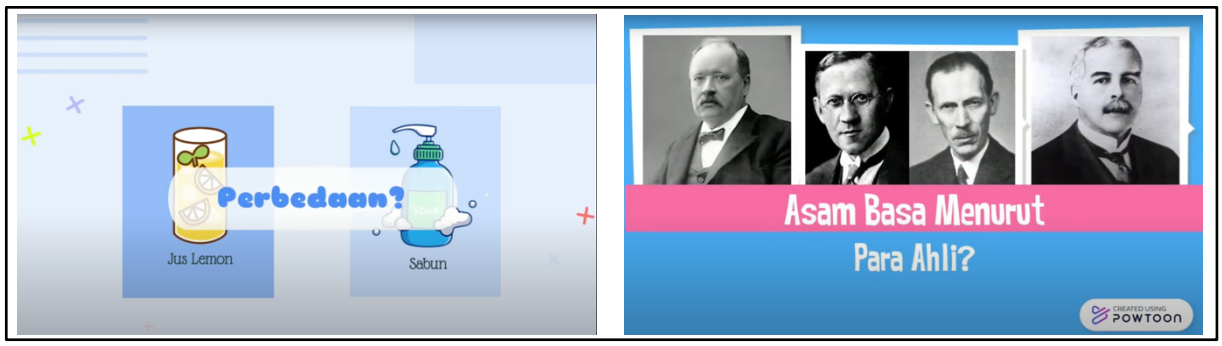


Figure 5. Characteristics of Asking Questions in the Video

The characteristics of the learning community emphasize that learning outcomes will be more meaningful if done in groups rather than individuals (Pardosi, 2020). This activity can be done in various ways, such as working on questions in groups, discussing, exchanging ideas, and sharing other things. The display of the learning community in the video is shown in Figure 6.

Figure 6. Characteristics of the Learning Community in the Video

The following characteristic is modeling. Modeling is an example in the learning process so that students can think, learn, and do (Parhan & Sutedja, 2019). This modeling can make students understand better and avoid mistakes that can cause misconceptions.

The modeling in the video is shown by giving examples of questions and how to do them before students are finally given practice questions. The modeling part of the video can be seen in Figure 7.

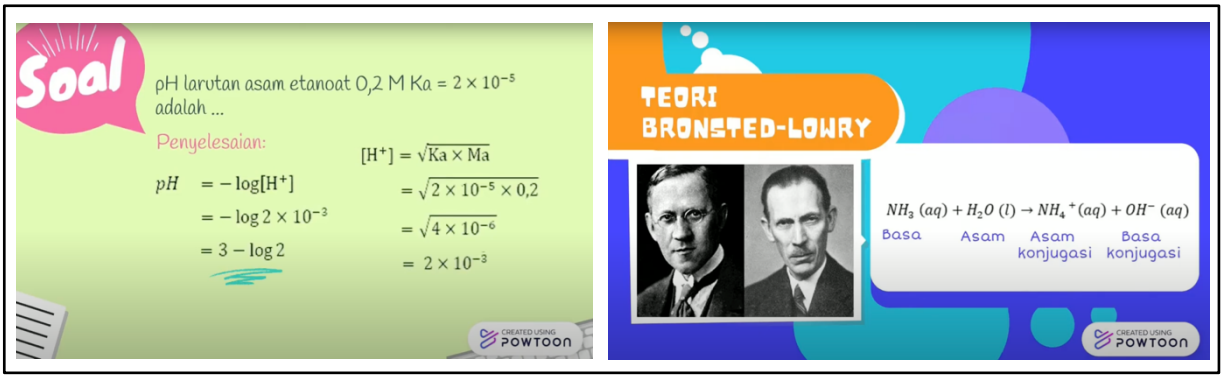


Figure 7. Part of the Modeling Characteristics of the Video

Reflection is a conclusion from what has been learned. Students can have a way of thinking and taking notes about what they have learned. This can also be a revision or enrichment of previously owned knowledge (Sinaga & Silaban, 2020). The video shows reflection characteristics by displaying a summary of all acid-base solution materials. This reflection video is made a separate video from the previous materials. The reflection component is illustrated in Figure 8.

Figure 8. Reflection Characteristic Part of the Video

The following format is closing. Closing is the closing part that marks the end of the video. The parts in the closing display are closing greetings, and affirmative sentences for the material studied, as shown in Figure 9.

