

Development of Booklet Assisted by Video Animation by Utilizing QR Code on Constitutional Isomers Sub-Material

Nurzam Indah Utami^{1*}, Rahmat Rasmawan¹, Ira Lestari¹, Rini Muharini¹, Maria Ulfah¹

¹Pendidikan Kimia, Universitas Tanjungpura, Pontianak, Indonesia.

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Corresponding Author:

Nurzam Indah Utami

nurzamindah@gmail.com

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Abstract: This research aims to produce a product in the form of a booklet assisted by an animated video by utilizing QR codes on constitutional isomers sub-material to increase student understanding and reduce misconceptions on constitutional isomers. This research method is research and development (R&D) with a 4D development model consisting of the Define, Design, Develop and Disseminate stages. However, this research only reached the Develop stage. The validation data was analyzed using Content Validity Ratio (CVR) and Content Validity Index (CVI), while the student response questionnaire to the product was measured using a Likert scale. The results of product validation from every aspect, both in booklets and animated videos, obtained a CVI value of 0.99 and were declared valid and suitable for use as learning media. Students also gave good responses, which was shown in the initial response test with a percentage of 85% in the good category and in the main response test with a percentage of 84% in the good category.

Keywords: Animation videos; Booklets; Constitutional isomers; QR code

Introduction

Chemistry is a scientific discipline that studies matter and its changes. It contains complex material concepts and abstract phenomena, which often cannot be observed directly (Safitri et al., 2019). Chemistry is a scientific discipline that studies matter and its changes. It contains complex material concepts and abstract phenomena, which often cannot be observed directly (Rokhim et al., 2023). Chemistry subjects are often considered difficult because of their abstract nature (Taher, 2022).

One course that has complex material is Organic Chemistry. This course is taught to students in the Science and Health Education major or study program. Many students find the Organic Chemistry course difficult because it involves understanding various interrelated concepts. In mastering this subject, students need to have strong reasoning and understanding (Lestari & Erlina, 2020).

The concept of stereochemistry is studied in the Organic Chemistry of Monofunctional Compounds

course and is a basic concept that must be understood in studying reaction mechanisms studied in the Reactions and Organic Reaction Mechanisms course. Apart from that, the concept of stereochemistry involves three aspects of representation. However, the concept of stereochemistry is often considered difficult because students need to have the ability to convert and describe molecular structures into three-dimensional representations from two-dimensional shapes (Lestari & Erlina, 2021). One of the sub-materials found in hydrocarbon stereochemistry is isomers.

Isomers are different compounds, but the molecular formula is the same (Solomons et al., 2014). Understanding isomers well will help students understand the description of groups of organic compounds. Therefore, students' understanding of isomers has a significant impact on their success in studying Polyfunctional and Macromolecular Organic Chemistry courses (Purwanto et al., 2021).

Based on research conducted by Taher (2022) with a total of 21 students as participants, it is known that the indicator for writing isomers of hydrocarbon

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compounds is the most difficult for students because the average student answer is only 20% correct on this indicator. Subsequent research, namely that conducted by Djarwo (2019) on 24 students, concluded that there were misconceptions experienced by students in understanding isomer material. The identification results show that the percentage of misconceptions regarding constitutional isomers, namely positional isomers, is 4.17% and chain isomers is 8.33%. Misconceptions about constitutional isomers are also experienced by Chemistry Education students at FKIP Untan. This is supported by research conducted by Lestari et al. (2020) on 80 Chemistry Education students at FKIP Untan, with participants consisting of the 2019 and 2020 classes. It was found that there was a high level of misconception in the sub-material of the concept of constitutional isomers at 63.75%, while those who did not understanding the concept reached 32.50%.

Misconceptions are discrepancies or differences in the conceptual and proportional knowledge that a person has with the agreement of scientists. Misconceptions experienced by students can affect student learning achievement and the quality of the lecture process (Djarwo, 2019). Apart from that, if this misconception continues, it will affect students' understanding of further organic chemistry material whose concepts are related to the concept of isomers, especially constitutional isomers. According to Djarwo (2019), factors that can cause misconceptions are students' lack of basic abilities, students' low interest in learning and also the influence of other students.

Based on the problems above, one way to overcome them is by creating media that makes it easier for students to understand the material and also be interested in learning, so that it can increase student understanding and reduce the occurrence of misconceptions. According to Lestari et al. (2021) there are three learning media that students really want, namely in the form of modules, videos and worksheets. So, the media developed is a booklet assisted by an animated video using QR codes on the constitutional isomer sub-material. According to Harlis et al. (2021) Booklets can be used by students to better understand the concepts of the material being taught. A booklet is a form of printed media that contains writing and images with a number of pages that are not very thick, namely approximately forty-eight pages. Booklets are usually bound like books, but are smaller in size so they are easy to carry anywhere (Zalita et al., 2018).

The difference between the booklet developed by researchers and booklets in general is that there is a QR code in the booklet which contains an animated video explaining the concept and also the formation of constitutional isomers and there are 3-dimensional

shapes of these isomers. Animated videos are moving images that come from a collection of images that are combined into one frame into a video (Utami & Amaliyah, 2022). To view the video, simply scan the QR code using a smartphone camera or scan using a QR code scanner application and the video will appear on the user's smartphone screen displayed on the YouTube platform. Videos are very good as learning media in chemistry lessons (Gallardo-Williams et al., 2020). According to the opinion of Yendrita et al. (2019) Learning videos can attract students' attention to learning and can improve understanding and make it easier for students to remember the material they are studying. Apart from that, animated videos can visualize material that students cannot see or imagine (Wardana & Adlini, 2022).

