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Development of Interactive Video-Assisted Worksheets: Enhancing Students' Visual Intelligence

Khalia Rossie[1], Kusumawati Dwiningsih[2,*], Aisha Setiyanti[3], Mohammad Wahyu Setiawan[4]

[1,2,3,4] Prodi Pendidikan Kimia, Universitas Negeri Surabaya, Indonesia
*kusumawatidwiningsih@unesa.ac.id

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ABSTRACT

Purpose–Development of interactive videos assisted by worksheet to improve students' visual intelligence on hydrocarbon compound material which is said to be valid, practical, and effective.

Methodology–This research is a type of quantitative research with the ADDIE research development model. Data was collected from validation data, student questionnaire sheets, observation sheets and pretest and posttest question sheets. Then the validation data was analyzed using a Likert scale to test validity, observation sheets and student response questionnaires were analyzed to test practicality, and pretest and posttest question sheets were analyzed using SPSS and N-Gain hypothesis tests to test effectiveness.

Findings–The results of the study are interactive videos assisted by worksheet on hydrocarbon compound material to improve students' visual intelligence are suitable for use because they meet valid criteria with a median score of content validation, construct, and visual intelligence of 3 with a good category. The interactive video is effective because it has a Wilcoxon showed significant improvements in student understanding with N-Gain> 3 of 92.86% with a high category, and is said to be practical because it obtains a percentage of 98.9% with a good category.

Contribution–Innovation in the development of learning media, namely interactive videos assisted by worksheet to improve students' visual intelligence.

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INTRODUCTION

Chemistry is very important because it has a crucial role in understanding the world around living things and helping humans achieve technological progress and innovation (Putri & Ferianto, 2023). Various discoveries in chemistry have had a major impact on society, such as the development of medicines,

renewable fuels, advanced materials, and many more (Evangelista et al., 2022). One of the materials studied in chemistry is hydrocarbon. The simplest organic compounds are hydrocarbons Carbon has 4 valence electrons so it can form 4 bonds and then bonds with hydrogen which has 1 valence electron to form a covalent bond to be hydrocarbon (Dingrando et al., 2005). The material on hydrocarbon compounds discusses various derivatives of alkanes, alkenes, alkynes and so on. The material on hydrocarbon compounds in chemistry lessons provides motivation as well as a great challenge for teachers because they study abstract and imaginative concepts, even though in reality they are widely used contextually in everyday life (Munawarah, 2019). The difficulties experienced by students are a lack of imagination or a way to visualize the form of hydrocarbon compounds, so there is a need to increase visual intelligence for students (Prasetyo, 2020).

Visual intelligence is the ability to think to visualize, describe, and imagine three-dimensional forms (Yaumi, 2017). This skill is divided into 4, namely imagination, conceptualization, problem solving, and pattern searching (Haas, 2003). Visual abilities is needed in chemical material, for example in the material on molecular shapes and the identification of geometric isomers in the material on hydrocarbon compounds which requires students to imaginatively understand the image and rotation of a compound so that there is a need to improve visual intelligence (Achuthan et al., 2018). However, based on the results of pre-research data in one of the private high schools in Surabaya on the material of hydrocarbon compounds, it was found that students' visual intelligence was low. Proven by the results of the pre-test, only 43% of students were able to answer visual questions with the imagination aspect, 59% on the conceptualization aspect, 36% on the pattern search aspect, and 41% on the problem solving aspect. In overcoming this problem, teachers can try to use digitalization using learning media (Indrasvari et al., 2021). A teacher must be innovative in developing interesting, effective, and enjoyable learning media for students, especially in high school. This helps make learning materials easier to understand and can enliven the classroom atmosphere, which ultimately increases students' motivation to learn (Eva Ervia et al., 2024). In science education that covers various topics, learning media is very important (Unayah et al., 2025). Visual-based instructional media that is developed to distribute materials visually using the sense of sight or view (Tuerah et al., 2023). One example of visual media that has been proven to be effective is learning videos using the Powtoon application (Adha Subali et al., 2024). However, in this application, students can only view the video display without being able to interact directly.

