



Animation videos to enhance senior high school students' motivation in learning chemistry: A learning media in inclusive schools

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ABSTRACT

The instructional media in inclusive schools has not been fully developed inclusively in line with the potential and needs of students with disabilities. This research aims to develop inclusive instructional animation videos on chemical bonding to enhance the learning motivation of tenth-grade senior high school students. This study adopts a research and development (R and D) approach using the ADDIE development model. Research instruments utilized include quality assessment sheets and student responses. Evaluation results from subject matter experts, media experts, reviewers, and student responses indicate that the video is highly effective and well-received, with a high percentage of perceived appropriateness. Consequently, this video is deemed suitable as an alternative instructional medium in inclusive classrooms, supporting students' understanding of chemical bonding and enhancing learning motivation, especially for students with disabilities. Additionally, this research highlights the potential of utilizing Artificial Intelligence (AI) in developing inclusive instructional media.

Video animasi untuk meningkatkan motivasi belajar kimia siswa SMA: Sebuah media pembelajaran pada sekolah inklusif

ABSTRAK

Media pembelajaran yang ada di sekolah inklusif belum sepenuhnya dikembangkan secara inklusif sesuai dengan potensi dan kebutuhan siswa penyandang disabilitas. Tujuan penelitian ini adalah mengembangkan video animasi pembelajaran yang inklusif pada materi ikatan kimia untuk meningkatkan motivasi belajar siswa SMA kelas X. Penelitian ini merupakan jenis penelitian pengembangan (R and D) dengan model pengembangan ADDIE. Instrumen penelitian yang digunakan berupa lembar penilaian kualitas dan respon siswa. Hasil evaluasi dari ahli materi, media, dan reviewer, serta respon siswa, menunjukkan bahwa video tersebut sangat efektif dan diterima dengan baik, dengan persentase keidealan yang tinggi. Implikasinya, video ini layak dijadikan media pembelajaran alternatif di kelas inklusif, mendukung pemahaman siswa tentang ikatan kimia, dan meningkatkan motivasi belajar, khususnya bagi siswa penyandang disabilitas. Penelitian ini juga menunjukkan potensi penggunaan Artificial intelligence (AI) dalam pengembangan media pembelajaran inklusif.

Kata Kunci:

Video animasi
 Ikatan kimia
 Pembelajaran inklusif
 Motivasi belajar
 Powtoon

1. INTRODUCTION

Educational technology is essential to achieving quality education [1]. Educational technology solves learning problems [2]. Educational technology is needed to increase efficiency and effectiveness in the learning process [3]. The existence of well-developed educational technology can make the learning process more effective, high-quality, and inclusive for students. Educational technology can also create a fun and flexible learning atmosphere [4]. Educational technology also supports the development of students' potential in academic and non-academic fields [5]. Law on Teachers and Lecturers no. 14 of 2005 requires teachers to have professional competence to master educational technology. However, only 60.35% of teachers can master educational technology [6]. Therefore, teachers' mastery of educational technology is key to creating an inclusive and quality teaching and learning process.

Teachers' ability to utilize educational technology can be improved through training in developing technology-based learning media [7]. Learning media conveys messages from teachers to students that can attract students' attention [8]. Learning media is a supporting factor for the success of the school teaching and learning process [9]. Learning media can simplify complex material and provide a pleasant learning atmosphere [10]. Interesting learning media can increase students' interest and motivation [11]. Teachers must develop learning media to help students learn at school [12]. The learning media developed is not just an exciting learning media but is also inclusive so that all students from various groups can access it [13]. The existence of inclusive learning media can reduce the learning gap between regular students and students with disabilities [14]. Inclusive learning media can also provide new colors and enthusiasm for students with disabilities to understand learning material [15]. However, teachers still need to innovate more in the field to develop inclusive learning media [16]. Teachers consider inclusive learning media challenging to develop, so it becomes an inhibiting factor in teaching students with disabilities [17]. The implementation of innovative and inclusive instructional media will assist all students, including those with disabilities, to become more engaged and motivated in the learning process.