The reason QR codes are used is because they respond quickly and have a large capacity (Firmansyah & Hariyanto, 2019), so that it can make it easier for students to access the videos contained in the booklet media that researchers have developed. This research aims to develop learning media that can increase student understanding and reduce misconceptions regarding constitutional isomers, namely in the form of a booklet assisted by an animated video using a QR code.

Method

This research method is Research and Development (R&D) with a 4D (Four-D) model which includes the define, design, develop and disseminate stages which were initiated by Thiagarajan et al. (1974), However, this research was only at the develop stage and did not involve the disseminate stage. The 4D model development flow can be seen in Figure 1.

The first stage, namely define, carried out a three-tier diagnostic test on 30 students of Chemistry Education FKIP Untan Class of 2021, then student analysis was carried out by conducting interviews with 11 students, after that task analysis was carried out based on course learning achievements (CPMK), then concept analysis is carried out and learning objectives are also formulated.

The second stage is design, which involves preparing test standards based on learning objective specifications, selecting the media to be used, media format, then making an initial design which is a rough draft of the booklet assisted by an animated video using a QR Code.

The third stage is develop (development), which involves a feasibility assessment by five experts as material, language and graphics experts, but previously validation of the feasibility assessment sheet was carried out by two Chemistry Education lecturers at FKIP

Untan. After assessing the suitability of the booklet, a field trial was then carried out in the form of a student response test which consisted of 2 stages, namely an initial response test and a main response test. The initial response test was carried out on a small scale, namely 8 respondents, then revisions were carried out. After the revisions or improvements were completed, the main response test was carried out on 18 students of the Class of 2021 and 12 students of the Class of 2022 Chemistry Education FKIP Untan, then improvements were carried out so that the final product was a booklet assisted by an animated video using a QR code.

Booklet suitability assessment data is processed using the Content Validity Ratio (CVR) analysis technique. CVR is a content validity method to determine the suitability of items to the domain which is measured based on expert or validator assessments (Lawshe, 1975). The formula as seen in Formula 1.

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}} \tag{1}$$

Information:

n_e = Number of experts who agree (said to agree if the assessment item value is in the range of 3.00-5.00, if <3.00 then said to disagree with the validity of the media).

N = The total number of validator members involved in the assessment.

After obtaining the CVR value, proceed with calculating the Content Validity Index (CVI) value to illustrate that overall the instrument items have good content validity. The formula used is:

$$CVI = \frac{CVR}{\Sigma n} \tag{2}$$

Information:

n = total number of assessment items in all aspects.

If the CVI value is in the range 0 to 1, it can be concluded that the media has high content validity. If the final CVR and CVI score is 0.99, which means it meets the minimum threshold value determined by Lawshe (1975), then the booklet is considered valid and suitable for use as a learning medium.

Processing student response data involves calculating the number of respondents who chose "strongly agree", "agree", "disagree" or "strongly disagree", as well as calculating the score for each statement, which is calculated using the formula:

$$P = \frac{\Sigma X}{\Sigma Xi} \times 100\% \tag{3}$$

Information:

P = percentage of score acquisition

ΣX = percentage of score acquisition

ΣXi = total ideal score (highest score)

Next, the total percentage is calculated using the formula 4.

