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Development of Video Tutorials for Making Learning Media Based on Augmented Reality on Ion Material

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Abstract: Ionic matter is an abstract material that is included in the submicroscopic level. Augmented reality is a media that can be used to overcome these problems. This research aims to identify the level of validity and show the response of educators and students to video tutorials on making augmented reality-based learning media on ion material. The level of product validity is based on the results of validation tests by experts, while the teacher's response is from the results of the teacher's response test questionnaire on chemistry and junior high school chemistry subjects. Student responses from chemistry education students at FKIP Tanjungpura University class of 2020. The method used is development using a design thinking approach. The research results show that the average percentage results in terms of media, material and language validity is 95.2%, so it can be categorized as very valid. Then, the teacher's response obtained an average percentage result of 89.9% and the student response was 88.85%. Thus, it is concluded that the resulting product received a very good response from educators and students.

Keywords: Augmented reality; Ion material; Learning media; Video tutorial

Introduction

The characteristics of chemistry include three domains known as the chemical triangle, one of which is submicroscopic which refers to the abstract characteristics of the shapes of atoms, ions and molecules (Fahmy, 2016). These three characteristics of chemistry must be considered to achieve learning objectives (Sutrisno et al., 2020). Thus, this ability is very important for students' understanding of chemical concepts (Sutrisno et al., 2020). However, abstractness at the submicroscopic level often makes it difficult for educators to convey material presentations (Imaduddin, 2018).

Ionic matter is an abstract material that is included at the submicroscopic level (Herunata et al., 2024). Therefore, ion material, especially the acceptance and release of electrons, is difficult for junior high school students to understand (Nissa et al., 2017). This is supported by the results of observations and interviews conducted by Ishaq et al. (2012) at SMP Negeri 1 Balong Ponorogo which found that as many as 76% of students had difficulty studying atomic, ion and molecular material because of its abstractness.

Learning media can be used by educators to overcome the abstract nature of material. The abstractness of the material can be overcome by using learning media (Anggraini, 2022; Fatmadiwi et al., 2021; Harefa, 2020). However, currently the media used are whiteboards and PowerPoint. This is in line with the results of interviews with junior high school chemistry course educators at the FKIP UNTAN chemistry education study program which stated that, when most prospective educators were given the task of creating learning media on ionic material, they only used PowerPoint which contained mere descriptions of the material without any visualization. Supported by the results of interviews conducted by Rahmi et al. (2021)

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(2021) with educators at SMK Negeri 2 Anambas, it was found that the use of whiteboards and PowerPoint in abstract material resulted in students' learning outcomes in chemical bonding material in class X not meeting the minimum completeness criteria. namely 75. Therefore, appropriate media is needed in learning abstract material.

Augmented reality is a medium that can be used to overcome abstract learning problems. Augmented reality (AR) according to The New Media Corsotium in Garzón et al. (2017) can be used as a medium that combines digital information including 3D models, images, video and audio into a real world space which aims to combine reality with a virtual environment as well as allowing users to interact with both physical and digital objects. The use of augmented reality will make users feel a more real experience. Several studies support that augmented reality media can help students' understanding in studying ion material. The results of research conducted by Apriani et al. (2021) found that augmented reality-based modules can help students understand the concept of chemical bonds. Furthermore, the results of research conducted by Vitalocca et al. (2013) found an increase in student learning outcomes by using augmented reality media. Thus, students' understanding can be better by using Augmented reality media which contains 3-dimensional images of chemical bonding material (Ditcharoen et al., 2014). So it is important for educators and prospective educators to create augmented reality technology for understanding ion material.

Educators and prospective educators must be able to apply TPACK in creating Augmented Reality learning media. According to Koehler et al. (2009) TPACK is a development of PCK which was initiated by Shulman (1987) with the aim of being a framework for integrating technology and learning to produce effective teaching with the help of technology. However, based on the results of a survey by Hairida et al. (2023), it is known that educators are still not skilled in developing learning technology tools. This can be overcome by providing understanding to educators and prospective educators in the use of technology (Fitriah et al., 2019). One of them is using video tutorials for educators and prospective educators who are lacking in the use of technology. Video tutorials are videos that aim to provide guidance regarding understanding and knowledge in video form to viewers. Video tutorials are also very good to use as a tool in understanding the steps involved in the learning process (Adithya et al., 2022). Thus, it is hoped that the use of video tutorials can increase the understanding of educators and prospective educators in creating learning technology media. For this reason, it is necessary to carry out research on the development of video tutorials for making augmented reality-based learning media on ionic materials. Through this research, it is hoped that a video tutorial will be produced for making augmented reality-based learning media on ionic material that is suitable for use in learning.