One of the inclusive learning media innovations that is easy to develop is animated videos using Powtoon software [18]. Powtoon is a web-based animated learning media that allows users to create animated presentations with music and transitions [19]. Powtoon animation can be designed as an inclusive learning medium to increase student learning motivation [20]. Powtoon has various animation features in handwriting, cartoons, and transition effects [21]. Powtoon can present learning material in a more varied and fun way so students can easily understand the material taught [22]. Powtoon can also present realistic animations so that the material presented is accessible for students to remember [23]. Teachers should be able to develop inclusive PowerPoint learning animation videos to facilitate the learning process for students with disabilities [24]. Teachers must still improve in developing inclusive learning media [25]. Teachers tend to use something other than learning media available at school, such as textbooks, which makes students bored and need help understanding the learning material [26]. Inclusive learning media strongly supports inclusive learning; however, using technology as an inclusive learning medium is minimal. Many studies have developed animated videos as learning media. However, they are not designed to use artificial intelligence (AI) sign language translators inclusively, so certain parties can only use the learning media [27]. The lack of inclusive animated videos with AI sign language translators for chemical bond material is one of the inhibiting factors in learning, especially for students with disabilities.

Some students in high school consider chemistry difficult, especially students with disabilities [28]. One of the chemical materials that is considered difficult is chemical bonds [29]. The subject of chemical bonds has several abstract concepts, including atomic stability, Lewis structure, the process of forming chemical bonds, and handing over electrons [30]. Based on a survey of high school students in Yogyakarta, information was obtained that chemical bonding material was classified as challenging to teach to students with disabilities [31]. The difficulty of chemical bonding material lies in the sub-material of ionic and covalent bonds [32]. Students need clarification about determining the types of chemical bonds due to a need for a conceptual understanding of chemical bond material [33]. Chemical bonding is essential, so students must understand this concept and its relationship to everyday life [34]. Phenomena in everyday life, such as the formation of table salt, limestone, and toothpaste, can be used in studying chemical bonding material so that students are more enthusiastic about studying it [35]. However, many students need help understanding chemical bonding material due to the need for more available learning media [36]. According to research conducted by Ananda et al. on chemical bond material, it was stated that 55.7% of students had yet to be able to achieve a minimum completion criteria score of 75 [37]. Well-designed instructional media can connect abstract theory and conceptual understanding, enabling students to gain a deeper comprehension of chemical bonding.

Students' low mastery of concepts can be overcome by increasing learning motivation so that students can study diligently [38]. Motivation is one of the factors that influences student learning outcomes [39]. Motivation is necessary for the learning process to run well [40]. Motivation is essential in fostering students' curiosity and enthusiasm for learning [41]. Motivation can create an active and comfortable learning atmosphere for students [42]. Students learning motivation grows because of encouragement and aspirations to succeed in learning [43]. The higher the student's learning motivation, the better the student's learning achievement [44]. Teachers are also crucial in increasing students' learning motivation [45]. However, in reality, students' learning motivation is still low, as evidenced by students' lack of active participation in learning, especially students with disabilities [46]. Teachers can enhance student participation and learning outcomes by understanding and implementing motivational learning strategies, particularly in challenging subjects such as chemistry.

Increasing the learning motivation of students with disabilities can be done by using inclusive learning methods [47]. Inclusive learning provides opportunities for all students with disabilities to participate in the same educational environment as students in general [48]. Inclusive learning provides equal opportunities for every student to receive an education regardless of the student's condition [49]. Inclusive learning allows students with disabilities to receive education in regular schools [50]. Inclusive learning ensures all students can access affordable, practical, and relevant learning [51]. Inclusive learning makes schools an open and fair place without discrimination against students with disabilities [3]. Inclusive learning can create a cooperative atmosphere and develop tolerant attitudes [52]. Inclusive learning can create a sense of self-confidence through an attitude of acceptance and inclusion in the classroom [53]. Inclusive learning implemented in the classroom can train and accustom students to respect differences [54]. However, inclusive learning has yet to be implemented optimally due to limited facilities and an insufficient understanding of inclusive learning [55]. The commitment to inclusive education will drive the development of more equitable and effective learning practices, ensuring that every student has an equal opportunity to succeed.

Research related to the development of animated videos as learning media has been conducted extensively, including the development of learning media for children with special needs [15], [17], [27], the development of Powtoon-based learning media [18]-[24], and the development of Android-based learning media [7], [41]. However, despite the various studies conducted, there has been no research yet on developing animated videos in inclusive education to enhance learning motivation. Therefore, this topic is highly intriguing and warrants urgent investigation at present.

