

Transforming Molecular Geometry Learning through EddPuzzle Interactive Videos to Improve High School Students' Visual Intelligence

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ABSTRACT

Understanding molecular geometry poses a significant challenge for high school students due to its abstract nature, often leading to misconceptions. This study aims to develop and evaluate an EddPuzzle-based interactive video to enhance students' conceptual understanding and visual intelligence in molecular geometry. Employing a Research and Development (R&D) method, the study adopts the 4D model (Define, Design, Develop, Disseminate) but is limited to the development phase. The interactive video was validated by three experts and achieved a median score of 4 across content, construct, and visual intelligence criteria, indicating excellent validity. The product was tested on 30 eleventh-grade students using a one-group pretest-posttest design. The results showed a significant improvement in students' understanding and visual intelligence, supported by N-Gain scores—93.3% of students reached the high category for cognitive tests, and 86.7% for visual intelligence tests. The Wilcoxon Signed-Rank Test confirmed a statistically significant difference ($p < 0.05$) between pretest and posttest scores. Student feedback indicated high practicality: 100% expressed interest in using the media, 97.8% found the material easier to understand, and 96.7% considered the video user-friendly. These findings suggest that EddPuzzle-based interactive videos are effective and feasible tools for improving students' visual intelligence in chemistry learning. Integrating interactive technology into science education supports more engaging and student-centered learning aligned with 21st-century education goals.

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1. INTRODUCTION

Chemistry is a discipline that encompasses numerous abstract concepts, many of which are not directly observable and therefore require schematic representations and well-developed visualization skills for effective understanding (Nurviandy & Dwiningsih, 2021). One particularly challenging topic is molecular geometry, which is grounded in the Valence Shell Electron Pair Repulsion (VSEPR) theory and demands spatial reasoning to accurately conceptualize molecular shapes. This difficulty has been

extensively documented in the literature. For instance, Kiernan, Manches, and Seery (2021) reported that students often struggle to recall and apply knowledge of molecular shapes during problem-solving tasks. Consistent with this, preliminary findings from the current study revealed that 75% of students perceived molecular geometry as difficult, 15% rated it as very difficult, and only 10% found it easy. Furthermore, research by Agung, Muhab, and Irwanto (2024) identified a high prevalence of misconceptions among students regarding molecular shapes, with error rates reaching 92% on the first question, 67% on the second, and 91% on the third. These findings underscore the cognitive demands associated with molecular geometry and the need for instructional strategies that support students' spatial understanding.

Understanding chemical concepts requires representation at three main levels: macroscopic, submicroscopic, and symbolic (Danin & Kamaludin, 2023). Technology-based visualizations can support submicroscopic and symbolic representations, making it easier for students to understand concepts and avoid misconceptions (Isaloka & Dwiningsih, 2020). In this context, visual intelligence is important in helping students understand spatial relationships in molecular structures (Dwiningsih, Fajaroh, Parlan, Munzil, & Habiddin, 2022). Visual intelligence involves visual thinking skills, drawing shapes and objects, and sensitivity to balance, spatial relationships, lines, colours, and visual space (Ainyn & Dwiningsih, 2022). Therefore, technology-based learning media that support the development of visual intelligence are needed to improve students' understanding of molecular geometry material.

Several studies have developed video-based media to help students understand molecular shapes more concretely. Dewi & Kamaludin's (2022) research showed that 89.5% of students responded positively to using animated videos in chemical bonding material, including the molecular shape sub-material. However, one of the study's shortcomings was that the learning media used was still passive animated videos that did not allow students to interact directly with the material (Dewi & Kamaludin, 2022). Recent research shows that interactive videos are more effective than traditional animated videos because they allow students to actively participate in learning through quizzes and direct feedback (Haerawan, Cale, & Barroso, 2024).

The advantage of interactive videos over traditional animated videos lies in their ability to increase student engagement in learning. In traditional animated videos, students only receive information visually and auditorily without directly interacting with the material (Untari, Kamdi, Dardiri, Hadi, & Nurhadi, 2020). In contrast, interactive videos allow students to answer questions in the video and get direct feedback, thereby increasing their understanding of the concepts being learned (Rahayu & Bhaskoro, 2022). One technology that supports interactive learning is EddPuzzle, which allows teachers to add quizzes, voice notes, and comments to learning videos (Ipek & Ustunbas, 2021). The main advantage of EddPuzzle is its ability to monitor student activity in the video and provide teachers with control in adjusting the material according to class needs (Alvarez & Mischel, 2024). In addition, EddPuzzle has also been shown to increase student learning motivation. Research by Sailendra, Erlina, Ulfah, Enawaty, & Nizam (2025) showed that in individual trials using EddPuzzle-based interactive videos, students obtained an average score of 95.9%, indicating its effectiveness in improving conceptual understanding (Sailendra, Erlina*, Ulfah, Enawaty, & Nizam, 2025). EddPuzzle also supports independent learning because it allows students to access materials at any time, repeat information as needed, and receive direct feedback from the system (Rahayu & Bhaskoro, 2022). Although this technology has many advantages, research by Hendri Adi, Wahda Wahdi, Safi'i, & Yunesman (2024) shows that the use of EddPuzzle in learning is still limited, especially among teachers who are not used to integrating technology into their teaching (Hendri Adi, Wahda Wahdi, Safi'i, & Yunesman, 2024).

