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Utilizing Animaker in Producing Interactive Chemistry Learning Media on the Topic of Atomic Structure

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Abstract: Today's learning process utilizes technological-based interactive learning media that improve students' understanding of chemistry. Animaker is one of the AI-powered platforms to create animation and live-action videos. Therefore, this research tried to utilize Animaker to produce interactive learning media on atomic structure material, analyze the quality of the media based on material and media experts, as well as teachers, and determine students' responses to the media. ADDIE model of research and development was used as the guideline in producing the media. *First*, needs analysis was carried out through literature reviews and preliminary studies. *Second*, the initial design was proposed, consisting of opening, main, and closing. *Third*, the design was then developed using Animaker website. In this stage, the media draft was validated by material and media experts. Two experts said that the media was excellent, although they provided feedback to improve the media. Some revisions were made before the media was delivered to teachers for quality testing. All teachers agreed that the media is of excellent quality (96.36%). The final media was then handed over to the student participants and they provided positive responses to the media. The Animaker is suitable for creating media that is interactive, interesting, and fun.

Keywords: Animaker; Atomic structure; Interactive learning media

Introduction

Technology and education are like two sides of a coin that cannot be separated in their development. This is proven by the increasingly rapid development of information and communication technology in the Industrial Revolution 4.0 era, which impacts the learning process (Umachandran et al., 2018). The Industrial Revolution 4.0 supports the development of information and communication technology (ICT), which benefits humans by increasing productivity, effectiveness, and creativity in daily activities (Santika, 2021). In the education field, ICT can be applied in in various ways and models (Saputra et al., 2021). Global demands encourage adapting to technological developments to improve the quality of education, especially by utilizing technology (Liao et al., 2018). One of them is interactive learning media.

Interactive learning media is a means that can facilitate the delivery of material from a learning source to students and stimulate creative ideas in learning activities (Pulungan, 2021). This interactive learning media presents learning content in text, video or animation, video, audio, and even video games (Adawi et al., 2021). Media is very important in learning activities because it is used to help visualize abstract teaching materials so that learning activities become easier and more interesting (Sari & Saputro, 2014). However, up to now, the use of learning media is less varied, so students cannot play an active role, are less enthusiastic, and are less energetic in learning (Alfian et al., 2022). The variety of learning media is important so students can easily understand and memorize certain

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subjects. Animaker can be utilized to develop interactive media.

Animaker is an audiovisual learning media with a two-dimensional animation platform that makes it easier for students to understand the subject matter (Sulthon et al., 2021) and is an alternative learning innovation for a teacher in the teaching and learning process (Munawar et al., 2020). In this application, various types of backgrounds and characters are available. Video Animaker can also be used many times because the videos created can be saved and shared via social media such as *YouTube*, *Facebook*, and *Instagram* (Sidabutar & Reflina, 2022). This application is easier for teachers to create and apply, available on the internet, and can develop movements complete with sounds and transitions to give a more interesting impression to students (Maheswari & Pramudiani, 2021). Animation video increases understanding of the content or learning material observed through the sense of sight and hearing, and students can have direct experience through the video. Animaker learning media can help students understand certain subjects, including chemistry.

Chemistry is a field of science that deals with natural phenomena, especially those related to the structure, composition, properties and changes of substances (Macariu et al., 2020). Besides studying changes in matter, chemistry also studies the energy that accompanies these changes (Wahidi, 2017). In other words, chemistry is a science full of concepts, from simple to complex theories and from concrete to abstract theories. Therefore, many students consider chemistry as a lesson that contains quite complicated concepts because of the many abstract elements and reactions (Muderawan et al., 2019). Chemicals are composed of many elements, which often makes students reluctant to study chemistry, especially those related to memorizing the periodic table of chemical elements, studying the composition and properties of objects as well as changes in the formation of these substances (Sunyono & Meristin, 2018).