$$P_{total} = \frac{\Sigma P}{n} \tag{4}$$

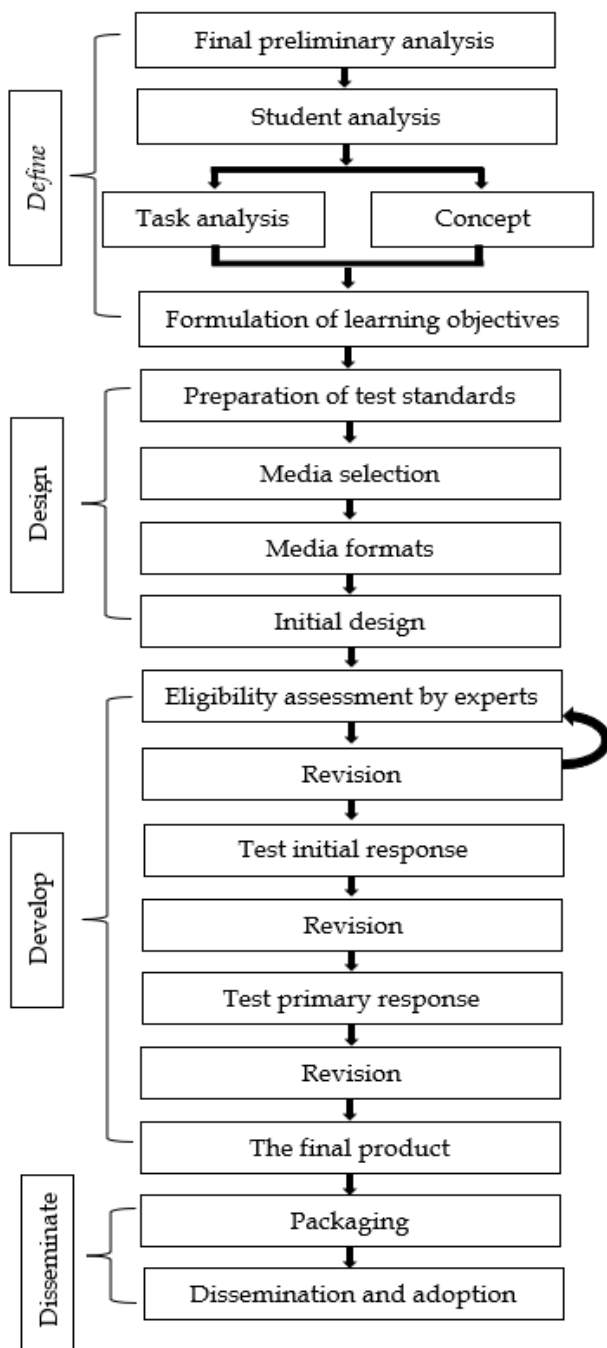


Figure 1. 4D Model Development Flow

Information:

- P_{total} = average percentage
 ΣP = the average percentage score for each statement item
 n = number of statement items

Categories of student responses to booklets assisted by animated videos using QR codes per item are presented in Table 1.

Table 1. Student Response Categories (Amirullah & Susilo, 2018)

Percentage (%)	Category
86 - 100	Very good
76 - 85	Good
60 - 75	Enough
≤ 55 - 59	Not good

Results and Discussion

The stages carried out in this research were to produce a booklet assisted by an animated video by utilizing a suitable QR code, namely as follows.

*Define Stage (Definition)**Front-end Analysis (front end analysis)*

Front end analysis was carried out to identify the problems faced in the learning process which is the background for this research. Based on the results of the literature review analysis conducted, 63.75% of misconceptions were found and 32.50% of the students did not understand the concept of constitutional isomers in the 2019 and 2020 FKIP Untan Chemistry Education students with a total of 80 students (Lestari & Erlina, 2021). So, a three-tier diagnostic test was carried out on students of the 2021 FKIP Untan Chemistry Education study program with 30 students participating. The test questions given consist of 5 indicators. The results of the three-tier diagnostic tests carried out can be seen in Table 2.

Based on Table 2, it is known that each indicator of students experiencing misconceptions and not understanding the concept. In indicator 1, misconceptions and not understanding the concept occur because students still do not know the number of atoms contained in the structure made using the bond-line formula which only displays lines and does not show the atoms and students assume that structural shapes that are similar are isomers, even though judging from the formula the molecules are different. Constitutional isomers are compounds that have the same molecular formula, but have a different atomic order or structure (Fessenden & Fessenden, 1986).

Table 2. Analysis of Understanding the Three-Tier Diagnostic Test Concept

Indicators	Understand the Concept Well (%)	Understand the Concept but Not Sure (%)	Misconceptions (%)	Don't Understand the Concept (%)
Indicator 1	50.00	10.00	16.67	23.33
Indicator 2	23.33	6.67	43.33	26.67
Indicator 3	16.67	3.33	56.67	23.33
Indicator 4	0.00	0.00	43.33	56.67
Indicator 5	0.00	0.00	53.33	46.67

Information:

- Indicator 1: Identify pairs of structural (constitutional) isomers based on known chemical formulas
 Indicator 2: Identify pairs of functional group isomers
 Indicator 3: Identifying framework isomers
 Indicator 4: Identify structural (constitutional) isomers based on known structures
 Indicator 5: Identifying pairs of positional isomers

In indicator 2, misconceptions and not understanding the concept occur because students assume that functional group isomers are isomers that have the same functional group and also students only focus on the number of C and H atoms in the same structure as the same functional group different and does not pay attention to other atoms, even though if you look at the molecular formula they are different. Functional group isomers are isomers that have the same

molecular formula, but different functional groups (Riswiyanto, 2009).

In indicator 3, misconceptions and not understanding the concept occur because students assume that compounds that have the same molecular formula and functional group are functional group isomers and assume the structure shown in the question is a position isomer because they see a change in the C atomic framework. The pair of structures shown shows the same molecular formula and functional groups, but there are variations in the structure due to the order of the atoms bonded in the carbon chain, so they are included in a pair of skeletal isomers (Wardiyah, 2016).

In indicator 4, misconceptions and not understanding the concept occur because students think that the alicyclic structure is not an isomer of an alkene compound because the structure is cyclic and does not have double bonds and the functional group is different

from the structure shown in the question. Apart from that, students do not know the types of structural (constitutional) isomers. Cycloalkanes or alicyclics are functional group isomers of alkene compounds (Hadanu, 2019).

In indicator 5, misconceptions and not understanding the concept occur because many students cannot differentiate between position isomers, functional group isomers, configuration isomers and geometric isomers. Many students think that configuration and geometric isomers are position isomers because they see substituents in the two structures that are in different positions, but in the same structure. Apart from that, students make mistakes in determining the functional groups in structures, so they assume that the pair of structures has the same functional groups and the location of the functional groups is different, even though the pair of structures have different functional groups, so they are functional group isomers, not positional isomers. Positional isomers are isomers that have the same molecular formula and functional groups, but the positions of the functional groups are different. Meanwhile, configurational isomers are isomers that have the same molecular formula but have differences in chiral atomic configurations and geometric isomers are isomers that have the same molecular formula but have different spatial arrangements (Wardiyah, 2016).