Based on these problems, this study aims to develop interactive videos based on EddPuzzle as an innovative solution to improve students' visual intelligence in understanding molecular geometry. The uniqueness of this study is the integration of interactive features that allow students to interact directly with the material, different from previous studies that only focused on passive animated videos. In addition, this study supports the implementation of the Independent Curriculum, which emphasizes using technology to improve students' learning independence (Wannesia, Rahmawati, Azzahroh,

Ramadan, & Agustin, 2022). Thus, this study contributes to the development of technology-based learning strategies and offers a more effective approach to overcoming students' difficulties in understanding abstract concepts in chemistry.

2. METHODS

Research and development is a research method approach using the Thiagarajan 4-D model. This model consists of four main stages: Define, Design, Develop, and Disseminate. The 4D model was chosen because it allows for learning media's systematic and structured development. However, time constraints limit this research to the development stage. This approach aims to develop a structured and effective learning product according to the needs of learners. Regarding the research procedure, it is presented in the Figure 1

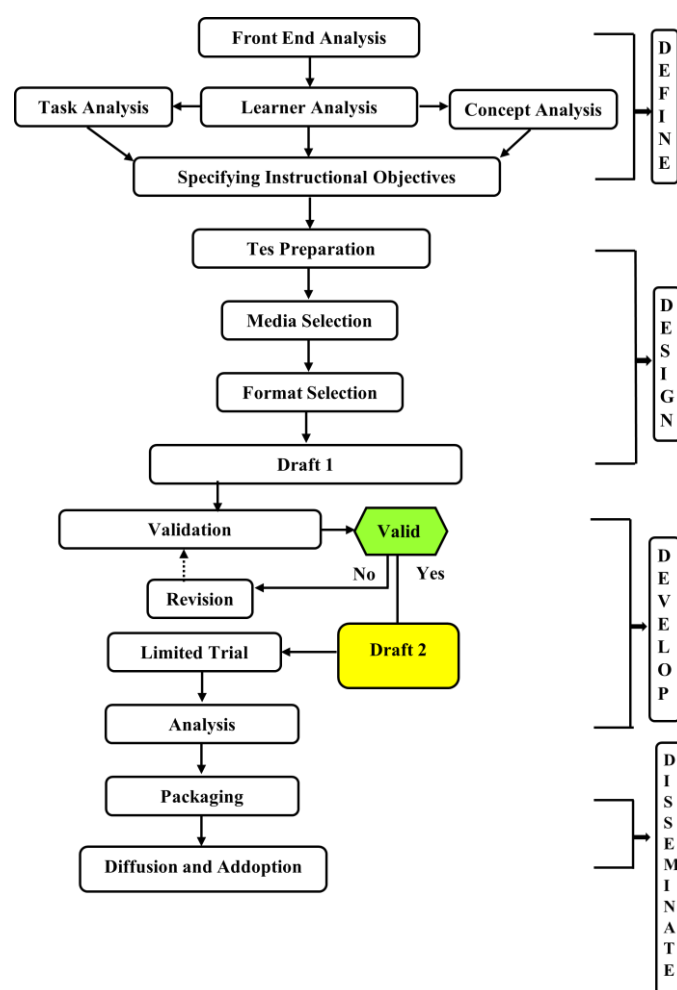


Figure 1. 4-D Model

This research is focused on developing interactive videos that can be used as a learning medium on molecular form materials to increase students' visual intelligence. The limited trial participants of this research are senior high school students of classes XI-5 SMAN 1 Taman, totalling 30 students. Although the sample size is relatively small and comes from one school, the purpose of this study is not to generalize the findings to a wider population, but rather to assess the feasibility and effectiveness of the developed learning media. Therefore, this is included in the limitations of this study. This study uses the One Group Pre-test Post-test design, where the experimental class is given two treatments, namely before and after using interactive videos as a learning medium. The pre-tests were given before students used interactive videos as a learning medium. The post-test is carried out after students use interactive videos as a learning medium. The instruments selected in this research consist of validation sheets (content, construct, and

visual intelligence), response questionnaires from students regarding interactive videos, student activity observation sheets, and test sheets, namely pretest (given before using interactive videos) and posttest (given after using interactive videos). Three validators will also validate all research instruments used in this study so that their suitability for use can be known. The research instrument was validated by three validators selected based on their expertise in their respective fields and relevance to this study. The validators comprised two chemistry lecturers and one chemistry teacher with experience developing learning media and assessing educational instruments. To ensure alignment in the assessment between validators, a consistency check was carried out through reflection on the feedback provided by each validator. This process ensures that each assessment considers the aspects determined with uniform standards and the same understanding. The validation instruments used are content validity, construct validity, and visual intelligence. The aspects assessed in each validation can be seen in Table 1