Method

The type of research used is Research and Development or R&D, namely: developing products in the form of video tutorials for making learning media based on Augmented Reality on ion material. According to Sugiyono (2019) Research and Development is a method used in research to validate, develop a product or improve an existing product, or one that can be accounted for. The method used in this research is a design thinking approach which consists of 5 stages, namely empathize, define, ideate, prototype, and test (Sari et al., 2021).

The steps for development research using a design thinking approach can be seen in Figure 1. In the empathize stage, learning media interviews were conducted with educators and students of Chemistry Education, FKIP, Tanjungpura University. The define stage is identified from the empathize stage by observing the interview data, then concluding the essence of the problem based on the needs and desires of educators and prospective educators.

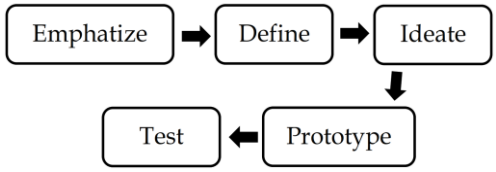

Figure 1. Design thinking method

After finding the problem and the necessary needs, the ideate stage is carried out. At this stage, researchers hold discussions with experts to exchange opinions and conduct literature studies regarding the product to be developed. The product developed is a Video Tutorial on Making Learning Media based on Augmented Reality on Ion Material. At this stage, research instruments were also created, namely validity test questionnaires and response tests. At the prototype stage, the researcher created a prototype in the form of a video tutorial storyboard and augmented reality learning media on ion material to realize the ideas that had been designed. In addition, the research instrument was validated first by 2 validators. The scoring on the research instrument validation sheet uses the Guttman scale consisting of a score of 1 (Yes) and a score of 0 (No).

The results of the research instrument validation were analyzed using the following formula:

$$K\% = \frac{\text{total score}}{\text{criteria score}}\ x\ 100 \quad (1)$$

The criterion score is obtained from the highest score for each item x Σitem x Σvalidator. The calculation results obtained can be adjusted to the validity categories in Table 1.

Table 1. Instrument Validity Category (Meliana et al., 2022)

Range (%)	Category
0-40	Invalid
41-60	Less valid
61-80	Valid
81-100	Very valid

The test phase carried out a prototype validity test which consisted of material, media and language validation. The validation process involved 4 material and media experts and 2 language experts. In media validation there are 2 components, namely media and video tutorials. There are 2 aspects measured in the media component, namely display and software, while in the video tutorial component only the display aspect. In material validation, there is 1 component, namely the media and 1 aspect, namely the material aspect. In language validation there are 2 components, namely media and video tutorials. There are 5 aspects of the media component, namely straightforward, communicative, suitability of language to educational level, conformity to Indonesian language rules, and use of terms, symbols and icons. Meanwhile, in the video tutorial component there are 4 aspects, namely straightforward, communicative, conformity with educational level, and conformity with Indonesian language rules. Apart from validation by the validator, the researchers also conducted a response test involving 13 educators and 30 students of the Tanjungpura University FKIP Chemistry education study program class of 2020. In the teacher and student response test there were 2 components, namely media and video tutorials. There are 4 media components in the educator response test, namely appearance, material, software and benefits. Meanwhile, in the student response test there are only 3 aspects, namely appearance, material and software. The video tutorial component in the teacher and student response test has 2 aspects, namely appearance and benefits.

The response test aims to get responses from educators and students to video tutorials on making augmented reality-based learning media on ion material. The scoring on the response test questionnaire sheet refers to the Likert scale adapted from Sugiyono (2016), which consists of a score of 4 = Strongly Agree (SS), 3 = Agree (S), 2 = Disagree (TS), 1 = Strongly Disagree Agree (STS). The results of the validator and respondent assessments in the form of comments and suggestions will become evaluation material for researchers to carry out revisions. Data in the form of assessment results from validators and respondents will be analyzed using percentage analysis techniques adapted from Akbar (2013) as follows:

$$V - ah = \frac{\text{TSe}}{\text{TSh}}\ x\ 100\% \quad (2)$$

Information:
V-ah : Expert validity
TSe : Total validator empirical score
TSh : Maximum score

The percentage results obtained from the validator can be seen in the validity criteria as in Table 2.