Interactive video is one example of the visual based instructional learning media that can be developed by teachers to increase the effectiveness of the learning process on hydrocarbon compound material. This media is contain material that is made in an interesting and creative way so that the material can be understood easily by students (Niswa, 2010). Interactive learning videos contain text, images, animations, audio and graphics, which are able to invite students to feel what they are seeing and understanding. (Anggraeni et al., 2021). In this media, there is interaction between students and the video which can make the learning material easier to understand (Biassari, I., Putri, K.E., Kholifah, 2021). Interactive video as a learning medium has been proven effective in many studies that it can improve student grades when compared to learning that is only centered on the teacher (Riayah & Fakhriyana, 2021). Therefore, it is necessary to develop interactive videos to improve students' visual abilities so that they better understand the material on hydrocarbon compounds (Julianti et al., 2022). Students' visual intelligence in studying hydrocarbon compounds can be enhanced by stimulating their imagination in solving problems, especially those related to compound structures, through interactive videos.

As a complement to interactive video, Student Worksheets can be used to train visual thinking skills. With the help of worksheet, it is expected to help students to directly train their visual abilities by working on activities and questions in the worksheet while watching interactive videos (Maulana et al., 2022). Worksheet acts as a support for interactive videos, containing practice questions. The activities and practice questions in the worksheet have been adjusted to the sequence in the interactive video so that student understanding of hydrocarbon compound material can be enhanced. Interactive videos are practical and can

be accessed anywhere and anytime, and can also be played repeatedly so that it is expected to make it less complicated for students to learn with time and place that can be anywhere and anytime. Based on the background that has been described, the researcher took the initiative to conduct a study entitled Development of Interactive Videos Assisted by worksheet to Improve Students' Visual Intelligence in Hydrocarbon Compound Material. The formulation of the problem of this study is how the validity, effectiveness, and practicality of interactive videos assisted by worksheet can improve students' visual intelligence in hydrocarbon compound material with the purpose of this study is being able to explain the the validity, effectiveness, and practicality of interactive videos in enhancing students' visual intelligence in hydrocarbon compound material.

METHODOLOGY

Research Design

This research uses the ADDIE development model with five research stages, that are analyze, design, developement, implementation and evaluation (Maydiantoro, 2019). In the initial stage, specifically analyzing the curriculum and conducting student analysis through interviews with chemistry teachers. The purpose of analyze stage is to analyze the need for interactive video development in learning purposes. (Cahyadi, 2019). This analysis includes the needs, materials, and characteristics of students.

Next, at the design stage, an interactive video design is carried out, starting with the initial step of making a flowchart or flow diagram that refers to the indicators of the main material of hydrocarbon compounds. At this stage, a storyboard is also made after making the flowchart (Syahri et al., 2017). The storyboard contains the interactive video display design. At this stage, editing software is also selected and the results of the interactive video display design are obtained.

The stage after the design has been completed is the development stage, with activities to develop and validate interactive videos as well as develop the supporting materials and strategies needed. (Hidayat & Nizar, 2021). The interactive video that has been created will be validated by 3 expert validators consisting of two chemistry lecturers and one chemistry teacher. After the interactive video is said to be valid, the research can proceed to the next stage, namely implementation to implement the interactive video design that has been developed. During implementation, interactive videos assisted by worksheet are applied to real class conditions with materials that are in accordance with learning. (Cahyadi, 2019). At this stage, small group trials and interactive video effectiveness tests were conducted through student response questionnaire results. The final stage was evaluation to assess the quality of the product and the learning process.

Participants

The sample in this study were students in class 11.5 of the private high schools in Surabaya with the characteristics that some students may have high motivation to learn chemistry, while others may be less interested. Not a few students complain about the difficulty of learning chemistry, especially the material on hydrocarbon compounds.

Data Collection

The data collection methods used in this study are described as follows:

Interview

Interview is the first stage of research. The purpose of this activity is to analyze the need for developing teaching materials in learning objectives.

Validation questionnaire

The validation questionnaire was used to collect validity data for interactive video assisted by worksheets based on assessments by two chemistry lecturers and one chemistry teacher. The assessment data obtained from the validators were analyzed descriptively qualitatively and used as a reference for

revising the product, resulting in a feasible product. The design of the developed product was assessed by the validator using a validation sheet.