Learner Analysis

Student analysis was carried out to determine the suitability of the media to the development level of media users. In creating and selecting learning media, it is important to consider the needs of students because the media will be used by them (Wijaya, 2020). Therefore, it is important to carry out student analysis to determine the right media. The characteristics of the 2021 and 2022 FKIP Untan Chemistry Education students are: (1) Students have studied the main material of hydrocarbon stereochemistry, (2) The average age of students is 19-21 years, at this age someone is able to develop their formal thinking. According to Piaget (in Parnawi, 2021) The age range between 11 years and adulthood is a formal period in which the development of high-level mental operations occurs. Students at this age can not only relate to concrete objects, but also have the ability to relate to abstract hypothetical events.

Based on the results of interviews with 11 FKIP Untan Chemistry Education students Class of 2021, it is known that the media desired by students for presenting material on constitutional isomers is through video media, power point which presents the main material and there are lots of pictures of structures (isomers) and students also want it when Presentation of material on

constitutional isomers using molymod media when explaining the isomers of a compound so that you can see the structural form directly.

Task Analysis

The task analysis was carried out based on the KOSMO Course Learning Outcomes (CPMK) of the Chemistry Education Study Program, FKIP Untan. The Sub-CPMK achieved was being able to differentiate between structural (constitutional) isomers and stereoisomers. Regarding constitutional isomers, students must know constitutional isomers and their types. The assignments given in the booklet are evaluation questions consisting of multiple choice questions accompanied by reasons for choosing the answers in a total of ten questions and two essay questions.

Concept Analysis

Identifying the main concepts included in the booklet is done by means of concept analysis. Constitutional isomers consist of framework isomers, positions and functional groups which will then be arranged into a concept map.

Specifying Instructional Objectives (Formulation of Learning Objectives)

Based on the concept and task analysis, the aim of using the booklet assisted by an animated video using this QR code is that students are able to explain concepts, differentiate and determine and be able to describe the shape of skeletal isomers, positions and functional groups.

Design Stage (Designing)

The design stage is carried out to develop learning media. The media developed is a booklet assisted by animated videos. At this stage, a series of steps are taken including developing test standards, choosing media, choosing a format and making an initial design.

The initial step taken at this stage is to develop test standards based on learning objectives. The test in the booklet that was developed is in the form of evaluation questions consisting of multiple choices along with giving reasons for choosing ten numbered answers and two numbered essay questions.

The second step taken is determining the media. The media developed in this research is in the form of a booklet assisted by an animated video using a QR code. This booklet was developed in hardfile form with A5 paper size. The device used to make the booklet was Microsoft Publisher and the design was made using the Canva application. Animated videos are made using several applications, namely for chemical structures using the 3D prism application and video editing using

a video maker. This animated video is accessed via the QR code contained in the booklet. QR codes can be accessed using a QR code scanner application, smartphone camera and Google Lens.

The third step is to determine the format of the booklet. Teaching materials must at least contain learning instructions, competencies to be achieved, learning materials, information that supports the materials, exercises, work instructions, and evaluations, as well as responses or feedback to the evaluation results (Hernawan et al., 2008). The booklet format developed consists of a front cover, booklet identity, instructions for using the booklet and accessing the QR code, foreword, table of contents, course learning outcomes, concept map, material (there is a QR code on certain pages), summary, evaluation questions, instructions for answering evaluation questions, answer key and scoring guidelines, glossary, bibliography and biodata of the booklet author and back cover. This stage produces a draft booklet assisted by an animated video by utilizing QR codes on the constitutional isomer sub-material.

At the design stage, the last step taken is to create an initial product design. The initial design is the entire media design that is developed before being validated by validators and tested on students.

Development

The development stage was carried out with the aim of producing a development product, namely a booklet assisted by an animated video using a QR code. This stage is carried out by expert appraisal (feasibility assessment) and developmental testing (field trials).

Expert Appraisal (feasibility assessment)

A feasibility assessment by experts was carried out to determine the feasibility level of the booklet assisted by the animated video by utilizing QR codes in terms of the material, language and graphic aspects of each booklet and animated video. These three aspects were assessed by five validators. Validation results are processed using the CVR CVI method. If the final CVR and CVI values are 0.99, that is, they meet the minimum limit for the five experts who carry out the assessment set by Lawshe (1975), then the booklet is considered valid and suitable for use as a learning medium.

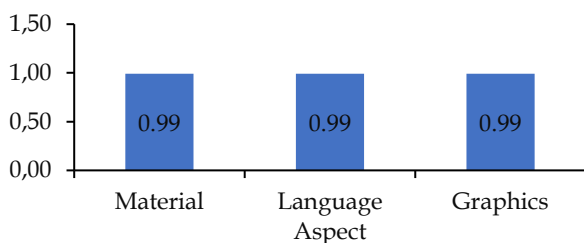


Figure 2. Booklet validation results CVI value

Based on Figure 1, it is known that each aspect in the booklet suitability assessment each has a CVI value of 0.99 with valid criteria and is suitable for use as a learning medium.