Table 2. Validity Percentage Criteria (Akbar, 2013)

Achievement criteria	Level of validity	Information
85.01-100%	Very valid	Can be used without repair
70.01-85.00%	Quite valid	Can be used with minor revisions
50.01-70.00%	Less valid	It is recommended not to use it because it needs major revisions
01.00-50.00%	Invalid	Cannot be used

The percentage results obtained from respondents can be categorized into response test categories in Table 3.

Table 3. Response Test Assessment Categories

Response criteria (%)	Response Rate
85.01-100%	Very good
70.01-85.00%	Pretty good
50.01-70.00%	Deficient
01.00-50.00%	Not good

Result and Discussion

The result of this research is that a video tutorial was developed for making augmented reality-based learning media on ion material. The video tutorial was developed using the 3D Blender, Unity Hub, Vuforia Engine, Canva and Capcut applications. Video tutorials can be accessed by users via Linktree as in Figure 2, so that educators and students can study them directly. This product was developed to identify the level of validity of video tutorials as well as the response of educators and students to video tutorials. Video tutorials for making augmented reality-based learning media on ion material were developed using a development method with a design thinking approach.

Figure 2. Display tutorial video link

The videos developed consist of 6 videos and 4 links in the form of an Opening video tutorial which contains a foreword and motivation for creativity, a video tutorial for making designs in the Canva application, a video tutorial for using the Vuforia engine, a video tutorial for creating 3D objects in the 3D Blender application, a video tutorial for using Unity Hub application, video tutorial on using augmented reality-based learning media on ion material, Canva application download link, 3D Blender application download link, Unity Hub application download link, and Vuforia Engine access link.

Emphatize

Interviews were conducted with teachers and students of Chemistry Education, FKIP, Tanjungpura University. The results of interviews with junior high school chemistry course educators in the Tanjungpura University FKIP Chemistry Education study program show that ionic material is abstract material so appropriate media is needed for educators to explain this abstract material.

Define

Data identification was carried out from the empathize stage. Identification of problems is carried out by observing interview data and then concluding.

Ideate

The problems found at the define stage were then discussed with experts at the ideate stage and a literature study was carried out regarding solutions to the problems, namely video tutorials for making augmented reality-based learning media on ion material. Apart from that, the researchers also created a validity test and response test questionnaire, looked for the SMP Chemistry CPMK sub, collected references for compiling material in the media, prepared the necessary equipment and software, and designed the product design. After finding a solution to the problem, the prototype stage is carried out.

Prototype

At this stage the researcher created a video tutorial storyboard and augmented reality learning media to realize the ideas designed at the ideate stage. Apart from that, validation of the research instruments was also carried out by 2 validators. The purpose of validating this research instrument is to ensure that the research instrument created is valid and able to measure according to the aspects intended by the researcher (Sari et al., 2021). Data obtained from the validation results of research instruments were analyzed using the Guttman formula. The results of the analysis show that the research instruments in the form of media validation questionnaires, material validation, language validation, educator responses and student responses obtained an instrument content validity coefficient of 100%. Thus, the research instrument is categorized as very valid so that it has a high level of validity and is suitable for use in research.

Test

Validation of the prototype that has been realized is carried out. The purpose of this validation is to determine the validity of the product being made (Janna et al., 2021). In this research, media, material and language validation was carried out. Each validation result is presented in Table 4.

Media and material validation involved 1 lecturer in Chemistry Education, FKIP, Tanjungpura University, 1 lecturer in Chemistry Education, FKIP, Muhammaddiyah University, Pontianak, 1 lecturer in PG Early Childhood Education, FKIP, Tanjungpura University and 1 teacher at SMP Negeri 16 Pontianak.