Student response questionnaire

The response questionnaire was used to determine the assessment or response of students to the interactive video about hydrocarbon compounds that were developed. The questionnaire was given after the trial was conducted. The data from the questionnaire that had been filled out by students were then analyzed.

Student observation questionnaire

Observation questionnaires are used to determine student activities during the research. This method is carried out by observing and recording data on student activities when limited trials are carried out. Observations will be carried out by 3 observers using observation sheets.

Test

The test is used to obtain quantitative data in the form of test scores as a result of increasing visual intelligence and student learning outcomes. The test used is in the form of multiple choice questions. The researcher conducted two tests, namely pretest and posttest. The pretest was carried out before the learning activities were carried out which functioned to determine the initial knowledge of students. The posttest was carried out at the end of the learning activities which aimed to measure the increase in visual intelligence and understanding or learning outcomes of students after using interactive videos about hydrocarbon compounds

Data Analysis

Data from the validation of interactive videos on hydrocarbon compound material were analyzed descriptively quantitatively. Validity assessment consists of the main aspects, namely content, construct, and visual intelligence. Based on the validation data, the median value for the content, construct, and visual intelligence aspects is 3 with good criteria so that the interactive video assisted by worksheet on the hydrocarbon compound material to improve students' visual intelligence that is developed can be said to be valid because the validation value is ≥3 and can be tested limited. The results were used to determine whether the interactive video on hydrocarbon compound material was valid or not. Scoring was based on a Likert scale.

Table 1. Likert Scale

Scale	Category
0	Very not good
1	Not good
2	Enough good
3	Good
4	Very good

Adapted (Riduwan, 2016)

Based on the Likert Scale Table, interactive video is said to be valid if each indicator gets a median validity value of ≥3 with good criteria. If the data is assessed by two or more validators and the total score is obtained by adding up the ratings, there is a tendency to add up the scores and use the average. The average is an appropriate statistic for central tendency if the distribution is normal or platykurtic. However, if the average is not right, the median is an appropriate statistic for the validity score (Haladyna & Rodriguez, 2013).

Practicality of the product, namely when there is consistency between the researcher's expectations and reality, meaning that in its operation it provides results that are in accordance with expectations (Lutfi, 2021). In this case, the Guttman Scale is used to calculate the percentage of the questionnaire.

Table 2. Guttman Scale

Response	Answer	Score
Negative	Yes	0
	No	1
Positive	Yes	1
	No	0

The formula below will be used to analyze data in the form of questionnaire responses. The response questionnaire will be used to determine the practicability of interactive video as a learning medium for the Hydrocarbon Compounds material by using the score interpretation shown in Table 3.

Table 3. Score Interpretation

Presentation (%)	Criteria
0-20	Very not good
21-40	Not good
41-60	Enough good
61-80	Good
81-100	Very good

Based on Table 3, interactive videos are said to be practical to very practical if the practicality percentage is ≥ 61%.

Product effectiveness, namely in reality (operation) providing results according to expectations. The expected results in the form of impacts due to the product being developed can be learning results, motivation, activities during use, interest, and other special skills (Lutfi, 2021). Data Analysis of Interactive Video Effectiveness using SPSS and interpretation of N-gain scores to measure the improvement of learning results. The initial stage of the effectiveness test with SPSS is to to test data normality that must be carried out before carrying out data analysis which aimed at determining whether the distribution of the data produced is normal or not. The test criteria for rejecting or not rejecting H_0 based on the P-value are; 1) If P-value(sig) ≥ α = 0.05, then H_0 is accepted, namely the sample comes from a distributed normally, 2) If P-value(sig) < α = 0.05, then H_0 is rejected, namely the sample comes from a distributed non-normally.

If the data is distributed normally, then parametric statistical testing can be continued. However, if the data is not distributed normally, testing only can be continued using non-parametric statistical tests. The Wilcoxon Test is an example of a non-parametric test (Zumbo, 2020). The following is the hypothesis of the Wilcoxon Test; 1) H_0 (Null Hypothesis): There is no difference in median between pretest and posttest (Pretest = Posttest). 2) H_1 (Alternative Hypothesis): There is a difference in median between pretest and posttest (Pretest ≠ Posttest).