Based on the description of the problem above, this research aims to develop an inclusive learning animation video on chemical bonding material to increase the learning motivation of the class Powtoon animation video specifically for chemical bonding material. This research also has the novelty of using an AI sign language interpreter in an inclusive learning animation video for chemical bonding material so that it can increase insight regarding the use of technology for students and teachers. It is hoped that this animated video can support inclusive learning in the classroom. Apart from that, teachers can use these inclusive learning animated videos as learning media to make it easier for students, especially those with disabilities, to understand the relationship between chemical bonds in everyday life. Regular students and people with disabilities are expected to be more motivated to study chemical bonding material to improve learning outcomes.

Contribution to the Literature

This research contributes to:

- This research fills a crucial gap by introducing, based on a comprehensive review, the first development of an inclusive learning animation video using AI technology for chemical bonding material in high school education.
- By evaluating the effectiveness and student responses to the developed animated video, this study provides empirical evidence on the potential of AI-enhanced inclusive learning materials to improve motivation and comprehension in complex subjects like chemical bonding.
- The findings from this study enrich the discourse on inclusive education, demonstrating how AI can be leveraged to create accessible educational content for a diverse student population, including those with disabilities.

2. METHOD

The research method used is the research and development (R&D) method. The product of this research is an animated video for inclusive learning using the ADDIE development model. The ADDIE development model was chosen because it has advantages in its systematic work stages. Each phase evaluates and revises the stages passed so that the resulting product becomes a valid product. The ADDIE model includes analysis, design, development, implementation, and evaluation [56]. This research method involves four main stages: analysis, design, development, and implementation. During the analysis stage, five main steps are carried out, including initial analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives, utilizing interviews with chemistry teachers and students, particularly those with disabilities. The design stage involves the development of learning media, selection of format, literature search, initial design, and creation of assessment instruments. In the development stage, media and subject matter experts customize, validate, and evaluate the learning media. Implementation involves limited testing on tenth-grade high school

students, including those with disabilities, to test and refine the developed inclusive learning media product, focusing on student responses and the product's suitability in the learning process. Five development stages were used in this research, as illustrated in Figure 1.

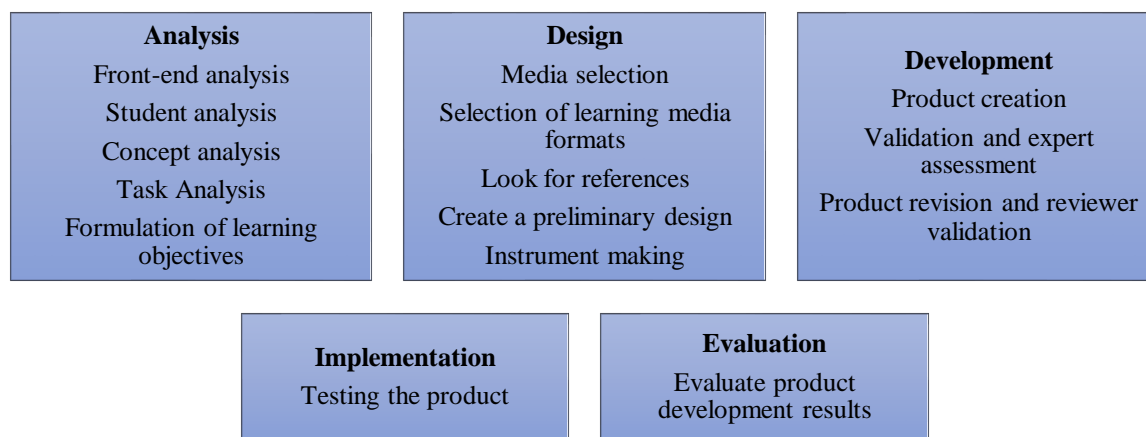


Figure 1. Development stages of the ADDIE model

3. RESULTS AND DISCUSSION

The research aims to develop inclusive learning animation videos on chemical bonding material using Powtoon software. This research uses the ADDIE model, which includes analysis, design, development, implementation, and evaluation stages.