Based on Table 4, it can be seen from the results of media validation on media components that the average percentage of display aspects obtained was 89% with a very valid category. This shows the suitability of the media display to the media display size standards, presentation layout, attractiveness of the display, and instructions for use. Thus, the appearance of teaching material media that meets standards and is attractive, the correct layout and presentation, as well as instructions for using the media that are easy to understand will encourage students' interest in learning (Mumpuni, 2019) and be easy for users to understand in operation (Joni et al., 2020). Furthermore, the software aspect obtained 96.25% with a very valid category. This shows that the media is easy to use, navigation buttons that function well, and 3D visualization that can be used and is in accordance with the ionic material concept. Thus, navigation buttons that function well can have a positive impact on user motivation and understanding (Mella et al., 2022). Meanwhile, 3D visualization that is conceptually appropriate and easy to use can help users understand the concept of the material (Fitrihana, 2022). So the use of augmented reality in learning ion material is considered effective, because ion material is very abstract so to visualize it requires media such as visualization from augmented reality (Muhayat et al., 2017). The video tutorial component with the display aspect obtained an average percentage result of 94%, so it can be categorized as very valid. This shows that in the video tutorial the researcher was right in choosing colors, images and animation. Appropriate and appropriate colors, images, animations and sounds can help users understand material with concepts that are difficult to discuss textually (Azkia et al., 2023). Apart from that, the validation results also show that the talent's voice matches the video, the subtitle text presented matches the video, and the video tutorial can be used well. The suitability of the talent's voice to the video will help users understand the material being presented and the message in the video tutorial will be conveyed clearly to the user (Sari et al., 2021). Thus, it can be concluded that the tutorial video for making augmented reality-based learning media on ion material is in the very valid category and is worth testing.

Table 4. Average Results of Media, Material and Language Validator Assessments

Validator	Component	Aspect	Average validator rating (%)	Category
Media	Media	Appearance	89%	Very valid
		Software	96.25%	Very valid
	Video Tutorials	Appearance	94%	Very valid
Material	Media	Material	96.42%	Very valid
Language	Media	Straightforward	100	Very valid
		Communicative	100	Very valid
		Suitability of language to educational level	100	Very valid
		Conformity with Indonesian language rules	100	Very valid
		Use of terms, symbols, and icons	87.50	Very valid
	Video Tutorials	Straightforward	87.50	Very valid
		Communicative	100	Very valid
		Suitability of language to educational level	100	Very valid
		Conformity with Indonesian language rules	87.50	Very valid

In material validation, an average material validity of 96.42% was obtained. Thus, it can be concluded that the validity of the product material is categorized as very valid. This shows that the sub CPMK delivered is in accordance with the sub CPMK for the junior high school chemistry course. A teaching material will provide a complete understanding if it can present a description of the material that is in accordance with what is to be achieved (Lau et al., 2019). The material presented is in accordance with the concept of ionic material. According to Mappiara et al. (2020) correct presentation of material can prevent conceptual errors from arising. In line with Dewi et al. (2021) which states that students will experience conceptual errors if they receive incorrect or distorted information. Furthermore, the material presented is coherent and easy to understand. Teaching materials that are delivered coherently can make it easier for students to understand the material, so that learning objectives will be easier to achieve (Kusuma et al., 2018). Apart from that, the practice questions presented in the media are in accordance with the CPMK Sub. Suitability of questions with sub-CPMK can make it easier to understand the material (Ratriyana, 2020).

In language validation, it involved 1 lecturer at Elementary School Teacher Education, FKIP, Tanjungpura University and 1 teacher at MAN 1 Singkawang City. Then, an average percentage result was obtained of 95.83%. Thus, it can be concluded that the language used in the product meets straightforward, communicative aspects, according to educational level, according to Indonesian language rules, consistent in the use of terms, symbols and icons. According to Panjaitan et al. (2021) using appropriate language will prevent

multiple interpretations so that it will make it easier for readers to understand the information.

The response test involved 13 educators consisting of 5 chemistry subject educators in high school and 8 science subject educators in junior high school. As well as 30 students of the Tanjungpura University FKIP Chemistry education study program class of 2020. The average results of educators' responses from each aspect are presented in Table 5.