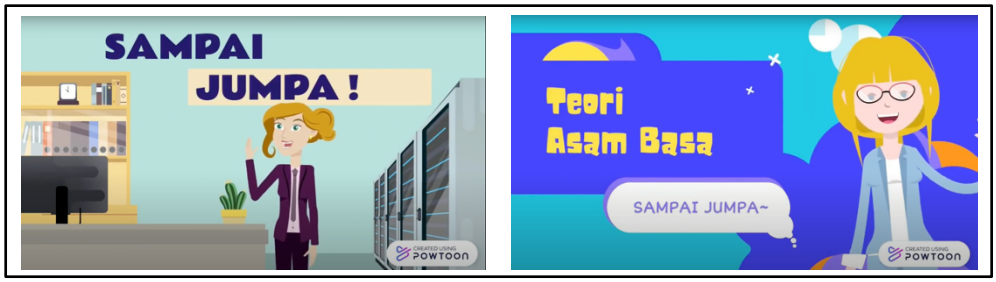


Figure 9. The Closing Part of the Video

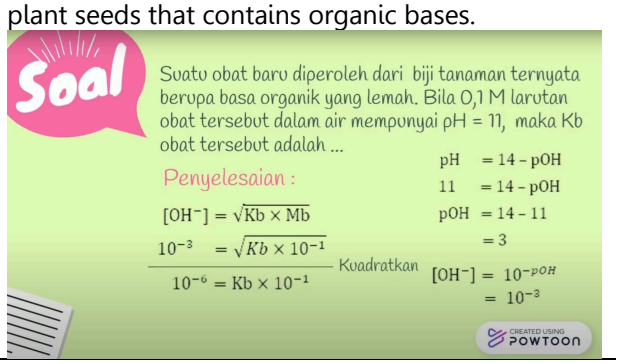
The next phase involved the development of research instruments. These instruments included validation sheets for material experts, media experts, and reviewers, as well as student response questionnaires. The validation sheets for material experts, media experts, and reviewers utilized a Likert scale with response options ranging from *Very Good* to *Very Poor*. In contrast, student responses were measured using a Guttman scale with *Yes* or *No* answer choices.

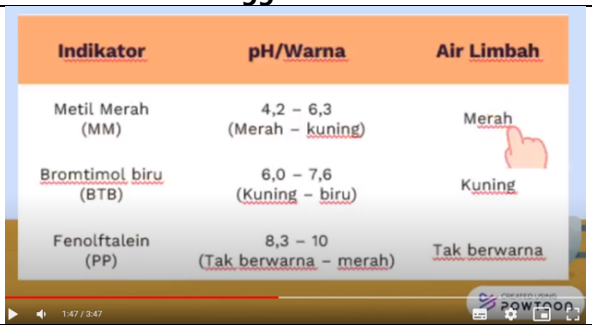
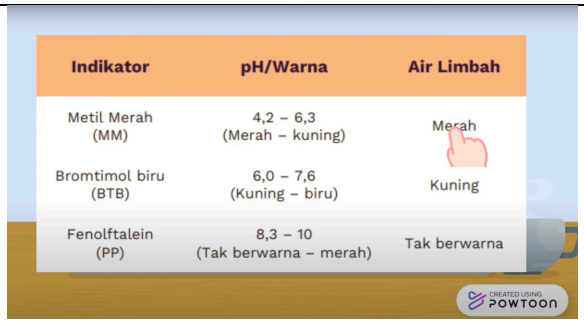
The questionnaires were designed to evaluate various aspects of the developed media and to gather feedback on student perceptions of the product. Before being used for validation, all instruments were reviewed by the research supervisor and subsequently evaluated by an expert in instrument design.

3.3. Development

The finished product is then validated by media experts and materials experts. Based on the feedback provided by these experts, revisions were made to improve the quality of the product. Table 2 presents a summary of the suggestions and corresponding revisions. Media experts evaluated the visual aspects of the video, while content experts assessed the scientific accuracy and contextual relevance of the material.

Table 2. Suggestions and Revisions

No	Suggestions	Revisions
1	The material could be further elaborated, particularly on the use of natural indicators. It is suggested to mention other natural substances besides hibiscus that can serve as acid-base indicators, to enhance the contextual value of the content	The content was improved by adding more contextual examples of natural acid-base indicators. 
2	Include images or real-life situations, followed by pH calculations or other relevant computations. Provide a real-world context.	Add a real-life story about a medicine derived from plant seeds that contains organic bases. 
3	The table design was revised to improve its visual quality and eliminate unnecessary formatting artifacts, such as red borders typically generated by Microsoft Word's default settings.	Uses a cleaner layout with consistent line spacing and border styles to enhance readability and professional appearance.