To find out the truth of the hypothesis, the Wilcoxon Test can be interpreted as follows. The results seen in the SPSS output are Asymp. Sig. (2-tailed); 1) If p(sig) < 0.05 → H_0 is rejected → There is a significant difference between pretest and posttest. 2) If p(sig) > 0.05 → H_0 is can't be rejected → There is no significant difference between pretest and posttest.

Interactive Video Effectiveness Data Analysis uses N-gain score interpretation to measure the improvement of learning outcomes which can also be used as data in the interactive video effectiveness test. The improvement of students' learning outcomes can be calculated using the following formula:

$$(g) = \frac{(Sposttest - Spretest)}{(Smaks - Spretest)}$$

The results of the analysis are then interpreted according to the criteria shown in the following table.

Table 4. N-Gain Score Criteria

Range of values	Category
G ≥ 0,7	High
0,3 ≤ G < 0,7	Medium
G < 0,3	Low

The developed interactive video is said to be effective if it obtains an N-gain value ≥ 0.3, which indicates that there is an increase between the pre-test and post-test scores of students. (Hake, 1998).

FINDINGS

This research is a type of quantitative research with the ADDIE research development model with the following steps are:

Analyze

The first step is analyze, observations were conducted in one of the high schools in Surabaya and interview with chemistry teachers to obtain information about the chemistry learning process starting from the teaching model used, the curriculum applied, and student difficulties and how to overcome them. The researcher also discussed permission and schedule adjustments to test interactive videos assisted by worksheet on the hydrocarbon compound material that had been developed and was expected to improve students' visual intelligence. From the analysis, it noted that the learning model of chemistry that was always applied by chemistry teachers was student-centered learning. So that media for learning are needed that can facilitate students in the learning activity on hydrocarbon compound material that contains abstract and imaginative concepts. At the analysis stage, researchers also conducted a pretest to know the visual intelligence and cognitive abilities of students. Then the pretest results showed that there were 0% of students who scored above the KKM. This is because the students who were given treatment were grade 11 who had just entered the hydrocarbon compound material. The pretest results of the visual intelligence itself showed that the visual intelligence of students was still relatively low. The data from the visual intelligence test results, the number of students who answered correctly on questions with the imaging aspect indicator was 43%, the conceptualizing aspect was 59%, the problem-solving aspect was 36%, and the pattern-seeking aspect was 41%.

Design

At the design stage, the design of interactive videos was carried out. Interactive video design was designed using Canva, Capcut, and Edpuzzle editing software. Here are some interactive video displays.