3.1 Analysis Stage

The analysis stage has five main steps: front-end analysis, student analysis, concept analysis, task analysis, and learning objective specification. Front-end analysis was conducted through interviews with SMA N 1 Sewon chemistry teachers, SMA N 1 Ciawi, and SMA N 3 Yogyakarta. The topics discussed relate to the chemistry learning process and inclusive learning media. The teacher said that the chemistry learning process was running as it should. The teacher provides material, and students listen so that learning only goes in one direction. Media does not use various learning media in the learning process because of the lack of available learning media. Next, an analysis of the students is carried out. Based on student interviews, information was obtained that the learning media used in chemical bonding material were textbooks, power points, and material summaries. These learning media are less effective in supporting learning, especially for students with disabilities. Students with disabilities tend to have difficulty understanding abstract material. Concept analysis is carried out by analyzing the core and essential competencies of the material. Task analysis is translated into learning indicators, and learning objectives are formulated so that the material is more focused. The materials used in this research are chemical bonds. The use of AI technology in education can be realized in other subjects and levels of education to create educational equality for disabled and non-disabled students [57]. Analysis stages aim to identify possible causes of a learning performance gap and then describe a strategy for solving it.

3.2 Design Stage

The design stage has five stages: media selection, design selection, reference collection, initial design creation, and instrument creation [58]. Based on the interview results, the media developed was animated videos for inclusive learning. The video was

designed using Powtoon software, Canva, and equipped with a sign language translator using AI. The format used in inclusive learning animation videos includes opening, content, and closing. Material about chemical bonds is obtained through textbooks and learning videos from YouTube. The sub-material on chemical bonds developed in the video includes understanding chemical bonds, atomic stability, Lewis structures, ionic bonds, covalent bonds, and metallic bonds. The initial design was made by creating a script and animation layout in sketch form. Voice recording was done using a Samsung M32 smartphone, and sign language translation was done using AI in the Hear Me application. Next, the resulting products are combined using the CapCut application, and background sound is added. Instrument making is done by creating an instrument for assessing product quality and student responses. A product prototype will be developed at this stage, and a research instrument will be produced. The design stage describes the strategy concept that will be carried out to solve the problems that have been analyzed previously [59]

3.3 Development Stage

The development stage contains the realization of the product design in the previous stage and product validation [60]. Video development is carried out with the help of software such as Powtoon, Canva, Hear Me, CapCut, and smartphone recorders. Apart from that, there are supporting websites such as www.remove.bg and www.unscreen.com, which are used to remove image and video backgrounds and convert them into gif format, as well as the website <https://podcast.adobe.com/Enhance>, which is used to clear voice. The process of creating an inclusive learning animation video begins with compiling the entire video design according to the script that has been created using Powtoon. Next, build the appropriate visuals and graphic designs. He used Canva to develop graphic designs, including the characters and animations required for the video's beautiful appearance. Creating attractive designs and visualizations will determine students' interest in animated videos [61]. Figures 2 illustrate the process of creating inclusive learning animation videos.

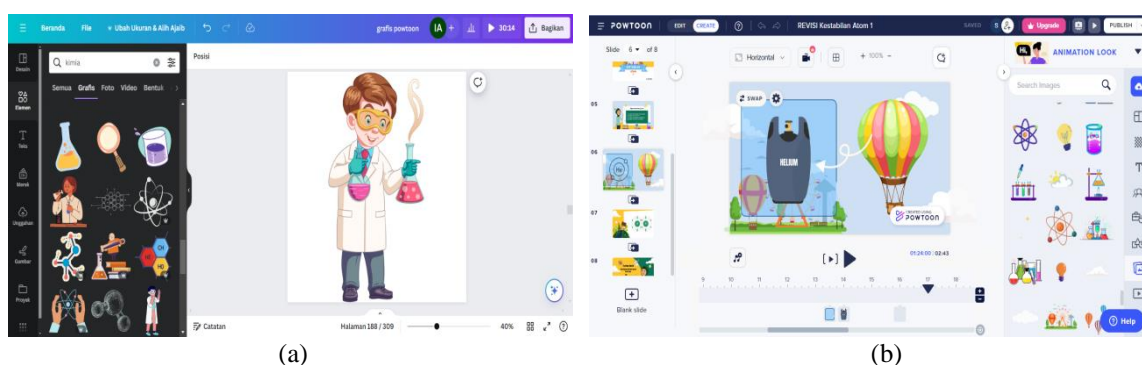


Figure 2. (a) Selection of animations in canva and (b) Video creation in Powtoon

Making inclusive learning animated videos continues to be carried out by adding audio and enhancing its quality. Audio is recorded on a smartphone and then clarified using Adobe Podcast. Figure 3 illustrates this process.