Table 1. Validation Aspects

Validation	Aspect/Indicator	Question number
Content	Aspects of the suitability of material to the curriculum	1, 2, 3, 4
	Aspects of the suitability of learning material substance	5, 6
	Aspects of the suitability of video content with learning materials	7, 8, 9
Construct	Aspect interactive video engineering	1, 2
	Display design aspects	3, 4, 5, 6, 7
	Audio aspects	8, 9
	Image and animation aspects	10, 11
	Aspect quiz	12
	Aspect video interactivity	13, 14
	Linguistic aspects	15, 16, 17
Visual	Aspect imaging	1, 2, 3, 4, 5, 6
Intelligence	Aspect conceptualizing	7, 8, 9, 10, 11, 12, 13
	Aspect problem-solving	14, 15
	Aspects pattern-seeking	16, 17

The data after the validation questionnaire by the validators will be analyzed with a Likert scale with the criteria in Table 2.

Table 2. Validity Assessment Criteria

Score	Category
0	Very Poor
1	Poor
2	Fair
3	Good
4	Excellent

The data obtained through the validation process is ordinal, which cannot be processed using mathematical operations such as adding, subtracting, multiplying, or dividing. Because the nature of this data does not support direct mathematical calculations, the analysis method used is to determine the median value as a representation of the data. Accordingly, when two or more assessors carry out the assessment, and the total score is obtained by summing the ratings, there will be a tendency to add up the scores and use the average. However, if the average obtained is skewed because the rating of the appraiser is too broad, then one of the calculation steps that can be used is the median. This means that the decision is set at the middle value. Interactive videos are valid if they get a median score of 3 or in the good to excellent category (Haladyna & Rodriguez, 2013).

After using this product, the Guttman scale is used to analyze the student response questionnaire results. The Guttman Scale was used to capture clear and explicit feedback on interactive videos' practicality and ease of use. This scale was chosen because it is direct and does not cause ambiguity in the answers, thus ensuring consistency in data interpretation. This method can effectively measure student engagement and acceptance of the learning media without causing interpretation bias or response

variability. The data collected were analyzed quantitatively to determine the level of acceptance and usability of the developed interactive videos. The criteria used are as in Table 3.

Table 3. Guttman Scale

Score	Category
1	Agree
0	Disagree

Source: (Sugiyono, 2013)

The questionnaire response data will be interpreted in percentage form using the formula:

$$\text{Percentage} = \frac{\text{score obtained}}{\text{Max score}} \times 100\% \quad (1)$$

The student response questionnaire data results are then calculated and interpreted according to Table 4.

Table 4. Score Interpretation Criteria

Percentage (%)	Category
0-20	Very Poor
21-40	Poor
41-60	Fair
61-80	Good
81-100	Excellent

Source : (Sugiyono, 2013)

Referring to the table above, interactive video is considered practical if the percentage result of the response questionnaire reaches or exceeds 61%, which is included in the sound and excellent categories. Data from observations of student activities as supporting data to test practicality

In the pretest and posttest questions, there are two types of questions, namely cognitive questions to test students' understanding of the material on molecular shapes and there are visual intelligence questions on the material on molecular shapes, which include four indicators, namely imaging, conceptualizing, problem-solving, and pattern-seeking. For details on the aspects of the questions in the questions, see the Table 5 and Table 6

Table 5. Molecular Geometry Cognitive Test Questions

Question	Question Indicator	Cognitive Level
1	Given the number of PEB and PEI of a molecule, students can analyze the shape of the molecule.	C4
2	When presented with a molecular shape and the size of its bond angle, students can analyze why this can happen.	C2
3	A table showing the amount of PEI and PEB and the shape of the molecules formed is presented. Students can determine the correct statement based on the table.	C5
4	Presented with a phenomenon regarding a product, students can determine the amount of PEB and PEI.	C4
5	Given data on a molecule's atomic number, students can analyze the type of hybridization and the shape of the molecule formed.	C2
6	Given a statement regarding the bond angles of a molecular shape, students analyze the causes of the molecular bond angles of a compound.	C4
7	When presented with a phenomenon involving an element, students can determine its molecular shape and type of hybridization when it becomes a molecule.	C4
8	Given the bond angles of several molecules with a specific hybridization, students can analyze the factors that influence changes in the bond angles.	C5
9	Given the design of a molecule with a certain amount of PEB and PEI, students can predict the shape of the molecule and the bond angles formed.	C6