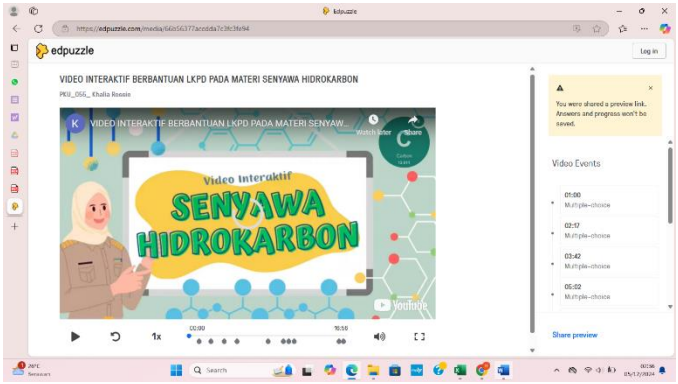

Figure 1. Opening Screen of the Interactive Video

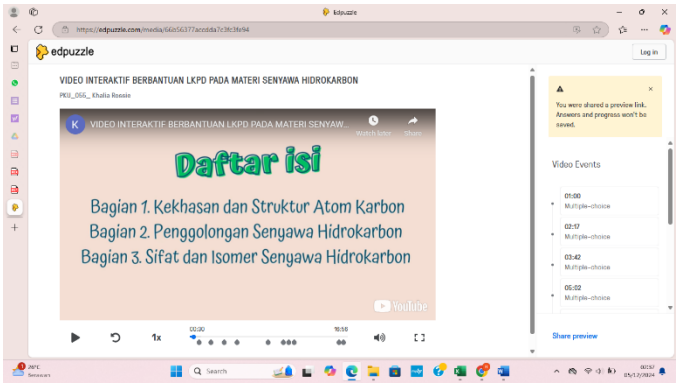

Figure 2. Content Screen of the Interactive Video

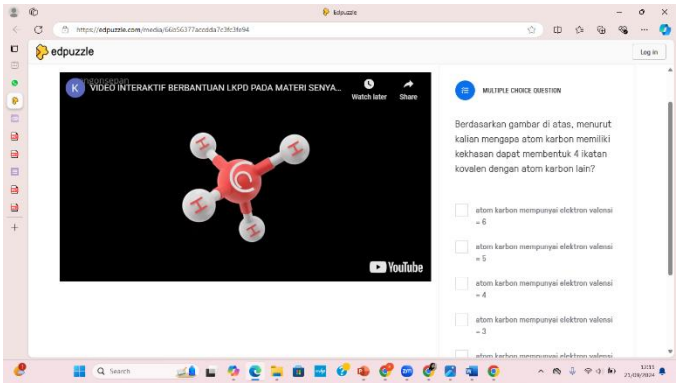

Figure 3. Interactive Video Practice Question Screen

Develop

In the develop stage, the learning media was reviewed by a reviewer to provide suggestions and input, which was then continued with revision. The interactive video validity test was conducted by expert and the result in table 5.

Table 5. Table of validation test of video interactive results

Content	Score	Criteria
Content	3	Good
Construct	3	Good
Visual Ability	3	Good

Based on the table 5, it found that interactive videos supported by worksheet are suitable for use as media of learning to improve visual intelligence in hydrocarbon compound material from the results of content validity, construct, and visual intelligence, with a median score of 3, categorized as good, namely valid. At this stage, validation of the research instrument is also carried out. The validation results are shown in the table 6.

Table 6. Instrument Validation Results Table

Aspects assessed	Score	Criteria
Pretest and Posttest Question Sheets	3	Good
Student Observation Sheets	3	Good
Student Response Questionnaire Sheets	3	Good

Based on the table 6, it found that the instrument that used in this research is suitable to ensure research results are accurate because have a median score of 3, categorized as good, namely valid.

Implementation

The implementation stage which aims to test the effectiveness and practicality of interactive videos. The trial was conducted with 28 students who had received learning activities with interactive video learning media using pretest and posttest sheets with a total multiple choice questions of 8 visual intelligence questions and 5 cognitive questions to test the effectiveness of interactive videos. The pretest and posttest results as a whole showed that students experienced an increase in learning result. The increase in understanding of the material on the hydrocarbon compound material was due to the interactive video developed to improve visual intelligence in real problems. The following is a diagram of the data from the pretest and posttest students.