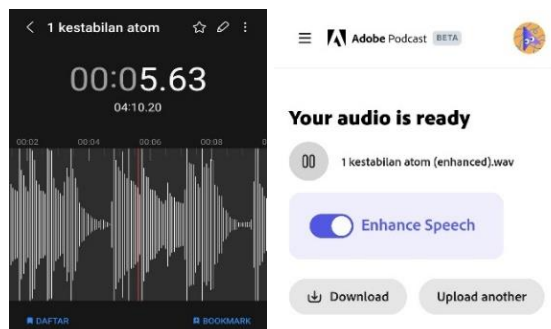


Figure 3. Sound recording and clarity

The Hear Me application uses AI technology to add sign language. Hear Me is a social startup that provides Indonesian Sign Language translation and interpretation technology as access to information and communication for Deaf friends. When used by entering sentences via voice or typed form, the Hear Me application will translate it into sign language with a 3D animation called Dave. The sign language translation is then downloaded and included in the learning video.

The language format used in the Hear Me application is Indonesian Sign Language (BISINDO). BISINDO is a natural sign language that deaf people in Indonesia widely use as a communication tool. In addition, BISINDO has different variations of signs in each region, which are influenced by regional language and culture. BISINDO is one of the rich languages used not only by deaf people but also by all groups so that they can interact with fellow humans in everyday life.

AI sign language using attractive 3D animation can increase students' motivation and interest in learning. In addition, translated sign language can be easily understood by students with disabilities. Therefore, the learning media developed can create equality in learning between disabled students and non-disabled students [62]. The process of creating sign language with AI in the Hear Me application can be seen in Figure 4.

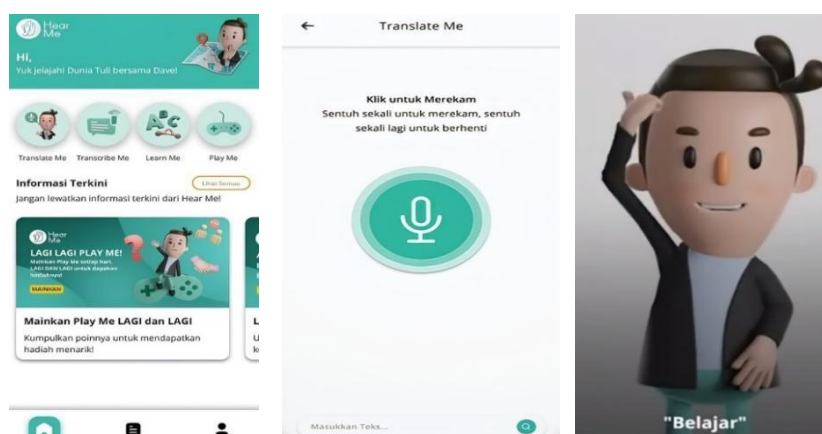


Figure 4. The process of creating sign language based on AI through the Hear Me application

The application works through the Translate Me feature on the Hear Me application, which translates sentences into sign language. The sentence you want to translate can be entered by typing or recording the voice directly. Then, the Hear Me application, with the help of AI technology, will translate the sentences entered into sign language that corresponds to a 3D animated visualization called Dave. There is a sign language translator with AI that will facilitate the learning process and increase insight regarding the use of technology for students and teachers.

The Powtoon video created is then edited using the CapCut application to include background sound, stickers, voice recordings, and sign language with the previously created AI. Adding background sound can reduce student boredom. Apart from that, stickers and clear sound recordings can increase student focus when watching inclusive learning animated videos [63]. Inclusive learning media must be equipped with easy access and understanding for all groups, one of which is by adding sign language interpreters to learning videos [64]. The editing process can be seen in Figure 5.

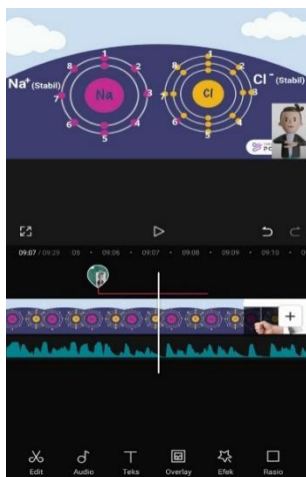


Figure 5. Editing videos in CapCut

The final product produced is an animated learning video with chemical bonding material, divided into five videos lasting 10-15 minutes. The video is made in the opening, content, and closing format. The opening section consists of an introduction, a table of contents of the learning video, a title, and learning objectives. The opening section will be the basis for students interested in inclusive learning animated videos. Therefore, the opening section must be designed attractively, displaying animation and beautiful color contrast [65], as seen in Figure 6.