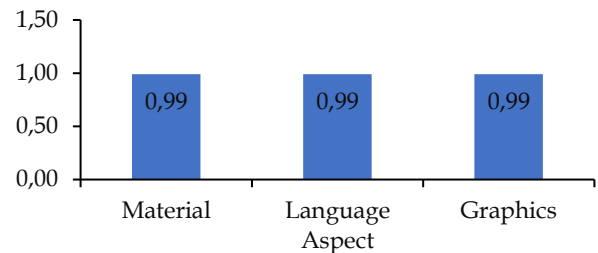


Figure 3. Animation video validation results

Based on Figure 2, it is known that every aspect in the assessment of the suitability of animated videos received a CVI value of 0.99 with valid criteria and is suitable for use as learning media. According to Kantun et al. (2015) Teaching materials must include appropriate aspects of content, presentation, language and graphics. The booklet and animated video include these components. The appropriateness of the content and presentation of the booklet with the help of the animated video developed is included in the material aspect. An assessment item is declared valid if the CVR value is equal to or exceeds the critical value, whereas below the critical value the statement item is considered invalid. For the 5 experts who assessed, the critical CVR value was 0.736 (Nengsih et al., 2019). The following is a description of each aspect assessed.

Material Aspect

The material aspect includes aspects of appropriateness of content and presentation. The assessment of the suitability of the material aspects was carried out in two assessments, namely assessing the suitability of the material in the booklet and the animated video. The suitability aspect of the material in the booklet contains an assessment of the scope of the material, accuracy of the material, presentation techniques, completeness of the presentation and support for the presentation. The five indicators contained in the material aspects of the booklet were analyzed using CVR CVI.

Table 3. CVR Value of Material Aspects in the Booklet

Indicator	CVR value
Material coverage	0.99
Material accuracy	0.99
Presentation technique	0.99
Presentation equipment	0.99
Presentation support	0.99

Based on Table 3, it is known that the CVR value for each indicator is 0.99 and the CVI value for all indicators is 0.99, meaning that the material aspects contained in the booklet are valid and suitable for use. This shows that the scope of the material concepts presented is in accordance with the agreement of experts and uses multiple aspects of representation in the form of symbolic and macroscopic. Apart from that, the evaluation questions given in the booklet are in accordance with the competencies being measured. According to Ayuningtyas et al. (2016) The appropriate aspect of material is good if the material has strength in the learning process, is in accordance with scientific concepts, is accurate according to the material and the context of students' thinking.

The aspect of assessing the suitability of the material in animated videos contains an assessment of the suitability of the material, accuracy of the material, stimulating curiosity, presentation techniques and presentation of learning. These five indicators were analyzed using CVR CVI.

Table 4. CVR Value of Material Aspects in Animation Videos

Indicator	CVR value
Material suitability	0.99
Material accuracy	0.99
Stimulate curiosity	0.99
Presentation technique	0.99
Presentation of learning	0.99

Based on Table 4, it is known that each indicator obtained a CVR value of 0.99 and a CVI value of 0.99, meaning that all indicators in the material assessment aspect of the video are valid and suitable for use. This shows that the material concept in the animated video is in accordance with the concept agreed upon by experts which is presented using multiple aspects of representation in the form of symbolic and microscopic in a coherent manner. The material in the video is easy to understand and can foster students' curiosity.

Language Aspect

Two assessments were carried out on linguistic aspects, namely assessing the suitability of the language in the booklet and the animated video. The aspects contained in assessing the suitability of the language in the booklet consist of indicators of straightforwardness, communicativeness, conformity with student development, and conformity with language rules. These four indicators are analyzed using CVR CVI.

Table 5. CVR Values for Language Aspects in Booklets

Indicator	CVR Value
Straightforward	0.99
Communicative	0.99
Suitability to student development	0.99
Conformity to language rules	0.99

Each indicator received a CVR value of 0.99 and a CVI value of 0.99, which means that the indicators contained in the language assessment aspect of the booklet are valid and suitable for use. This shows that the information in the booklet is easy to understand, presented with appropriate and effective sentence structures and the language used is appropriate to students' intellectual development. The language in learning materials must be easy to understand so that students can easily learn (Masrifah et al., 2020).

Aspects of assessing the appropriateness of language in animated videos consist of communicative indicators and conformity with language rules. Based on the analysis carried out on indicators using CVR CVI.

Table 6. CVR Value of Language Aspects in Animation Videos

Indicator	CVR Value
Communicative	0.99
Conformity to language rules	0.99

Based on Table 6, it is known that the communicative indicators and conformity with language rules each obtained a CVR value of 0.99 and a CVI value of 0.99, meaning that the indicators contained in the language assessment aspect of animated videos are valid and suitable for use. This shows that the voice intonation in the video is appropriate and the information conveyed is easy to understand and the grammar and spelling spoken are correct.

Graphic Aspects

In assessing the feasibility of graphic aspects, it is divided into two, namely assessing the feasibility of graphics in booklets and animated videos. The graphic assessment aspect of this booklet consists of the size of the booklet, the design of the booklet cover and the design of the booklet contents. These three indicators are analyzed using CVR CVI.

Table 7. CVR Value of Graphic Aspects in Booklets

Indicator	CVR Value
Booklet size	0.99
Booklet cover design	0.99
Booklet content design	0.99

Each indicator in the graphic aspect assessment in the booklet received a CVR value of 0.99 and a CVI value

of 0.99, meaning that the indicators in the graphic assessment aspect in the booklet were valid and suitable for use. This shows that the size of the booklet complies with ISO standards, namely A5 paper size (148 × 210 mm) which is adjusted to the content of the material, the typography of the booklet is simple and easy to read and the placement of layout elements is consistent. In addition, the illustrations used on the cover illustrate the content of the material. According to et al. (2016) The illustration used on the cover must describe the contents of the book. Apart from that, the graphic aspect must include clarity of layout, type and size of letters, presentation of illustrations and colors and symbols that are attractive and make things easier for students.