10	Given two-element molecules, students can correctly determine the name of the molecular shape when the two elements combine to form a compound molecule according to the hybridization theory.	C4
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Table 6. Molecular Geometry Visual Test Questions

Question	Question Indicator	Visual Intelligence Indicator
11	Students can determine the amount of PEI and PEB of a compound by looking at its molecular shape.	Imaging
12	Presented with a picture of the Lewis structure of a compound, students can analyze the shape of the molecule formed if the Lewis structure is known.	Conceptualizing
13	Given a compound's molecular form, students can analyze the molecular form formed when the compound re-bonds with other atoms.	Problem-Solving
14	Students can analyze the correct statements related to several compounds by being presented with images of their molecular shapes.	Pattern Seeking
15	Presented with a picture of a molecular shape, students can imagine the hybridization of its central atom.	Imaging
16	A picture of a compound's molecular shape was given. Students can correctly determine the compound's hybridization process.	Conceptualizing
17	Given a compound's molecular form, students can analyze the hybrid orbitals formed when it rebounds with other atoms.	Problem-Solving
18	Students can analyze the correct statements related to several compounds by being presented with images of their molecular shapes.	Pattern Seeking

The data analysis methods applied include prerequisite tests and hypothesis tests. The prerequisite test is conducted through a normality test by reviewing the significance score of the Shapiro-Wilk test. The criterion in decision-making for the normality test is that if the Sig score (sig.) is more than 0.05, it can be concluded that the data is normally distributed. Conversely, if the sig value (sig.) is less than 0.05, it can be stated that data is not normally distributed.

Furthermore, hypothesis testing is carried out by comparing the average using a paired-sample t-test if the data shows a normal distribution. However, if the results show that the data is not normally distributed, the step is to carry out the Wilcoxon test. The hypothesis in this research is as follows:

- H_0 : The results of the pretest and posttest did not show any significant difference
- H_1 : The results of the pretest and posttest show a significant difference

The decision-making criteria in the hypothesis test are as follows:

- If the value of sig. < 0.05, so H_0 is rejected and H_1 is accepted.
- If the value of sig. > 0.05, so H_0 is accepted and H_1 is rejected.

If you use the calculated t value, then the decision is made based on a comparison with the t table:

- If t counts > t table, so H_0 is rejected and H_1 is accepted.
- If t counts < t table, so H_0 is accepted and H_1 rejected.

Test result data is also used to find out whether students have improved. The following N-Gain formula is used to determine this increase.

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{Max score} - \text{pretest score}} \quad (2)$$

The N-Gain score is calculated for each student. After the calculation results are obtained, the N-gain score is categorized based on the criteria for improving learning outcomes listed in Table 7. The interactive video developed is compelling when the N-Gain value is ≥ 0.3 .

Table 7. N-Gain Criteria

N Gain Value	Category
$g > 0.7$	High
$0.3 \geq g \geq 0.7$	Moderate
$g < 0.3$	Low

3. FINDINGS AND DISCUSSION

3.1. Findings

Research and development (R&D) is used in this research, using the Thiagarajan 4-D model. However, the stages implemented in this study are limited in their development. So, the stages implemented are defined, designed, and developed.

3.1.1. Results of Needs Analysis (Define Stage)

At the definition stage, chemistry teachers were interviewed to obtain information related to the chemistry learning process and the needs and shortcomings of teachers and learners in the molecular shape learning process so that a solution could be found to overcome these needs and shortcomings. The interview results are in Table 8 below.

Table 8. Chemistry Teacher Interview Results

No	Aspects Asked	Chemistry Teacher Response
1	Student's difficulties in learning	Students have difficulty memorizing molecular shapes because it is difficult to imagine their shapes visually.
2	Training visual intelligence	Training visual intelligence Teachers have never trained visual intelligence directly on molecular shape material.
3	Media used	Ms PowerPoint and Molymod.

At this stage, pre-research was also conducted by giving questionnaires to students regarding difficulties in the molecular shape material and giving cognitive tests and visual intelligence tests on the molecular shape material. The results of the pre-research questionnaire can be seen in the Table 9

Table 9. Results of The Pre-Research Questionnaire

Question	Answer Option	Student Answer (%)
The level of difficulty of the molecular shape material	Quite Difficult	75
	Difficult	15
	Easy	10
Use of videos in chemistry learning	Ever	43
	Never	57

The results of the analysis showed that 90% of students considered the molecular shape material quite difficult or difficult. In addition, 57% of students had never used videos in chemistry learning, indicating the need for innovation in learning media. The diagram of the student pre-research questionnaire can be seen in the Figure 2 and 3.