No	Suggestions	Revisions
		

Following the revisions, the evaluation by media experts is shown in Table 3, with an ideal percentage score of 95%, categorized as "Very Good." This indicates that the visual quality and interactivity of the media are highly suitable for use in educational settings. These findings are consistent with Fitriyah et al. (2024), who found that animation-based visual media effectively enhances student engagement.

Meanwhile, content experts assigned an overall score of 90% (Table 4), also falling into the "Very Good" category. The theoretical component received a perfect score (100%), while the contextual component was rated at 80%. Although there is room for improvement in terms of depth and diversity of contextual integration, the media was deemed successful in connecting scientific concepts to real-life contexts. This aligns with the findings of Sari et al. (2023), who reported that contextualized chemistry materials significantly increasing students' interest in learning.

Table 3. Product Rating by Media Experts

No	Assessment Aspect	∑ score	Max Score. Ideal	Ideal Percentage	Category
1	Videos	19	20	95%	Very good
	Total	19	20	95%	Very good

Table 4. Product Rating by Material Experts

No	Assessment Aspect	∑ score	Max Score. Ideal	Ideal Percentage	Category
1	Theory	10	10	100%	Very good
2	Contextual	8	10	80%	Very good
	Total	18	20	90%	Very good

Following expert validation, the product was evaluated by high school chemistry teachers to assess its practicality for classroom implementation. As shown in Table 5, the total score reached 92%, which falls under the "Very Good" category. The media aspect received the highest score (95%), indicating that teachers found the media easy to use and well-aligned with classroom instructional needs. This finding supports the perspective of Switri (2023), which emphasizes that educational media must be practical, accessible, and capable of functioning effectively within the constraints of the learning environment. According to Switri, technology-based media that is both simple to operate and adaptable to classroom conditions significantly enhances the effectiveness of learning, especially in settings with limited instructional time and resources.

Table 5. Product Respon by Teachers

No	Assessment Aspect	∑ score	Max Score. Ideal	Ideal Percentage	Category
1	Theory	37	40	92.5%	Very good
2	Contextual	34	40	85%	Very good
3	Media	76	80	95%	Very good
	Total	147	160	92%	Very good

Readability testing was conducted using a Guttman-scale questionnaire administered to eleventh-grade science students. The results, shown in Figure 10, reveal an overall score of 95%, indicating high student appreciation for the media. The contextual aspect received the highest score (100%), followed by presentation (96%) and animation (95%). These scores suggest that the video effectively aids student comprehension by clearly linking scientific concepts to real-life situations. This supports the findings of Azmi and Latisma (2022), who emphasized that contextual learning media is more effective in enhancing students' conceptual understanding. On the other hand, the language aspect received a slightly lower score (89%), indicating an area for potential improvement in future revisions.

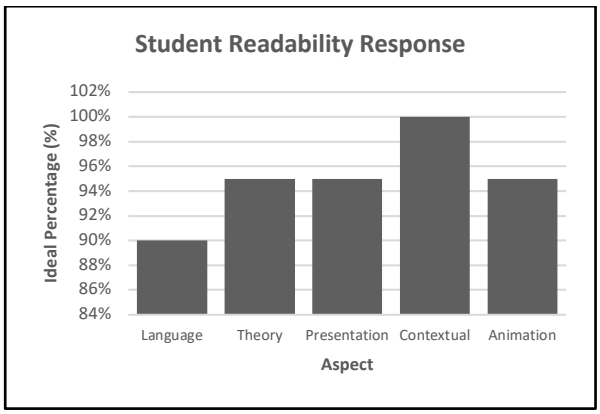


Figure 10. Student Readability Response

Overall, the data reveal a consistent trend: educational media that combines animated visuals, contextual narratives, and clearly structured content is highly valued by students, teachers, and experts alike. Comparisons with previous studies indicate that a contextual approach integrated with interactive animation has a greater positive impact on both student engagement and conceptual understanding.

4. Conclusion

This research and development study produced an instructional animated video on acid-base solutions, created using the Web Apps PowToon and designed with a contextual learning approach. The product underwent a comprehensive validation process involving media and content experts, practicality testing by high school chemistry teachers, and readability testing with Grade XI science students. The evaluation results are 95% from media experts, 90% from content experts, 92% from teachers, and 95% from students, were all classified in the "Very Good" category. These findings demonstrate that the developed media is highly appropriate for implementation in formal educational settings, particularly in the context of chemistry instruction. In addition to meeting technical and pedagogical criteria, the integration of contextual learning components and visual representations has been shown to enhance student engagement, improve conceptual understanding, and facilitate connections between scientific concepts and real-world applications. Accordingly, this media represents an innovative and effective tool for promoting more interactive, meaningful, and contextually relevant learning in chemistry education.

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