The graphic assessment aspects of animated videos consist of media design, media format and media audio. These three indicators are analyzed using CVR CVI.

Table 8. CVR Value of Graphic Aspects in Video Animation

Indicator	CVR Value
Media design	0.99
Media formats	0.99
Media audio	0.99

Each indicator received a CVR value of 0.99 and a CVI value of 0.99, meaning that the indicators in the graphic assessment aspect of animated videos are valid and suitable for use. This shows that the colors in the animated video are harmonious, the animation displayed makes it easier to understand the material, the type of letters used are easy to read, the resolution and sound in the video are clear and the duration of the video is no more than 6 minutes. According to Mashuri et al. (2020) A good and effective learning video has a duration of approximately 6 minutes because if it is more than that it will cause boredom and not focusing on learning.

During the feasibility assessment process, there were improvements and suggestions from the material validators for the animated video-assisted booklet being developed. Improvements made to aspects of the material in the booklet include adding instructions for accessing the QR code using Google Lens, adding information to the concept map, clarifying the differences between the 3 types of isomers, increasing the resolution of sentences or words in the booklet, changing the structure of compounds, adding examples of isomers. framework, adding the use of compounds contained in the booklet, changing the evaluation questions and improving the instructions for the evaluation questions. Improvements made to the material aspects in the animated video include improving the shape of the two-dimensional structure, deepening the explanation of the differences between

the 3 isomer concepts and changing the image of polybutene. It is important to pay attention to the images in the booklet because the use of images can add interest to the teaching material (Yani et al., 2020).

In terms of language aspects, improvements made to the booklet include sentence accuracy, sentence effectiveness, grammatical clarity and spelling accuracy. Improved language in animated videos, namely voice intonation which must be clarified and emphasized again when conveying the material concept.

Improvements made to the graphic aspects of the booklet include increasing the size of the Tanjungpura University symbol on the front cover of the booklet, increasing the size of the image captions and changing the color of the source image to black. Improvements to the graphic aspects of the animated video include changing the red text to white, changing the atomic connecting rods in the two-dimensional structure from gray to black, speeding up the movement of structural changes, and increasing the sound of the explanation of the material in the video.

Developmental Testing (field trials)

Field trials were carried out to determine students' reactions, responses and comments on booklets assisted by animated videos using QR codes on the constitutional isomer sub-material that was developed. Apart from that, this field test also aims to determine the feasibility of a booklet assisted by an animated video by utilizing a QR code on constitutional isomers from a student's perspective. Field trials carried out initial response tests and main response tests. Initial response testing on a small scale is important to anticipate errors that occur in the main response test and to reduce obstacles that occur during the main response test (Puspita et al., 2017). The initial response test was carried out on students from the Chemistry Education study program, Class of 2021, totaling 8 students who were selected based on an analysis of concept understanding carried out at the define stage and who had studied the Organic Chemistry of Monofunctional Compounds (KOSMO) course. The main response test was carried out on students from the Chemistry Education study program, with a total of 18 students from the Class of 2021 and 12 students from the Class of 2022, who were chosen randomly on condition that they had studied the Organic Chemistry of Monofunctional Compounds course. There are three aspects to the student response questionnaire, namely material, language and media.

Table 9. Results of Student Response Questionnaire

Aspect	Initial response (%)	Main response (%)
Material	86	86
Language	82	81
Media	87	84
Average	85	84

Based on Table 9, it can be seen that the results of the student response questionnaire in the initial response test show a percentage of 86% in the material aspect, with a very good category. In the main response test, the percentage in the material aspect was also 86% in the very good category. This percentage illustrates that the material presented in the booklet and animated video is easy to understand.

In the language aspect, the results of the student response questionnaire showed a percentage of 82%, in the good category. In the main response test it was 81%, in the good category. There was a decrease in percentage between the initial response test and the main response test, but the decrease that occurred was not significant when compared to the number of respondents available. Overall, the language used in the booklets and animated videos is easy for students to understand. Apart from that, the questions given in the booklet are easy to understand. According to Ayuningtyas et al. (2016) A good textbook contains language, explanations of assignment questions and exercises that are easy for students to understand.

In the media aspect, the results of the student response questionnaire in the initial response test showed a percentage of 87%, in the very good category. In the main response test, the percentage of media aspects was 84%, in the good category. There was a decrease in percentage between the initial response test and the main response test, but the decrease that occurred was not significant compared to the number of respondents and both were still in the good category. This shows that the design used in the booklet and animated video presented is attractive, the QR code contained in the booklet is easy to access and the writing and images contained in the booklet and animated video are simple and clear.

There are suggestions and input given by respondents, both initial response tests and main response tests which are considered for improvement. The improvements made are that the front cover, which originally used one type of font, namely Arial, has been repaired using two types of font, namely Arial and Times New Roman. ...” and change the image on the instructions for accessing the QR code from one with a shadow to one without a shadow.