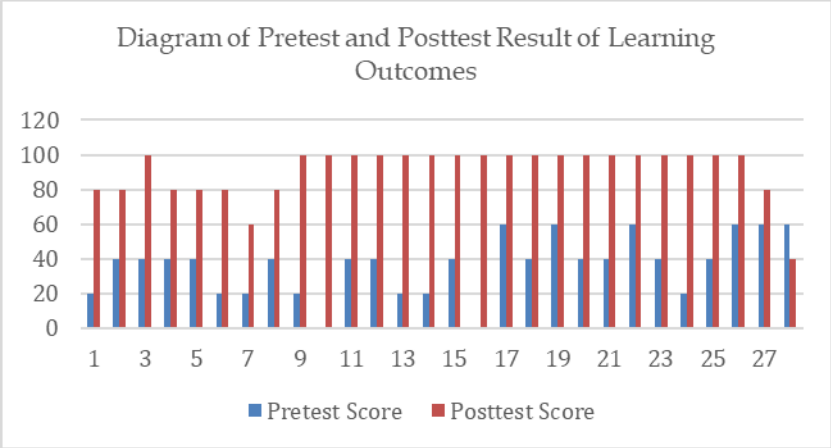

Figure 4. Diagram of Pretest and Posttest Results of Learning Outcomes

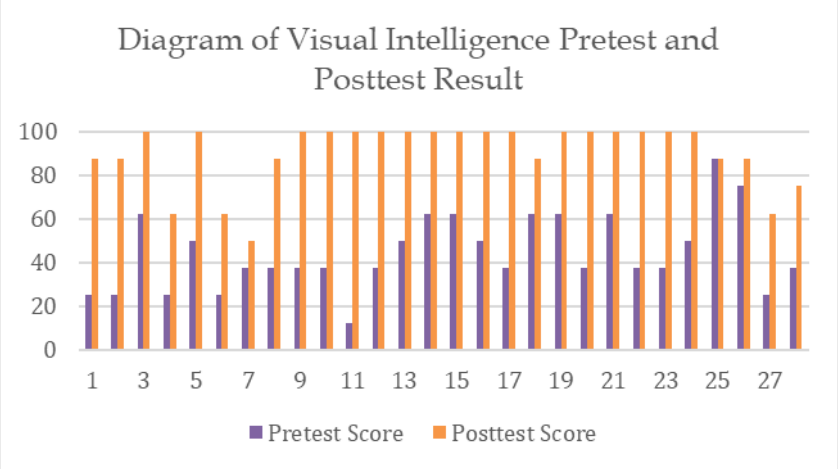

Figure 5. Visual Intelligence Pretest and Posttest Results Diagram

From the pretest and posttest data, students will use it as a test of the effectiveness of interactive videos. Effectiveness is reviewed from the SPSS Test and N-gain score. The results of the SPSS Test using the Kolmogorov-Smirnov Test to test normality in the table 6.

Table 7. Kolmogorov-Smirnov Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.234	28	.000	.930	28	.060
Postest	.347	28	.000	.688	28	.000

From the table 6, it was found that the data was not distributed Result because it obtained a P-value(sig) <α = 0.05 so that it was included in non-parametric statistics. Therefore, the effectiveness test was continued with the Wilcoxon Test.

Ranks

		N	Mean Rank	Sum of Ranks
Postest - Pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	27[b]	14.00	378.00
	Ties	1[c]		
	Total	28		

a. Postest < Pretest

b. Postest > Pretest

c. Postest = Pretest

Test Statistics[b]

	Postest - Pretest
Z	-4.560[a]
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

Figure 6. Wilcoxon Test Result

From the figure 7, it was found that the negative ranks of the pretest and posttest were 0.000, which stated that there were no students who experienced a decrease in value from the pretest to the posttest. From the Wilcoxon Signed Ranks Test, p <0.05 were obtained so that H_0 was rejected, which states that there is a difference between the pretest and posttest scores of students. Therefore, the interactive video assisted worksheet is effective.

The data on the pretest and posttest scores of students also used for the N-gain test to determine the effectiveness of the interactive video assisted by the worksheet. The following is a percentage diagram of the N.gain test.

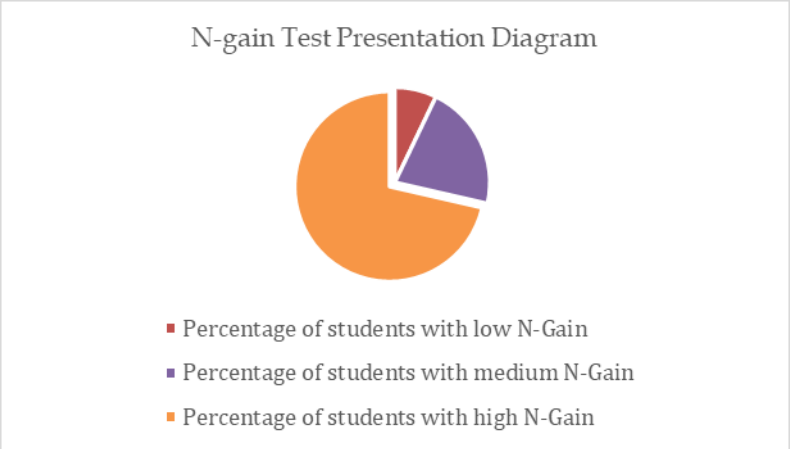

Figure 7. N-Gain Test Presentation Diagram

Data from the learning outcome test and visual intelligence test of students, As many as 7.14% of students obtained an n-gain score ≤ 0.3 with a category low, as many as 21.43% of students obtained an n-gain score of 0.3 ≤ g ≤ 0.7 with a category medium and as many as 71.43% of students obtained an n-gain score > 0.7 with a category high. Based on these data, the interactive video developed is effective.