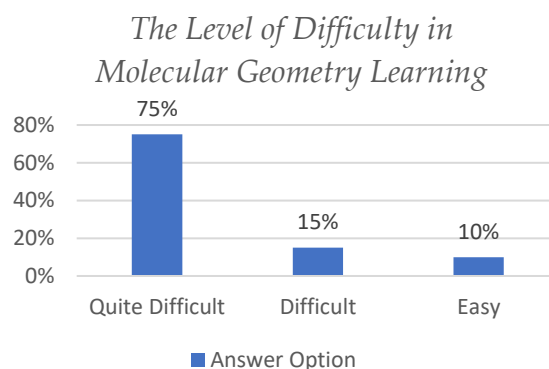


Figure 2. The Level of Difficulty in Molecular Geometry Learning

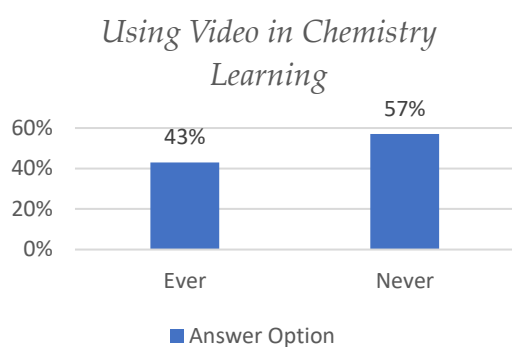


Figure 3. Using Video in Chemistry Learning

Based on the cognitive test results, 24% of students scored above the KKM with a score of 75 when the pre-research was conducted. Conversely, 76% scored below 75.

Table 10. Cognitive Test Results in The Pre-Research

Student's Score	Percentage (%)
0-74	76
75-100	24

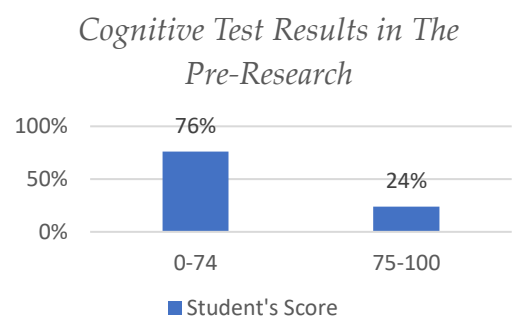


Figure 4. Cognitive Test Results in The Pre-Research

The data in the visual intelligence test results for students who answered correctly on each indicator of visual intelligence are presented with percentages, as in Table 11 and Figure 5

Table 11. Visual Intelligence Initial Test Results

No	Visual Intelligence's Indicator	Correct Answer (%)
1	Imaging	42
2	Conceptualizing	38.5
3	Problem-Solving	31
4	Pattern Seeking	43

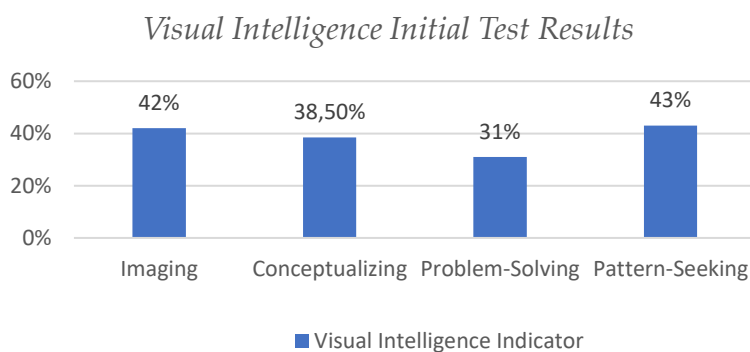


Figure 5. Visual Intelligence Initial Test Results

Therefore, based on the identified challenges, there is a clear need for innovative learning media to support students in visualizing abstract molecular concepts.

3.1.2. Results of Interactive Video Design (Design Stage)

The product developed is an interactive video based on animation that focuses on visual intelligence. It has been validated by experts and tested on students. This product was developed using Canva, Audacity, CapCut, and EddPuzzle. This video contains molecular shape material based on VSEPR theory and hybridization theory.



Figure 6. VSEPR Theory

It has animation, simulation, and interactive features such as quizzes and automatic evaluations.

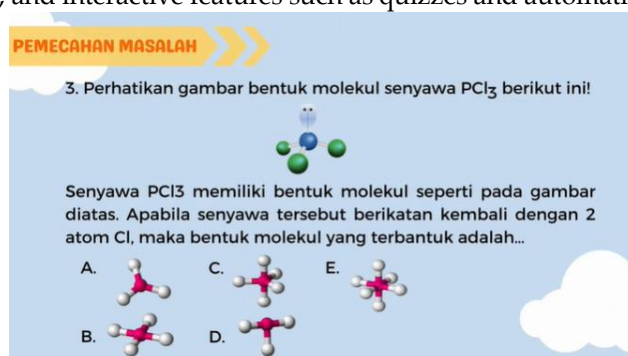


Figure 7. Evaluation

Figure 8 shows the title of the material, how to use it, and learning objectives at the beginning of the video display.