Based on the results of validation and student response tests, it is known that booklets assisted by animated videos using QR codes are very suitable for

use as learning media. These findings are in line with research Ulandari et al. (2021) which concludes that booklets are teaching materials that have good suitability and validity for use in learning activities. Apart from that, booklets are also a learning medium that can attract attention because they are equipped with pictures and explanations that are easy to understand, and have a practical size, so they are easy to carry (Masrifah et al., 2020). The existence of animated videos in the booklet also makes it easier to understand the concept of the material presented (Nurfutriana et al., 2022). Dewi et al. (2022) also stated that information or material conveyed via video was easier to understand.

Conclusion

Based on the research results, it can be concluded that booklets assisted by animated videos using QR codes on constitutional isomer sub-materials are very suitable for use as learning media. This can be seen from the appropriateness of the material, language, graphics in the booklet and animated video, each of which received a CVI value of 0.99. The booklet assisted by an animated video using the developed QR code also showed a good response from students in terms of the initial response test showing an average of 85% in the good category and the main response test showing an average of 84% in the good category. This research was only carried out to the field trial stage. Therefore, it is necessary to test the effectiveness of the booklet in overcoming misconceptions regarding the sub-material of constitutional isomers.

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Author Contributions

Conceptualization, methodology, data analysis, investigation process, writing original draft, visualization, booklet media development, N. I. U.; guiding, supervising and validating the instruments used in the research, R. R. and I. L.; wrote the review and edited, R. R., I. L., R. M., and M. U.

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Conflict of Interest

The authors declare no conflict of interest.

References

- Amirullah, G., & Susilo, S. (2018). Pengembangan Media Pembelajaran Interaktif Pada Konsep Monera Berbasis Smartphone Android. *WACANA AKADEMIKA: Majalah Ilmiah Kependidikan*, 2(1), 38. <https://doi.org/10.30738/wa.v2i1.2555>
- Ayuningtyas, R., & Budiyono. (2016). Analisis Kualitas Buku Siswa Kurikulum 2013 Kelas VII Sekolah Menengah Pertama. *Indonesian Journal of Curriculum and Educational Technology Studies*, 4(1), 17–24. <http://dx.doi.org/10.15294/ijcets.v3i1.8675> Article
- Dewi, A. M., & Kamaludin, A. (2022). Development of Audiovisual-Based PowToon Animation Video on Chemical Bonds for Tenth Grade. *Jurnal Penelitian Pendidikan IPA*, 8(1), 222–229. <https://doi.org/10.29303/jppipa.v8i1.865>
- Djarwo, C. F. (2019). Analisis Miskonsepsi Mahasiswa Pendidikan Kimia Pada Materi Hidrokarbon. *Jurnal Ilmiah IKIP Mataram*, 6(2), 90–97. Retrieved from <https://ejournal.undikma.ac.id/index.php/jiim/article/view/2788/0>
- Fessenden, R. J., & Fessenden, J. S. (1986). *Organic Chemistry* (Ketiga). Jakarta: Erlangga.
- Firmansyah, G., & Hariyanto, D. (2019). The use of QR code on educational domain: a research and development on teaching material. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, 5(2), 265. https://doi.org/10.29407/js_unpgri.v5i2.13467
- Gallardo-Williams, M., Morsch, L. A., Paye, C., & Seery, M. K. (2020). Student-Generated Video in Chemistry Education. *Chemistry Education Research and Practice*, 2, 448–495. <https://doi.org/10.1039/C9RP00182D>
- Hadanu, R. (2019). *Kimia Organik Jilid 1*. Leisyah.
- Harlis, H., Budiarti, R. S., & Natalia, D. (2021). Pengembangan Booklet Budidaya Jamur Edible Sebagai Bahan Ajar Mikologi. *Biodik*, 7(01), 33–42. <https://doi.org/10.22437/bio.v7i01.12063>
- Hernawan, A. H., Permasih, & Dewi, L. (2008). Panduan Pengembangan Bahan Ajar. In *Depdiknas*.
- Kantun, S., & Budiawati, Y. S. R. (2015). Analisis Tingkat Kelayakan Bahan Ajar Ekonomi yang Digunakan Oleh Guru di SMA Negeri 4 Jember. *Jurnal Pendidikan Ekonomi*, 9(2), 129–146. Retrieved from <https://jurnal.unej.ac.id/index.php/JPE/article/view/3384>
- Lawshe, C. H. (1975). a Quantitative Approach To Content Validity. *Personnel Psychology*, 28(4), 563–575. <https://doi.org/10.1111/j.1744-6570.1975.tb01393.x>
- Lestari, I., & Erlina. (2020). *Analisis Kebutuhan Untuk Pengembangan Sumber Dan Media Pembelajaran Kimia Di Perguruan Tinggi*. Unpublished.
- Lestari, I., & Erlina. (2021). Identifikasi Pemahaman Mahasiswa Pendidikan Kimia pada Materi Stereokimia Hidrokarbon. *Edukatif: Jurnal Ilmu Pendidikan*, 3(6), 4810–4817. <https://doi.org/10.31004/edukatif.v3i6.1555>
- Mashuri, D. K., & Budiyono. (2020). Pengembangan Media Pembelajaran Video Animasi Materi Volume Bangun Ruang untuk SD Kelas V. *Jpgsd*, 8(5), 893–903. Retrieved from <https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/35876>
- Masrifah, S., Musdansi, D. P., & Ningsih, J. R. (2020). Pengembangan Media Pembelajaran Booklet Pada Materi Sistem Koloid Untuk Kelas XI IPA SMA Negeri Binai. *Jurnal Online Mahasiswa Fakultas Tarbiyah Dan Keguruan Universitas Islam Kuantan Singingi*, 2(20), 159–166. Retrieved from https://www.ejournal.uniks.ac.id/index.php/JO_M/article/view/1045/703
- Ningsih, N. R., Yusmaita, E., & Gazali, F. (2019). Evaluasi Validitas Konten dan Konstruksi Bahan Ajar Asam Basa Berbasis REACT. *EduKimia*, 1(1), 1–10. Retrieved from <https://doi.org/10.24036/ekj.v1i1.104017>
- Nurfitriana, A., Enawaty, E., Harun, A. I., Sahputra, R., & Ulfah, M. (2022). Pengembangan Media Video Animasi pada Materi Perkembangan Model Atom. *Edukatif: Jurnal Ilmu Pendidikan*, 4(2), 2434–2453. <https://doi.org/10.31004/edukatif.v4i2.2032>
- Parnawi, A. (2021). *Psikologi Perkembangan*. Deepublish.
- Purwanto, K. K., & Fathul Jadid Anshori, A. (2021). Analisis Pemahaman Mahasiswa Pendidikan Kimia Tentang Materi Isomeri Senyawa Karbon. *Karangan: Jurnal Bidang Kependidikan, Pembelajaran, Dan Pengembangan*, 3(1), 26–35. <https://doi.org/10.55273/karangan.v3i1.84>
- Puspita, A., Kurniawan, A. D., & Rahayu, H. M. (2017). Pengembangan Media Pembelajaran Booklet Pada Materi Sistem Imun Terhadap Hasil Belajar Siswa Kelas Xi Sman 8 Pontianak. *Jurnal Bioeducation*, 4(1), 64–73. <https://doi.org/10.29406/524>
- Riswiyanto. (2009). *Kimia Organik*. Erlangga.
- Rokhim, D. A., Rahayu, S., & Dasna, I. W. (2023). Analisis Miskonsepsi Kimia dan Instrumen Diagnosisnya: Literatur Review. *Jurnal Inovasi Pendidikan Kimia*, 17(1), 17–28. <https://doi.org/10.15294/jipk.v17i1.34245>
- Safitri, N. C., Nursaadah, E., & Wijayanti, I. E. (2019). Analisis Multipel Representasi Kimia Siswa pada Konsep Laju Reaksi. *EduChemia (Jurnal Kimia Dan Pendidikan)*, 4(1), 1. <https://doi.org/10.30870/educhemia.v4i1.5023>
- Solomons, T. W. G., Fryhle, C. B., & Snyder, S. A. (2014).