Students' difficulties in studying chemistry are caused by the level of complex and abstract characteristics of the material (Eliyawati et al., 2020). Abstract chemical concepts will become a problem when these concepts are key concepts that are useful for understanding an event in nature (Saputra et al., 2021). Abstract concepts such as molecules, atoms, and quantities of substances are difficult for students to understand. The composition of substances is an important concept in chemistry because it is the basis for further learning about chemistry and organic chemistry. However, students' ability to imagine substances is limited, and it is difficult for them to imagine how particles such as atoms make up substances (Cai et al., 2014). Therefore, teachers must improve the learning methods and media to increase students' understanding.

The success of student learning cannot be separated from the teacher's active role in motivating and creating a learning atmosphere that is harmonious, enjoyable, and can boost student enthusiasm (Sasuang & Saiya, 2022). A teacher is also a colleague and a mentor to help and accompany students when they experience difficulties in the learning process (Maheswari & Pramudiani, 2021). With the development of learning media, a teacher must be able to facilitate and inspire student learning creativity. Learning activities designed by teachers must be able to develop critical thinking skills, communication and collaboration skills, as well as creativity and innovation skills in the use of technology (Yusri, 2021). However, some teachers have not fully utilized technology and still use traditional methods to deliver material (Sari & Harjono, 2021). Thus, there is a way to help teachers provide explanations to students on certain materials, especially atomic structure material, by utilizing media produced by Animaker.

Atomic structure is one of the chemistry topics that can be studied using fun and interactive learning media. Atomic structure and the periodic system are basic materials that students must understand in order to be able to learn further chemistry materials (Mellyzar et al., 2022). The concept of atoms was first coined by Democritus. According to him, atoms are everything that can be divided into the smallest particles that cannot be divided further (Sastrohamidjojo, 2018). This atomic structure cannot be seen directly with the naked eye, and the name atom comes from the word *a-tomos* (a means not and *tomos* means to cut) (Muslim et al., 2021). The science of atoms continues to be developed by scientists; until now, the parts and their roles are known. The atomic structure content is abstract and cannot be studied quickly. Besides, this content is new as it is usually first introduced to the students who learn chemistry as they have not yet obtained in-depth knowledge of chemistry in junior high school (Sari & Saputro, 2014).

The development of interactive media on atomic structure material is important because it has the potential to influence and improve student learning outcomes. This media is also useful for making learning atomic structure easier for students to understand. The media is also essential for teachers because it can help them easily manage and monitor student learning progress. Teachers can give more personal attention to students who need additional support while ensuring that the classroom takes place efficiently and is structured.

Method

This research applied Research and Development (R & D), which aims to develop, produce, and validate a product in which chemistry learning media on atomic structure using Animaker. The development model used in this research is ADDIE (Analyze, Design, Develop, Implement, and Evaluate) (Yu et al., 2021), but is limited to the implementation stage. The development process of the interactive learning media can be seen in Figure 1.

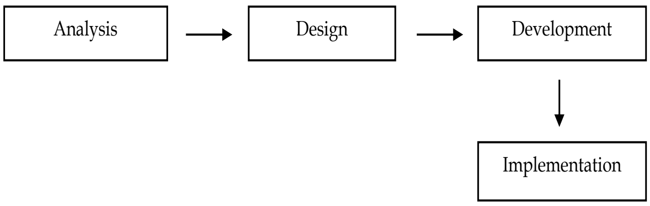

Figure 1. The procedures for developing the media

Initial observations were conducted at several high schools and Islamic high schools in Yogyakarta to determine and define the needs in the design and development processes. A material expert, a media expert, and two reviewers (high school chemistry teachers) were involved in validating the initial media draft.

Data in this research consists of qualitative data (validation data of the experts and teachers) and quantitative data (media assessment from teachers and responses from students). Feedback from the experts was used for media revision. The experts' and teachers' quantitative media assessment data were analyzed in three steps. The qualitative category was converted into the score (see Table 1) and then calculated as an average using the formula $x=\frac{\sum x}{n}$ (x = average score; $\sum x$ = total score, and n = number of appraisers).

Table 1. Conversion of Qualitative Data Values

Score	Category qualitative
5	Excellent
4	Very good
3	Fair
2	Poor
1	Very poor

The score was then calculated using the formula, and the calculation result is shown in Table 2. Quantitative data is also used to calculate the ideal percentage of high school chemistry teachers' assessments of products.

Furthermore, the qualitative data from students' responses was scored into quantitative data using the Guttman scale, as in Table 3.