Figure 6. Opening part of the video

The video's content part explains chemical bonding material, including the meaning of chemical bonds, atomic stability, Lewis structures, ionic bonds, covalent bonds, and metallic bonds. The material is equipped with exciting animations, making it easy for students with disabilities to understand. The animations can also increase students' understanding of abstract and complex theories or concepts [66]. Part of the video content can be seen in Figure 7.

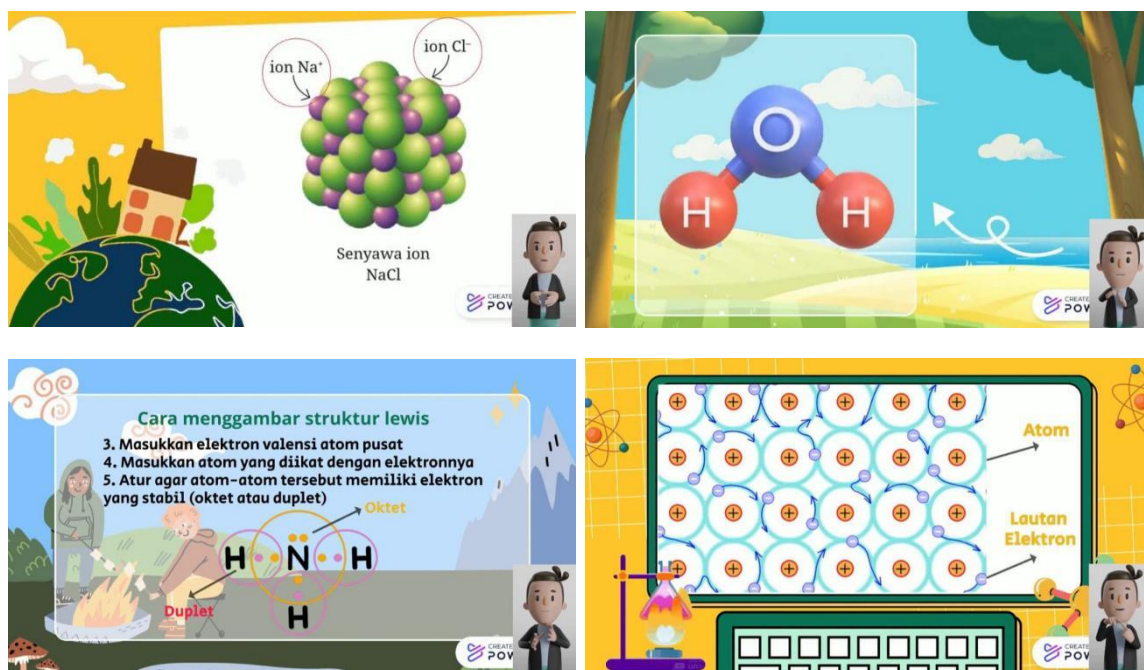


Figure 7. The Chemical Bonding Video Content Section

Usable means that all groups can use the learning video and meet the needs of students with disabilities in learning chemical bonding material. Accessible means that learning videos can be accessed without discrimination against certain groups. Access to learning videos can be done online or offline. Inclusivity in learning videos is proven by the presence of a sign language translator with AI, the use of high color contrast between text and background, and the provision of sufficient time for students to read and understand the information in the learning videos.

The characteristics of learning motivation consist of feelings of pleasure, interest, and attention to learning [67]. Indicators of feelings of enjoyment and interest in learning are seen from students with disabilities who feel happy and enthusiastic about studying chemical bonding material because every material presented in the learning video is designed to be inclusive and uses animations that are related to everyday phenomena. The phenomena in this research are natural events that students encounter daily. This phenomenon includes using vehicle batteries and gas to fill hot air balloons and manufacturing salt. Examples of phenomena contained in inclusive learning videos can be seen in Figure 8.