In the limited trial at the implementation stage, students were also given a response questionnaire to determine the practicality of this interactive video. Practicality can be measured using a response

questionnaire of student. The following are the data results obtained from the student response questionnaire.

Table 8. Student Response Questionnaire Results

Rated aspect	Persentation(%)	Category
Increasing Learning Motivation	96%	Very responsive
Ease of Understanding Material	95%	Very responsive
Ease of Understanding Material Visually	96%	Very responsive
Clarity of Material, Images, and Illustrations	95%	Very responsive
Ease of Use of Media	95%	Very responsive

From student response data, the assessment of each aspect achived a percentage score of more than 90% which can be categorized as very responsive. Then the overall practicality was calculated to get a percentage score of 95.4%. Therefore, it can be decided that this interactive video assisted by worksheet is practical with a percentage score of ≥ 61%, namely 95.4% with the Good category. At the implementation stage, an analysis of the results of student observations by 4 observers was also carried out on learning activities when the research was conducted.

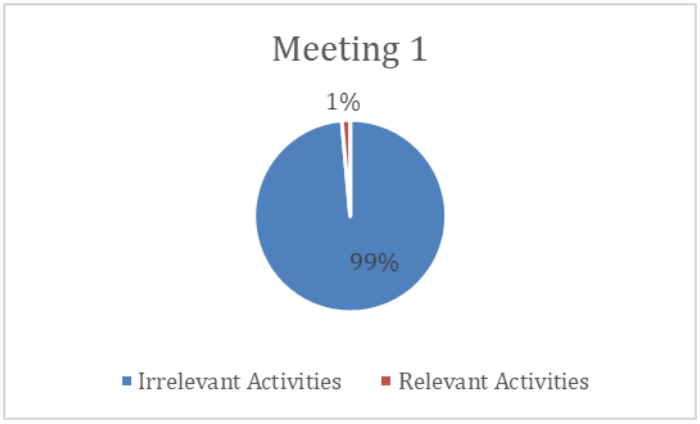

Figure 8. Learning Activity Observation Results Diagram 1

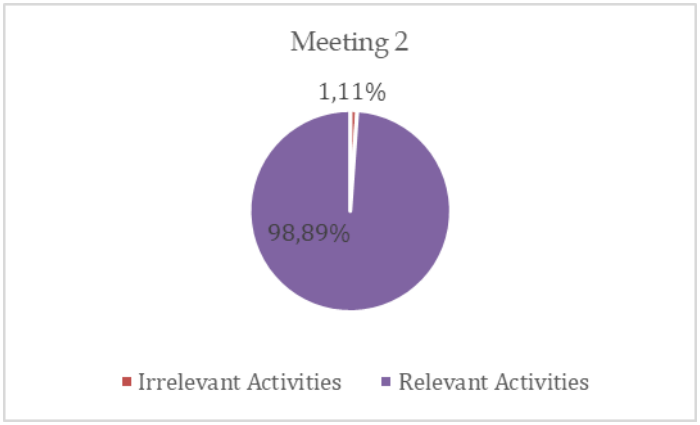

Figure 9. Learning Activity Observation Results Diagram 2

Based on the observation data at meeting 1, it was found that the percentage of activities relevant to the research was 99% and the percentage of irrelevant activities was 1%. Then at meeting 2 showed that the percentage of activities relevant to research was 98.89% and the percentage of irrelevant activities was 1.11%. From these relevant activities, the percentage of practicality of using interactive videos assisted by LKPD

based on the observation sheet is 98.9% so it can be said that this media is practical because it obtained a percentage of ≥61%.

Evaluation

The evaluation stage in the ADDIE development model is formative in nature, which is carried out to collect data at each stage which is used as material for revision or improvement so that the product development results are more perfect. Evaluation is carried out periodically starting from the analysis, design, development, and implementation stages.