Table 2. Ideal Assessment Category Criteria

Score range (i) quantitative	Qualitative category
Xi + 1.80 SBi < X	Excellent
Xi + 0.60 SBi < X ≤ Xi + 1.80 Sbi	Very Good
Xi – 0.60 SBi < X ≤ Xi + 0.60 Sbi	Fair
Xi – 1.80 SBi < X ≤ Xi - 0.60 Sbi	Poor
X ≤ Xi – 1.80 Sbi	Very Poor

Information:
X = actual score
Xi = average number of ideal scores
Xi $= \frac{1}{2}$ (ideal maximum score + ideal minimum score)
SBi = standard deviation of ideal scores
SBi $= \frac{1}{6}$ (ideal maximum score − ideal minimum score)
Ideal maximum score = Σ criteria items × highest score
Minimum ideal score = Σ criteria items × lowest score

Table 3. Scoring of Student Responses

Category	Score
Yes	1
No	0

All the final score (form the experts, teachers, and students) obtained was then converted into percentage using the formula:

$$\%\ ideal\ percentage = \frac{average\ score\ for\ all\ aspects}{the\ ideal\ highest\ score\ for\ all\ aspects} \times 100\% \quad (1)$$

Results and Discussion

Animaker has been proven to create interactive chemistry learning media on atomic structure. This media has attractive animation characteristics and features such as various writing styles, supporting images, audio, and attractive color combinations. The following is the process and results of media development.

Analysis

At this analysis stage, the developer analyzed the performance, needs and characteristics of students as a reference for research background through observation. The analysis was carried out before designing the media product to find out the learning problems, including what topics students usually find hard to understand and analyze the needs in learning activities so that the media that will be developed was more targeted (Rofiqoh et al., 2020). A needs analysis was used to determine the needs of teachers and students during the learning process (Dewi & Anggaryani, 2020). The following are the analysis stages that were conducted.

Job Analysis

At this stage, students' knowledge and skills were observed in the learning activity process. Interviews with teachers and students were also conducted to confirm the observation. The interview focused on the challenges, difficulties, and obstacles students and teachers face during the learning process, especially regarding atomic structure. Based on the observations and interviews, information was obtained that students tend to have a fairly low level of understanding in reading and studying chemistry because they memorize too much material related to the development of atomic theory.

Another analysis was the curriculum to determine the learning media material stated in the national curriculum document. Curriculum analysis was determined based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 37 of 2018 concerning Amendments to the Regulation of the Minister of Education and Culture Number 24 of 2016 concerning Core Competencies and Basic Competencies for Lessons in the 2013 Curriculum in Basic Education and Secondary Education. However, in the 2023/2024 academic year, there will be changes to the high school curriculum in various regions, especially in Yogyakarta, namely the emancipated curriculum. The learning outcomes and learning objectives used are as follows:

Learning Outcomes

Concept understanding: At the end of phase E, students can respond to global issues and actively provide problem solutions. These abilities include identifying, proposing ideas, designing solutions, making decisions, and communicating in the form of simple projects or visual simulations using available technological applications related to alternative energy, global warming, environmental pollution, nanotechnology, biotechnology, chemistry in everyday life, utilization of waste and natural materials, pandemics due to viral infections. All these efforts are directed at achieving sustainable development goals (*SDGs*). Through the development of this knowledge, noble morals and scientific attitudes are also built, such as honesty, objectiveness, critical reasoning, creativity, independence, innovation, cooperation and global diversity.

Process skills: At the end of this phase, students can carry out simple chemical research by choosing appropriate methods to observe, question and predict, plan and carry out investigations, process and analyze data, evaluate and reflect, and communicate results.

Learning Objective: understand atomic structure and its application in nanotechnology.

Needs Analysis

Needs analysis was conducted by conducting interviews with chemistry teachers at several senior high schools in Yogyakarta. Based on the interview, the learning media used by some schools is still limited to textbooks, PowerPoints and YouTube. As for the use of other network defence media, the material has no atomic structure yet. Learning models and methods were frequently used in lectures, discovery learning, and project-based learning (PjBL).