Figure 8. Animation on video

Adding everyday phenomena associated with chemical bonding material can increase students' motivation because the knowledge of chemical bonds learned through learning videos is applicable. Characteristics: Motivation for learning in the form of generating attention and involvement of students with disabilities in learning is presented through questions and quizzes in videos [68]. These questions and quizzes can also train students with disabilities to think critically and directedly by the characteristics of science learning. The presentation of questions and quizzes can be seen in Figure 9.

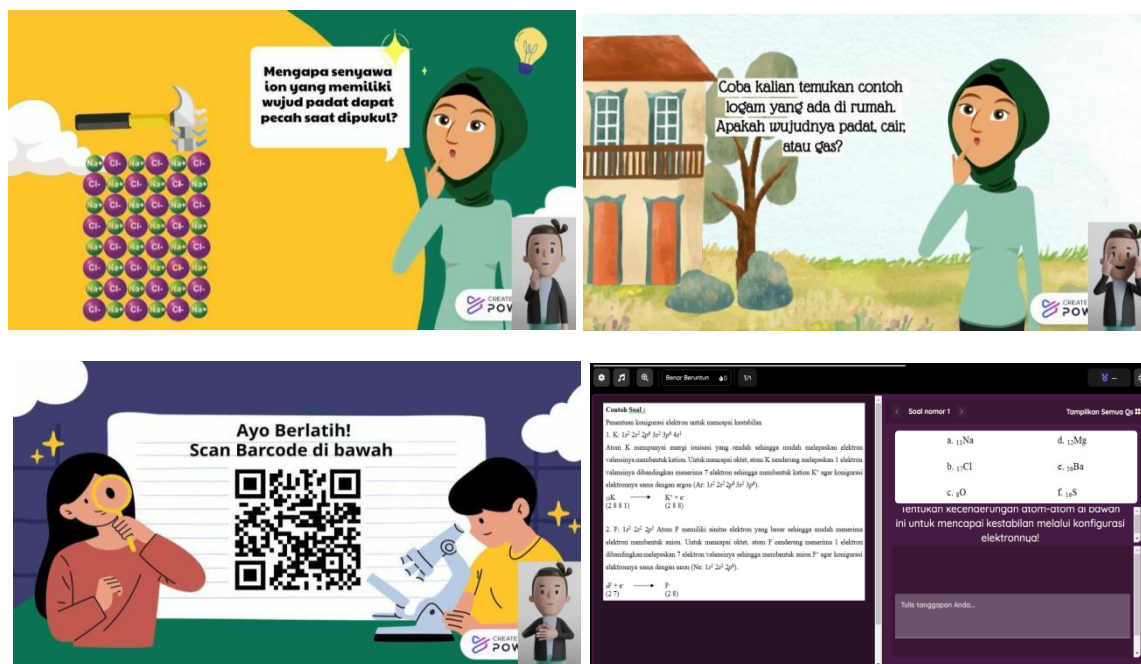


Figure 9. Questions and Quizzes in the video

The following format is closing. Closing is the closing part that marks the end of the learning video. The closing part consists of closing greetings and thanks, as seen in Figure 10.



Figure 10. Closing video

The research instrument created was a questionnaire for material experts, media experts, reviewers, and student responses. The assessment instruments for material experts, media experts, and reviewers use a Likert scale with excellent, good, enough, less, and significantly fewer answer choices. In contrast, student responses use a Guttman scale with answer options of Yes or No. The research instrument was created to assess the developed product and determine student responses. Instrument experts validate the instruments created before being used to search for research data. Table 1 shows the product quality assessment findings and student reactions.

Table 1. Data on Product Quality Assessment Results and Student Responses

Product Quality Assessment/Student Response	Assessment Aspects	Σ Skor	Σ Maximum Ideal Score	Ideal Percentage	Category
Materials Expert	Depth of Material	14	15	97.57%	Very good
	Language	20	20		
	Accessibility	20	20		
	Accommodating	20	20		
	Interest	9.2	10		
Media Expert	Activity	9.5	10	93.75%	Very good
	Opening	19	20		
	Visual	20	20		
	Audio	18	20		
Reviewer (Chemistry Teacher)	Closing	18	20	96.22%	Very good
	Depth of material	14.7	15		
	Language	20	20		
	Accessibility	20	20		
	Accommodating	20	20		
	Interest	9	10		
	Activity	9.7	10		
	Opening	18	20		
	Visual	20	20		
	Audio	19	20		
Student	Closing	18	20	94.6%	Very good
	Interest in learning	9.1	10		
	Attention learning	8.7	10		
	Motivation to learn	9.5	10		
	Inclusive	10	10		
	Knowledge	10	10		