Figure 8. Interactive Video Usage Instructions

3.1.3. Results of Validation (Develop Stage)

Validation from 3 validators shows that this interactive video is considered valid for use as a learning medium because the validation of content, construct, and visual intelligence obtained a median of 4, or in the excellent category.

Table 12. Validation Result

No	Validation	Median	Category
1	Content	4	Excellent
2	Construct	4	Excellent
3	Visual Intelligence	4	Excellent

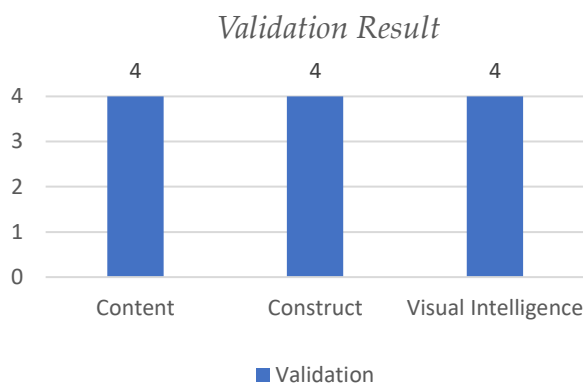


Figure 9. Validation Result

The three validators also validated the instruments used. The data results after the validation process are shown in Table 13 and Figure 10

Table 13. Instrument Validation Result

No	Instrument	Median	Category
1	Pretest and Posttest	4	Excellent
2	Student Response Questionnaire	4	Excellent
3	Student Activity Observation Sheet	4	Excellent

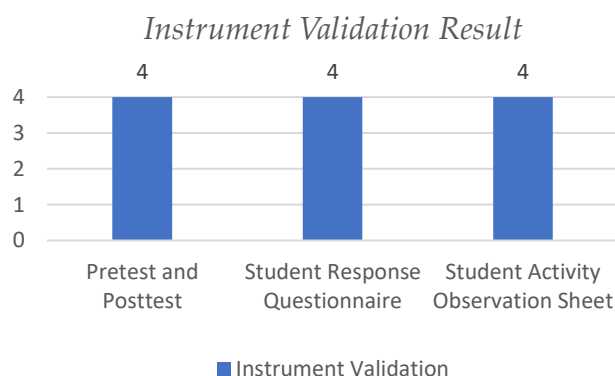


Figure 10. Instrument Validation Result

3.1.4. Results of Student’s Questionnaire (Develop Stage)

The data from the student’s questionnaire responses were used to test the practicality of interactive videos. More details of the results are in Table 14 and Figure 11

Table 14. Student Response Result

No	Aspect	Percentage (%)	Category
1	Students’ interest in multimedia	100	Excellent
2	Easy to understand the material	97.8	Excellent
3	Easy-to-use interactive videos	96.7	Excellent

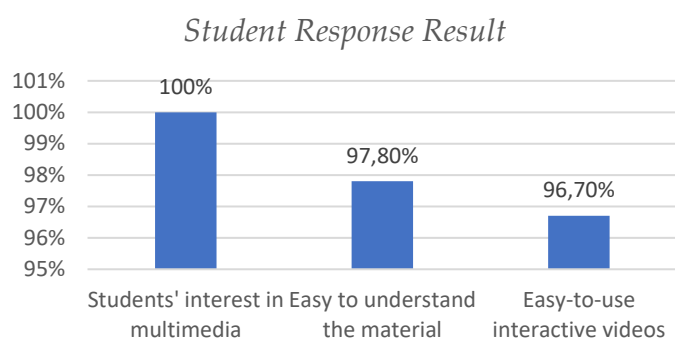


Figure 11. Student Response Result

The results showed that interactive videos are considered practical as a learning medium to increase visual intelligence in molecular materials because the acquisition of scores in all aspects reached $\geq 95\%$. The results of the N-Gain results (Cognitive Test and Visual Intelligence Test) can be seen in Table 15 and Figure 12.