These two analyses indicated that interactive learning media was needed to help students and teachers figure out the problems related to learning media and method.

Design

The design stage was carried out through a planning process for developing teaching materials, which included compiling teaching materials, designing learning scenarios, selecting teaching material competencies, determining the type of learning media, and designing learning materials. After this process, the idea was to create interactive learning media using Animaker on the atomic structure material for students in Grade X.

The interactive learning media on the atomic structure has attractive animation characteristics and is equipped with a writing style, supporting images, audio, and beautiful color combinations. The initial cover displays the video's title in a gorgeous writing style and is supported by animated characters. Users can find the video title, personal identity, and learning objectives on the home page. On the next page, an explanation of the atomic structure material with the help of animation so that it makes students easier to understand. The interactive learning media was also equipped with questions for practicing so the students could review how effective this learning media is in making them understand the atomic structure material. Animation applications such as Canva and Web Animaker were used to support creating characters in the media so students could be more interested and apply them. The final page was a closing containing words of wisdom and a thank you note.

Besides designing the media, a research instrument that consists of a material expert validation sheet, a media expert validation sheet, a product quality assessment sheet, and a student response questionnaire were made. All the instruments were validated by one expert.

Development

The development stage in the ADDIE Model contains product design realization activities. The development stage in this research includes activities to create and modify teaching materials (Cahyadi, 2019), based on the design stage. The conceptual framework from the design stage was realized and turned into a product that is ready to be implemented.

The interactive learning media was created using Web Animaker as the main tool, as well as other applications such as the Canva web, the CapCut application, and a smartphone recorder. Animaker video creation begins with pre-production by creating a script and animation layout as a sketch. After that, sound recording was done using a smartphone recorder and taping sound into the video. Then, the video was created by inserting animation and other components into the slide Animaker, and the video was exported in .*mp4 format. Next, all the videos made were combined using the CapCut application and then uploaded to Google Drive.

The final draft of the media consists of two videos lasting 10 – 15 minutes and consists of opening, content and closing. These three formats can be described as follows.

Opening

The opening or introduction section of the interactive learning media on the atomic structure material contains the title and author's identity (Figure 2), sub-material (Figure 3), and learning objectives (Figure 4) as competency targets (or learning outcomes).

Figure 2. Title and author's identity

The title and author's identity (Figure 2) are located in the first frame, equipped with animation and using a landscape background so that it adds to the beauty of this media. The interactive learning media has two sub-materials, namely the theory of atomic development and particles in atomic structure, but this Animaker video was packaged separately (Figure 3).

The opening section (Figure 4) is equipped with learning objectives as competency targets that students in the learning process must achieve.

Figure 3. Submaterial

Figure 4. Learning objectives

Contents

The content section is the main part of the interactive learning media because this section contains a description of the material that will be discussed. The contents can be seen in Figure 5 (for the Development of

Atomic Theory sub-material) and Figure 6 (for Particles in Atomic Structure sub-material).