DISCUSSION

Based on the research results, the development of interactive videos assisted by worksheets on the material on hydrocarbon compounds has proven to be very suitable for use as a learning medium to improve students' visual intelligence. At the analyzed step, so far, chemistry teachers have been very innovative in teaching chemistry, such as using quick ways to solve chemistry problems, using reading books, and Ms.Power Point as a bolster the chemistry learning activity. However, teachers have never trained students' visual intelligence, especially on hydrocarbon compound material, so that many students still have difficulty in depicting hydrocarbon compounds and find it difficult to understand them. Therefore, chemistry teachers strongly support the development of interactive videos assisted by worksheet on the hydrocarbon compound material to improve students' visual intelligence.

At the design stage, the design of interactive videos was carried out. Interactive video design was designed using Canva editing software. Next, edit with the Capcut application which is used to add sound. After the video was finished, to be said to be interactive, the researcher then continued to edit the video using Edpuzzle editing software so that students could directly listen to the hydrocarbon compound material, answer questions and find out the correct answers to the questions directly on the interactive video.

The interactive video developed focuses on enrichment material to train students' visual intelligence on hydrocarbon compound material that contains four aspects of visual intelligence, namely imagining, conceptualizing, pattern-seeking, and problem solving. There are questions for each sub-material of hydrocarbon compounds that contain aspects of visual intelligence presented in the interactive video. Students can immediately work on the questions in the worksheet with the time limit presented in the video and check the correct answers in the interactive video. If the student's answer is correct, then the student can continue watching the video in the next section. If the student's answer is wrong, then the student must work on the questions and listen to the explanation in the interactive video again.

After the interactive video and worksheet are completed at the design stage, at the development stage, this media will be validated by 3 expert validators, consisting of two chemistry lecturers and one chemistry teacher. From the results of content validity, construct, and visual intelligence, with a median score of 3, categorized as good, namely valid. So, this media can be tested to determine its effectiveness and practicality.

Based on the results of the Pretest and Posttest, there was a significant increase in students' understanding of the material and visual intelligence after using interactive videos. This is in line with the results of the Wilcoxon Signed Ranks Test which showed that there was a significant difference between the pretest and posttest scores, and based on negative ranks from this test, where students' scores increased after receiving learning using interactive videos. This effectiveness is also supported by the N-gain results which show that most students (71.43%) obtained high N-gain scores, indicating that they experienced a significant increase in understanding the material and visual intelligence.

In addition, the practicality of this interactive video has also been well tested. The results of the student response questionnaire showed that most students felt helped by the use of interactive videos in understanding chemistry material, especially in terms of visualizing hydrocarbon compounds. The

percentage of very positive responses in the aspects of learning motivation, ease of understanding the material, and ease of visualizing the material showed that this interactive video was not only effective, but also practical to use in the learning process in the classroom.

Observations of student activities also gave encouraging results. During the implementation of interactive videos, more than 98.9% of student activities were relevant to this study. This proves that interactive videos assisted by LKPD are able to create a learning environment that supports the development of students' visual skills. However, although the results obtained are very positive, there are several factors that need to be considered for further development. One of them is the diversity of student learning styles. Some students may need further adjustments in the form of modifications or additional support for learning media, especially for those who have a more dominant kinesthetic or auditory learning style. In addition, it is important to continue to update and develop existing materials, to ensure that interactive videos can continue to be relevant and interesting to students.

Overall, the results of this study indicate that interactive videos assisted by LKPD can be valid, effective and practical tool in improving students' visual intelligence in chemistry material, especially in hydrocarbon compound material. This increase in visual intelligence can help students to better understand abstract chemical concepts and make it easier for them to visualize the structure of compounds that are difficult to understand. Therefore, the use of this technology-based learning media is highly recommended for wider application in chemistry learning in schools.

CONCLUSION

The conclusion of is that interactive video assisted by worksheet on hydrocarbon compound material to improve students' visual intelligence is feasible to use because it valid, effective, and practical. However, although the results obtained are very positive, there are several factors that need to be considered for further development. One of them is the diversity of student learning styles. Overall, the results of this study indicate that interactive videos assisted by LKPD can be valid, effective and practical tool in improving students' visual intelligence in chemistry material, especially in hydrocarbon compound material.

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