Table 15. N-Gain Results from Pretest and Posttest Data

No	Students	Cognitive Test		Visual Intelligence Test	
		N-Gain	Category	N-Gain	Category
1	AAAS	0.8	High	1.0	High
2	APR	0.8	High	1.0	High
3	AFL	0.8	High	0.8	High
4	ANY	1.0	High	0.7	High
5	AA	1.0	High	1.0	High
6	BNI	0.8	High	1.0	High
7	CTW	1.0	High	0.9	High
8	CAW	0.7	High	0.8	High
9	CRWP	1.0	High	1.0	High
10	CPW	1.0	High	0.7	High
11	DA	0.9	High	0.9	High
12	DYP	1.0	High	0.6	Moderate
13	DB	1.0	High	1.0	High
14	FAYJ	0.9	High	1.0	High
15	FEM	0.8	High	0.8	High
16	LA	1.0	High	0.8	High
17	MQCS	1.0	High	1.0	High
18	MBBB	1.0	High	1.0	High
19	NAPI	0.5	Moderate	0.8	High
20	NNMA	1.0	High	1.0	High
21	RAS	0.8	High	0.7	High
22	RES	1.0	High	1.0	High
23	RAP	0.8	High	1.0	High
24	RSAB	0.8	High	1.0	High
25	SM	0.9	High	0.9	High
26	SNPS	0.8	High	1.0	High
27	STNZ	1.0	High	1.0	High
28	VSA	0.6	Moderate	0.5	Moderate
29	VBPM	1.0	High	1.0	High
30	VAM	0.9	High	0.8	High

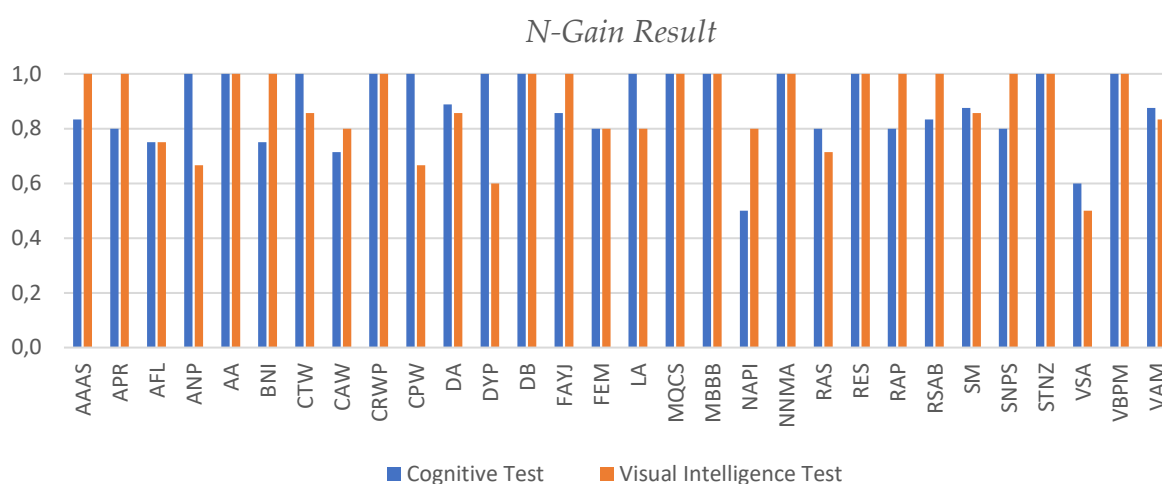


Figure 12. N-Gain Result

The results of the N-Gain analysis on the cognitive test showed that 93.3% of students reached the high category and 6.7% the medium category, while on the visual intelligence test, 86.7% of students reached the high category and 13.3% the medium category. So, it can be concluded that no students experienced a decrease in scores, meaning that all students improved at varying rates. The data was also analyzed with a normality test. The output data of the normality test are in **Error! Reference source not found.** and Figure 14.

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PreTest	.228	30	.000	.931	30	.052
PostTest	.292	30	.000	.772	30	.000

a. Lilliefors Significance Correction

Figure 13. Normality Test of Cognitive Test Result

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	.155	30	.062	.933	30	.060
Post Test	.335	30	.000	.732	30	.000

a. Lilliefors Significance Correction

Figure 14. Normality Test of Visual Intelligence Test Result

From the results of the cognitive pre-test and visual intelligence pre-test, the sig. Value was obtained > 0.05, meaning the data is normally distributed. While the results of the cognitive post-test and visual intelligence post-test data obtained a sig. Value < 0.05, which means that the data is not normally distributed. So, it is concluded that the data in this study is not normally distributed. Therefore, hypothesis testing uses the Wilcoxon Signed-Rank Test, a non-parametric test, to compare two groups of paired data. The data from the Wilcoxon statistical test are shown in Figures 15 and 16.