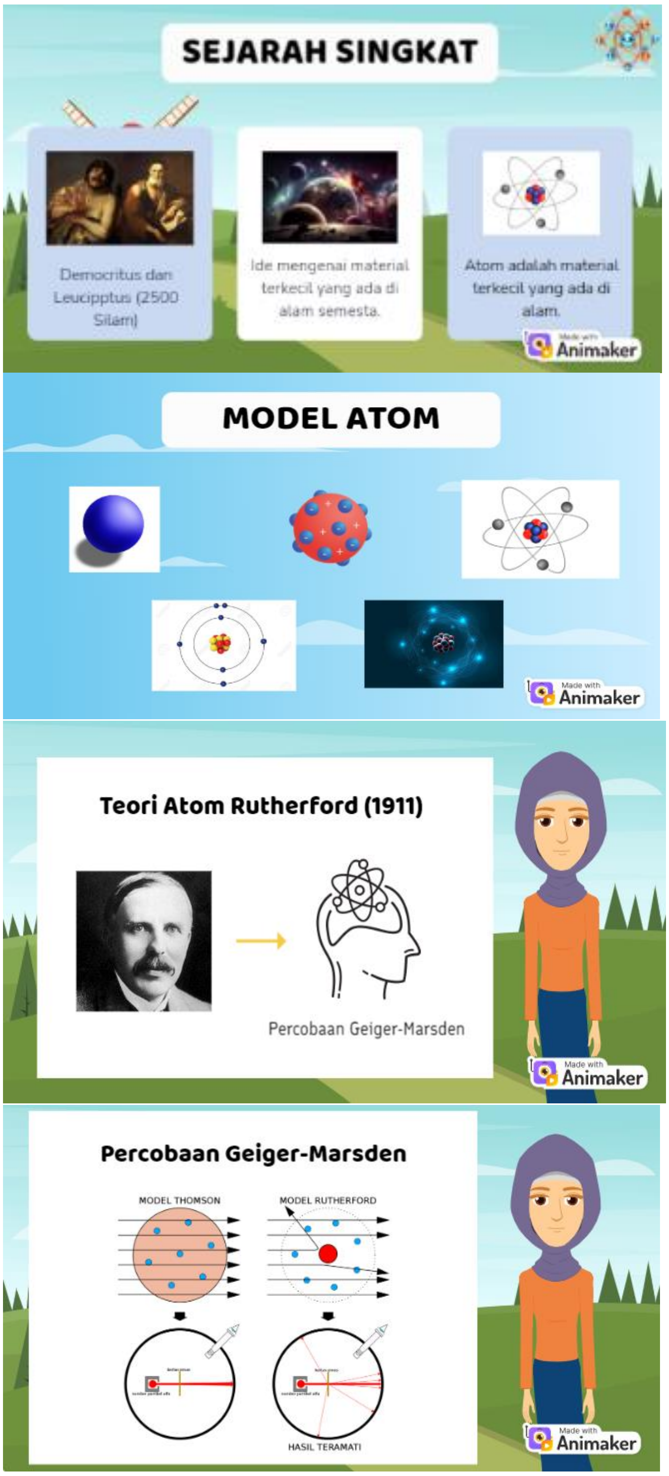

Figure 5. Sub-material for the development of atomic theory

The first sub-material, namely the theory of atomic development, consists of a brief history of the discovery of atoms, atomic models, Dalton's atomic theory, Thomson's atomic theory, Rutherford's atomic theory, Bohr's atomic theory, and quantum mechanical theory.

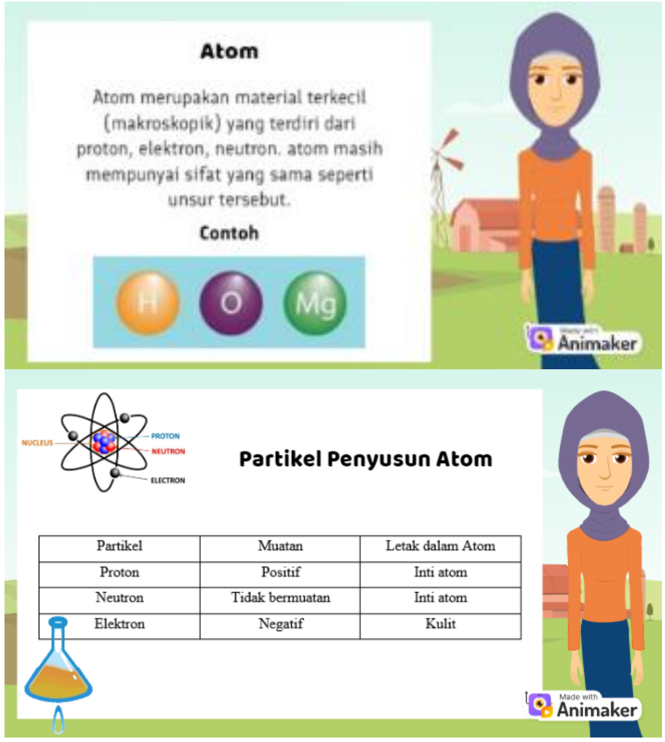

Figure 6. Sub-material particles in atomic structure

The second sub-material, particles in the atomic structure, consists of particles, atomic symbols, isotopes, isobars and isotones.