- Organic Chemistry* (11th ed.). Wiley.
- Taher, T. (2022). Deskripsi Pemahaman Konsep Mahasiswa pada Materi Hidrokarbon. *Jurnal Ilmiah Wahana Pendidikan*, 8(21), 656–660. <https://doi.org/10.5281/zenodo.7558597>
- Thiagarajan, S., Semmwl, D. ., & Semmel, M. . (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Indiana University. [https://doi.org/10.1016/0022-4405\(76\)90066-2](https://doi.org/10.1016/0022-4405(76)90066-2)
- Ulandari, T., & Syamsurizal, S. (2021). Booklet Suplemen Bahan Ajar pada Materi Protista untuk Kelas X SMA/MA. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 5(2), 301–307. <https://doi.org/10.23887/jppp.v5i2.37688>
- Utami, A. M., & Amaliyah, N. (2022). Effect of Blended Learning Model Assisted Video Animation to the Motivation and Learning Outcomes of Science. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1416–1424. <https://doi.org/10.29303/jppipa.v8i3.1675>
- Wardana, D. K., & Adlini, M. N. (2022). Pengembangan Video Pembelajaran Berbasis Animasi Materi Sistem Respirasi Kelas XI SMA. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1301–1307. <https://doi.org/10.29303/jppipa.v8i3.1641>
- Wardiyah. (2016). *Kimia Organik*. Kementerian Kesehatan Republik Indonesia.
- Wijaya, W. U. (2020). Analisis Kebutuhan Untuk Mengembangkan Media Video Animasi Pada Materi Struktur Atom Dan Ikatan Kimia. *Journal of Tropical Chemistry Research and Education*, 2(2), 59–67. <https://doi.org/10.14421/jtcre.2020.22-02>
- Yani, Y. P., Hardeli, H., Oktavia, B., & Kurniawati, D. (2020). Development of an Integrated E-Module of Scientific Literacy and Video Demonstration Using a Problem-Based Learning Model for High School Students on Acids and Bases. *Jurnal Penelitian Pendidikan IPA*, 8(2), 452–462. <https://doi.org/10.29303/jppipa.v8i2.1306>
- Yendrita, Y., & Syafitri, Y. (2019). Pengaruh Penggunaan Media Video Pembelajaran terhadap Hasil Belajar Biologi. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, 2(1), 26–32. <https://doi.org/10.31539/bioedusains.v2i1.620>
- Zalita, H. R., Hastuti, U. S., & Listyorini, D. (2018). Pengembangan Media Belajar Booklet “ Pembuatan Nata Sari Buah Jambu Darsono .” *Jurnal Pendidikan*, 3, 184–187. <https://doi.org/10.17977/jptpp.v3i2.10495>