		N	Mean Rank	Sum of Ranks
PostTest - PreTest	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	30 ^b	15.50	465.00
	Ties	0 ^c		
	Total	30		

a. PostTest < PreTest
b. PostTest > PreTest
c. PostTest = PreTest

Test Statistics ^b	
	PostTest - PreTest
Z	-4.800 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test

Figure 15. Wilcoxon Ranks Test of Cognitive Test Result

		N	Mean Rank	Sum of Ranks
Post Test - Pre Test	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	30 ^b	15.50	465.00
	Ties	0 ^c		
	Total	30		

a. Post Test < Pre Test
b. Post Test > Pre Test
c. Post Test = Pre Test

Test Statistics ^b	
	Post Test - Pre Test
Z	-4.802 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test

Figure 16. Wilcoxon Ranks Test of Visual Intelligence Test Result

The results of the Wilcoxon ranked test on both the cognitive test and the visual intelligence test showed that all students got positive ranks, meaning all students got a higher post-test score than the pre-test score. Then, both the cognitive test and the visual intelligence test got an asymp sig. <0.05, which means there is a significant difference between the pre-test and post-test. So it can be concluded that from the cognitive test and the visual intelligence test, all students experienced a significant increase in scores between the pre-test and post-test. So interactive videos can be said to be effective for use in the learning process of molecular shape material. This result is in line with previous research (Dwiningsih et al., 2022), which stated that visual-based learning media significantly improves students' spatial problem-solving skills.

3.2. Discussion

The findings of this study suggest that interactive animated videos developed using Edpuzzle are effective in enhancing students' visual intelligence, particularly in understanding molecular geometry. This aligns with the findings of Dwiningsih and Fajaroh (2022), who emphasized that visual-based interactive media can significantly support students in comprehending abstract chemical concepts. One of the core challenges students face in learning molecular shapes is the difficulty in visualizing three-dimensional molecular structures and the cognitive load of memorizing complex content (Kiernan et al.,

2021). Consistent with this, Agung et al. (2024) reported frequent student misconceptions in this topic area, reinforcing the need for more intuitive and engaging instructional tools.

The difficulties in mastering molecular geometry are often rooted in students' limitations in spatial and visual reasoning (Isaloka & Dwiningsih, 2020). Thus, the use of interactive animated videos provides a pedagogically sound approach, allowing learners to form clearer mental models of molecular structures (Untari et al., 2020). Notably, preliminary questionnaire data indicated that 57% of students had never fully utilized learning videos in classroom settings. However, post-intervention feedback revealed that 100% of students responded positively to the use of interactive video, demonstrating the potential of this media to enhance student engagement and comprehension.

Despite its promising outcomes, this study also uncovered important challenges, particularly in terms of infrastructure. Edpuzzle requires continuous internet access, which may not be feasible in all school settings, especially those with unstable connectivity. To address this limitation, a group-viewing strategy could be employed, whereby students are organized into small groups to collaboratively engage with the content on shared devices. This not only mitigates bandwidth constraints but also promotes cooperative learning through joint problem-solving during in-video quizzes.

While the study collected open-ended responses during the pre-research stage—revealing high levels of student enthusiasm for the integration of visual-based media—qualitative data was not obtained after the implementation of the videos. As a result, students' actual experiences and perceptions during the learning process remain unexplored. This represents a significant limitation. Future research should include post-intervention qualitative methods such as interviews, focus groups, or open-ended survey questions to better understand how students interact with and benefit from Edpuzzle's interactive features. Such data could offer richer insights into student cognitive engagement, potential misconceptions that persist, and how interactivity affects learning outcomes in diverse educational contexts.

These results further highlight the underutilization of technology in the classroom, despite alignment with the Merdeka Curriculum, which encourages independent and technology-integrated learning (Wannesia et al., 2022). Within the framework of Society 5.0, where technology is envisioned as a central component of human-centered learning, such innovations support the creation of active, student-driven educational environments (Haerawan et al., 2024). Nevertheless, for Edpuzzle-based media to be truly inclusive and scalable, considerations around technological infrastructure, digital literacy, and teacher readiness must be more fully addressed.

In summary, Edpuzzle-based interactive animated videos present a valuable pedagogical tool for improving conceptual understanding in molecular geometry. However, for broader impact, future research should integrate post-use qualitative evaluations, explore hybrid implementation strategies, and consider contextual factors such as school resources and curriculum integration. These steps are crucial for maximizing the educational benefits of technology-enhanced learning across varying classroom environments.

4. CONCLUSION

This research shows that interactive videos using EddPuzzle are valid, effective, and practical for learning molecular geometry. Expert validation results indicate this media falls into the very valid category (median = 4 or Excellent category). In terms of effectiveness, all students achieved N-Gain in the moderate to high category, both in the cognitive and visual intelligence tests. The Wilcoxon Signed Rank Test confirmed a statistically significant improvement in student understanding. The practicality aspect also received a positive response, with 100% of students interested, 97.8% finding the material easier to understand, and 96.7% considering the video easy to use. This study was conducted in one school with good internet access, so future research should test its implementation in schools with

different levels of internet connectivity. This interactive video model could also be applied to other STEM subjects, such as physics, biology, or mathematics, to assess its broader impact.

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