Based on Table 1, the quality of the inclusive learning animation video on chemical bonding material using Powtoon software received an outstanding category, with the ideal percentage of material experts at 97.57%, media experts at 93.75%, and reviewers at 96.22%. The quality assessment results show that the inclusive learning animation videos developed have material content that can increase students' knowledge, language that is easy to understand and communicative, and inclusive and fun presentation so that students feel interested in studying chemical bonding material. The results of this research are from research conducted by Mindhaudah et al., which states that Powtoon learning animation videos can be used as alternative learning media for people with disabilities [69].

3.4 Implementation Stage

The developed inclusive learning animation video was carried out in a limited trial. It was responded to by 20 students with information about five students with disabilities, namely two blind students, two deaf students, and one quadriplegic student. Moreover, 15 non-disabled students in the tenth-grade senior high school in terms of interest and attention to learning, inclusivity, knowledge, and learning motivation. According to student comments, the quality of the generated inclusive learning animation videos received an optimum percentage of 94.6% in the outstanding category. Apart from that, the learning motivation aspect obtained a percentage of 95%. These results show that this learning media can increase students' motivation to study chemical bonding material. The inclusive learning animation video meets students' needs and expectations regarding learning media on chemical bonding material. The media developed can increase student motivation and become an alternative learning medium in inclusive classes. The results of this research are from research conducted by Melati et al., which states that inclusive learning animation videos can increase students' learning motivation [70].

3.5 Evaluation Stage

At the evaluation stage, the product that had gone through limited trials obtained a perfect score from the analysis of the practicality of inclusive learning animated videos based on teacher and student responses, which stated that the use of inclusive learning animated videos could facilitate the learning process because inclusive learning animated videos could be accessed practically by anyone. Anytime, anywhere. Analysis of the effectiveness of inclusive learning animation videos is considered very good based on the results of tests on students' problem-solving abilities with an increase in the minimum completeness criteria score of 75%. Inclusive learning animation videos are also disseminated to inclusive schools at this stage. This aims to ensure that the developed inclusive learning animated videos can be widely used.

This study has successfully developed an inclusive learning animated video that enhances students' learning motivation on chemical bonding, aligning with previous research findings that underscore the effectiveness of utilizing visual media in education [71]. Furthermore, the integration of AI technology within the animated video offers new insights into how inclusive education can be enhanced through technological innovation, expanding upon prior research by Wang [72], who explored the use of AI in education. These findings demonstrate the importance of developing learning media responsive to the diverse needs of students, including those with disabilities, challenging the traditional paradigm that often overlooks these student groups. Despite providing promising initial evidence, there are limitations, including a limited sample size and a specific scope of material, suggesting the need for further studies to test the effectiveness of this video in

various contexts and with a larger sample. For future research, it is crucial to explore how this inclusive learning animated video influences concrete student learning outcomes and how the integration of student feedback can be utilized to enhance the design of instructional videos. Additionally, researchers should examine the long-term impact of using this animated video in inclusive education and how similar technologies can be adapted for other learning materials.

4. CONCLUSION

This research aims to develop inclusive learning animation videos on chemical bonding material using Powtoon software; based on educational technology and contemporary conditions, this medium can be used in teaching and learning activities as an inclusive learning tool. The ADDIE development model was employed. According to the assessment results, these inclusive learning animation videos had an excellent rating of 97.57% from material experts, 93.75% from media experts, 96.22% from reviewers, and 94.6% from student answers in the outstanding category. As a result, the inclusive learning animation videos created can boost students' learning motivation and are appropriate for usage as alternative learning media in classroom settings. As for suggestions for further research, namely the inclusive learning animation video on chemical bonding material that has been developed, further research can be carried out to determine its effectiveness on learning outcomes in the classroom and its relationship with student learning motivation. The impact of this research is significant within the context of inclusive education, indicating that the utilization of AI technology in the development of instructional media can enhance student engagement and learning motivation, particularly among those with special needs. These findings underscore the potential of digital learning technologies to render learning materials more accessible and appealing to diverse student populations.

AUTHOR CONTRIBUTION STATEMENT

IA contributed to conceiving and designing experiments, conducting experiments, analyzing and interpreting data and writing the paper. AK contributes to improving and providing input on the research manuscript.

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