The contents provided materials that could help students have feelings of joy, interest in learning, generating attention, and interactively involving students because it used videos and animations. It boosts students' happiness when studying the material. Another thing is that the interactive learning media was presented by linking natural phenomena in everyday life, such as children playing with sand on the beach, which can be seen in Figure 7.

Figure 7. The illustration of how the media is linked to everyday phenomenon

The selection of appropriate images and illustrations causes students to be interested in learning with interactive learning media. In addition, the right combination of colors and attractive designs make students feel a new nuance in the learning process. This condition makes students interested in studying atomic structure material. This also raises attention, which aims to provide encouragement and attention to the material. Students will respond when they are calm and focused on their learning. Some questions offered in the media could make the students focus and gain their participation. When the students actively participate in the teaching, it indicates that they are interested in learning activities so that they can feel happy and attentive. The participation of students in learning activities will create a pleasant learning atmosphere. Moreover, interactive learning media also provides a form of discussion to engage students in learning.

Closing

The closing section is the final part of the interactive learning media. The closing part consists of a thank you note and motivational words. The closing section frame is seen in Figure 8.

Figure 8. Interactive learning media closing section

After the first draft of the interactive learning media was finished, the next step was a validation process. The learning media was validated by one material expert and one media expert. The media that has been validated was then assessed by reviewers, namely two chemistry teachers at a high school in Yogyakarta and then responded to by 30 students of Grade X at a high school in Yogyakarta. Data from media validation and assessment results are described as follows.

Media Validation by Materials Expert

A material expert validated the initial interactive learning media on atomic structure material based on three aspects, namely material relevance, presentation, and language. Validation was done by filling in a sheet related to product revisions and initial product assessment. The descriptive assessment results were converted into quantitative data and tabulated and analyzed to determine the quality category of the developed media. Based on the validation results from the material expert, there were suggestions and feedback as a way to revise the media draft. This feedback lies in understanding concepts that give rise to misconceptions related to the definition of atomic structure and particles in atomic structure. Furthermore, there was a need to improve the writing of chemical symbols in the media presented. The feedback from the material expert was then used as the basis for revision. The revised draft was then resent to the material expert. Data from the assessment results by material experts can be seen in Table 4.

Table 4. Material Expert Validation Results

Assessment aspects	∑ score	∑ Ideal maximum score	Ideality percentage (%)	Category
Relevance of material	23	25	92	Excellent
presentation	14	15	93.30	Excellent
Language	19	20	95	Excellent
Total	56	60	93.30	Excellent

Overall, the material expert assessed the interactive media with the ideal percentage of 93.3% (56 out of 60), and the media was in the excellent category.

Media Validation by Media Expert

A media expert validated the interactive learning media on atomic structure material in terms of video format and ease of use. Like the material expert, media experts provide feedback and carry out qualitative assessments of the media draft. The media expert highlighted adding some backgrounds and animations related to chemistry. Data from the assessment by the media expert is in Table 5.

Table 5. Media Expert Validation Results

Assessment aspects	∑ score	∑ Ideal Maximum Score	Ideality Percentage (%)	Category
Video formats	28	30	93.30	Very good
Ease of use and language	19	20	95	Very good
Total	47	50	94	Very good

The media expert's assessment obtained a product ideal percentage of 94% with an average score of 47 out of a maximum ideal score of 50. The results of this product assessment are included in the Very Good (SB) category.

Media Assessment by the Reviewers

Two high school chemistry teachers assessed the interactive learning media based on five aspects: material relevance, presentation, language, video format, and ease of use. The assessment was carried out by judging each statement; if it gives a value of Poor or Very Poor, the reviewer should provide feedback to improve the media. The reviewers also provided feedback by adding more example questions. The results of this judgment were then quantified, tabulated, and analyzed to determine the quality of the learning media. Data on the media quality assessments by two high school chemistry teachers is in Table 6.