Table 5. Average Results of Educator Responses

Component	Aspect	Average validator rating (%)	Category
Media	Appearance	88.46	Very good
	Material	88.46	Very good
	Software	90.38	Very good
	Benefit	92.30	Very good
Video Tutorial	Appearance	92.30	Very good
	Benefit	87.50	Very good

Based on Table 5, it can be seen from the test results of educators' responses to the media components that the average percentage of display aspects obtained was 88.46% in the very good category. This shows the suitability of the media display, 3D visualization and instructions for use. In this way, the display of the media components is attractive and clear. Attractive media displays can steal users' attention (Ridwan et al., 2022). The material aspect received a score of 88.46% in the very good category. In this way, the material contained in the media is easy to understand. The software aspect received a score of 90.38% in the very good category. This shows that the software is easy to use. Furthermore, the benefits aspect received a score of 92.30% in the very good category, so it is said that the media can be used in the learning process and help educators convey ion concepts to students. Previous research results also suggest that augmented reality can help educators deliver learning material (Apriani et al., 2021). In the video tutorial component, it is known that the average percentage result from the display aspect is 92.30% in the very good category. This shows the talent's voice is clear and matches the video. A clear video display can increase learning motivation for students (Nuraeni et al., 2023). Furthermore, the benefits aspect received a score of 87.5% in the very good category. Thus, it shows that the resulting video tutorial can help and motivate educators in creating augmented reality-based learning media on ion material. This is because videos are able to convey understanding well and can be played repeatedly according to the user's wishes (Hairida et al., 2020). Apart from that, video tutorials are very good to use as a tool in understanding the steps involved in the learning process (Adithya et al., 2022).

Based on Table 6, it can be seen from the results of student response tests on media components that the average percentage of display aspects obtained was 90.16% in the very good category. This shows the suitability of the media display, 3D visualization and instructions for use. In this way, the display of the media components is attractive and clear. Attractive media displays can attract users' attention (Ridwan et al., 2022). The material aspect received a score of 91.12% in the very good category. In this way, the material contained in the media is easy to understand. The software aspect received a score of 83.87% in the good category. This shows the user's ease of use. However, there are students who find it difficult to use media because Android does not support it and there are students who use iOS. In the video tutorial component, it is known that the average percentage result from the display aspect is 91.13% in the very good category. This shows the talent's voice is clear and matches the video. A clear video display can increase learning motivation for students (Nuraeni et al., 2023). Furthermore, the benefits aspect received a score of 87.9% in the very good category. Thus, it shows that the resulting video tutorial can help and motivate students in creating augmented reality-based learning media on ion material. This is because videos are able to convey understanding well and can be played repeatedly according to the user's wishes (Hairida et al., 2020). Apart from that, video tutorials are very good to use as a tool in understanding the steps involved in the learning process (Adithya et al., 2022).

Table 6. Average Results of Student Responses

Component	Aspect	Average validator rating (%)	Category
Media	Appearance	90.16	Very good
	Material	91.12	Very good
	Software	83.87	Very good
Video tutorials	Appearance	91.13	Very good
	Benefit	87.90	Very good

In this research, there are advantages to the product being developed, namely video tutorials for making augmented reality-based learning media on ion material presented in stages and in several parts. The video, which is presented in stages and into several parts, is to guide and simplify the understanding process (Monica, 2021), and can be played back. Media that can be played back can add clarity and increase effectiveness (Syaparuddin et al., 2020), and the product being developed is a new innovation, especially in the field of chemistry.

Conclusion

The product produced in this research is a video tutorial for making augmented reality-based learning media using ion material. Based on the research results, it can be concluded that the video tutorial for making augmented reality-based learning media on ion material is classified as very valid in terms of the validity of the media, material and language, so it can be used without correction. So that educators provide a very good response to the products being developed. In this way, the product developed can make it easier for educators to produce good learning media. Then, students gave a very good response to the product being developed so that the tutorial video for making augmented reality-based learning media on ion material could help students visualize and produce good media for junior high school chemistry learning. Based on the research carried out, suggestions for further research are that this video tutorial should be further developed with video tutorials on other materials, with more varied augmented reality visualizations such as 3D visualization of other ions. Furthermore, the resulting media can be operated on iOS, PC or laptop.

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Author Contributions
Q.N, conceptualizing research ideas, methodology design, data analysis, obtaining data analysis results, making conclusions, and looking for references. H and M, guide, supervise, and provide advice and input. E.E and R.R checked and reviewed the articles.

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