Table 6. Product Quality Assessment Results

Assessment aspects	∑ score	∑ Ideal maximum Score	Ideality percentage (%)	Category
Relevance of material	48	50	96	Excellent
Presentation	30	30	100	Excellent
Language	36	40	90	Excellent
Video formats	58	60	96.60	Excellent
Ease of use	40	40	100	Excellent
Total	212	220	96.36	Excellent

Overall, interactive learning media that developed using Animaker has excellent quality based on the material expert, media expert, and reviewers. Two high school chemistry teachers, as the reviewers, gave their judgment as it was quantified to an ideal percentage of 96.36% with a total score of 212 out of a maximum ideal score of 110. Based on the reviewer's assessment criteria, the average score of the assessment results is in the range of Xi + 1.80 SBi < X. Even though interactive learning media is of excellent quality, there are advantages and disadvantages to this media.

Even though interactive learning media is of excellent quality, there are advantages and disadvantages to this media. The advantages of this product are first, the interactive learning videos developed have various interesting animations and illustrations to increase students' learning preferences. Second, the language used to deliver the material is simple, which makes the students digest the information easier. Third, the media contains natural phenomena that stimulate students to think about the relationship between daily life and the content. Fourth, the media is flexible and can be used anytime and anywhere. Fifth, the media can be operated using a handphone or laptop. While the disadvantages of this product are the material is limited to the atomic structure and the duration of Animaker-based learning videos is limited.

Implementation

Interactive learning media designs that have passed validation and assessment produce a final design that is then implemented in real situations (Aminah, 2018). Implementation is the final stage to test the interactive learning media developed for end users (students). The implementation stage was not conducted in the classroom for the media trial, but the students' responses to the media were gathered using a questionnaire that consisted of five positive and five negative statements about the media. A total of 30 students of Grade X High School in Yogyakarta agreed to respond to the interactive learning media. The questionnaire data was converted into quantitative data with the answers "Yes" = 1 and "No" = 0, then tabulated and analyzed according to ideal assessment criteria. Data from the students' responses is in Table 7.

Table 7. Results of Student Responses

∑ score	∑ Ideal maximum score	Ideality percentage (%)	Category
2	2	100	Excellent
2	2	100	Excellent
1.95	2	97.50	Excellent
2	2	100	Excellent
2	2	100	Excellent
1.9	2	95	Excellent
11.85	12	98.75	Excellent

The total score of the students' responses was 11.85 out of 12 or 98.75%, which was in the excellent category. Most of the student participants responded positively to the interactive learning media. They said that the learning media was easy to understand, the animated video was very interesting and helped them concentrate more while learning, and it had daily life-related content that made the students more engaged with atomic structure material.

The results of the implementation stage indicate that Animaker is very helpful in making the media interactive and interesting and connecting the students with the material they learned. It also shows that Animaker can build interactive learning media to increase students' insight and knowledge as the language is simple and easy to digest. Thus, the interactive learning media using Animaker is appropriate for meeting students' needs and expectations regarding learning media on atomic structure material. The media can become an effective and practical alternative to learning media. The results of this research align with research conducted by Sidabutar et al. (2022) and Munawar et al. (2020) where they stated that learning media with the Animaker application is feasible and practical to apply in the classroom during learning activities.

The interactive learning media on atomic structure material is very useful as a learning resource for students because it can increase students' enthusiasm during the learning activities to create effective and enjoyable learning. However, this research still has limitations and needs improvement, which is the last stage, i.e., the evaluation stage, which was not conducted. Therefore, future research is suggested to cover all the stages of the ADDIE model. A large-scale trial can be carried out on both educators and students to seek the effectiveness of the media or products developed.

Conclusion

The Animaker successfully created interactive media for the atomic structure. The Animaker has many features, such as animated characters and gorgeous colours, that can be utilized in the making process of interactive learning media. Any type of handphone or laptop can operate the interactive learning media using Animaker, and it complies with flexible and feasible criteria. The students can use the interactive learning media in the classroom or while at home, increasing the students' opportunity to learn. Because the interactive learning media was developed using a structural R&D model, it can be said that the process was highly maintained. It is indicated by all experts, teacher reviewers, and students who provided excellent categories to the interactive learning media. Therefore, the interactive learning media using Animaker can become an effective and practical alternative learning media suitable for use in learning activities.

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Author Contributions
D: conceptualization, data collection and analysis, and original draft writing. J: methodology, writing, review, editing.

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Conflicts of Interest
The authors declare that there are no relevant conflicts of interest related to this research.

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