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Students' and Teachers' Perceptions of Metaphor-Based Visual Media in Cell Biology Learning

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Abstract: *This study aims to develop an innovative instructional medium designed in the form of a visual metaphor-based learning media, specifically for the topic of cells in the science subject (IPA) at the junior high school level Class VIII in SMP Negeri 1 Plumbon. The topic of cell structure and function is often perceived as abstract and difficult for students to understand due to its microscopic nature and the spatial imagination it requires. This study employs a descriptive quantitative method by collecting and analyzing data in the form of student and teacher responses to the use of the media. The primary instrument used was a questionnaire designed to assess student and teacher perceptions regarding the effectiveness, appeal, ease of use, and usefulness of the media in supporting the learning process. The questionnaire was distributed after the classroom implementation of the visual metaphor-based learning media. The analysis results showed that the average student response score reached 89.25%, which falls into the "very positive" category. This indicates that the majority of students felt aided in understanding difficult concepts through metaphorical visualization, which was able to simplify complex biological information. In addition, teacher responses also indicated enthusiasm and support for the use of this media, as it was considered capable of increasing student engagement, deepening conceptual understanding, and encouraging reflective thinking. Therefore, the application of visual metaphor-based media holds great potential to support a more humanistic, contextual, and meaningful transformation of the learning process.*

Keywords: *visual metaphor media, biology learning, student responses, teacher responses.*

1. INTRODUCTION

Science education at the junior high school level emphasizes the understanding of scientific concepts that are often abstract, one of which is the topic of the cell as the structural and functional unit of life. The concept of the cell is often difficult for students to grasp because it is microscopic and cannot be directly observed with the naked eye (Yilmaz *et al*., 2017). This difficulty impacts students' scientific literacy in understanding the structure, function, and dynamics of cells within living organisms (Susanti & Amin, 2021). To overcome these difficulties and make biology learning more effective, it is recommended to teach biology through the use of visual materials (Muzaki et al. 2023). Media can present information visually, auditorily and kinesthetically, making abstract things real. When students see how concepts are relevant and used in everyday life, they are more likely to remember and apply that knowledge in the future (Hastuti *et al*. 2025)

One potential solution to this challenge is the use of effective visual learning media. Visual media holds great potential to help represent complex and abstract concepts in a way that makes them more concrete and easier for students to understand (Mayer, 2021). However, not all

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visual media can effectively bridge the gap between microscopic concepts and students' everyday experiences. Learning media are all forms of communication tools that can be used to convey information from sources or teachers to students to stimulate them to participate in learning activities as a whole, and can also be used to convey certain parts of learning activities (Fahria *et al*. 2023).

In this context, the use of visual metaphors becomes highly relevant. A visual metaphor is an approach that links abstract concepts to concrete and familiar imagery from everyday life, thereby facilitating students' cognitive processes in building conceptual understanding (Vadipoor *et al*. 2023). For example, representing the cell nucleus as the "brain" of the cell or the cell membrane as a "security gate" can help students form associations and develop a more meaningful understanding.

The ambiguity and complexity of teaching materials can be helped by presenting learning media as intermediaries for conveying information in the learning process (Nurdin *et al*. 2023). The use of the right media will provide the right learning experience to students so that they can build their own knowledge of a concept (Afriana *et al*, 2023), So the use of metaphor-based media has also been shown to increase student engagement and foster metacognitive skills, as students are encouraged to analyze the relationship between visual symbols and the scientific concepts they represent (Taber, 2001). This aligns with the humanistic and contextual approach of the Kurikulum Merdeka (Merdeka Curriculum), which emphasizes meaningful, contextual learning that empowers students' higher-order thinking skills. Although the metaphorical approach has been widely studied, research that specifically evaluates the use of visual media with the metaphor of "the cell as the house of life" in cell learning remains very limited. Moreover, studies on student and teacher responses to this approach within the context of 21st-century learning—which emphasizes scientific literacy, creativity, and metacognitive skills—are still underdeveloped. Therefore, this study aims to fill that gap by developing and evaluating metaphorical visual media that is designed to be contextual, humanistic, and based on students' needs.

Therefore, the development of metaphor-based visual media in science learning particularly in cell biology is both important and relevant for enhancing students' scientific literacy and cognitive abilities in a comprehensive manner. The purpose of this study was to determine the perceptions of students and teachers regarding metaphor-based visual media used in learning cell material.

2. RESEARCH METHOD

This research employs a quantitative descriptive analysis method. The study was conducted at SMP Negeri 1 Plumbon, specifically involving Grade VIII students. The research subjects included five science teachers and 32 students from Class VIII. The teachers selected as research subjects met the criteria for science education experts, namely: holding at least a bachelor's degree (S1), possessing expertise in instructional media, and having a minimum of five years of teaching experience. The student subjects were from Class VIII H, who had already studied the topic of cell structure and function, enabling them to evaluate the media by comparing it with previously used teaching materials.

The type of data collected is primary data, obtained through the distribution of closed-ended questionnaires and interviews (Supriyatin, 2024). The data collection instruments included teacher and student perception questionnaires, which were analyzed using descriptive methods. The teacher perception questionnaire was used to gather assessments from teachers regarding the metaphor-based visual media as a learning resource.

The indicators for the student perception assessment instrument referred to the implementation of learning using metaphor-based visual media. In this assessment, students were expected to reflect on their learning experience in understanding the concept of cells through the use of such media. The following table presents the indicators and assessment criteria for student perceptions

Table 1. Student Response Indicators

Code	Indicators
A01	Students are expected to be able to visualize the cell by connecting it to the "house of life" metaphor.

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Code	Indicators
A02	Students are expected to understand the concept and function of cell parts that are metaphorically represented as the "house of life."
A03	Students are expected to understand how cell parts are interconnected and function in a coordinated manner.
A04	Students are expected to understand the role of mitochondria as the energy supplier in the "house of life."
A05	Students are expected to understand the chloroplast organelle by using the metaphor of a "solar panel energy source" that produces food for all living beings.
A06	Students are expected to understand the cell membrane as a "tightly guarded entrance to a house."
A07	Students are expected to understand the cell nucleus as the "control center of the house."
A08	Students are expected to create a metaphor to describe the role of lysosomes in daily life.
A09	Students are expected to create a metaphor to describe the role of ribosomes in daily life.
A10	Students are expected to describe the cell in general terms using metaphors other than the "house of life."

The analysis guideline used for the questionnaire is based on the Likert scale. The Likert scale guideline for the questionnaire can be seen in the following table:

Table 2. Assessment Scoring Guidelines

Coefficient	Criteria
5	*Very Easy*
4	*Easy*
3	*Quite Easy*
2	*Difficult*
1	*Very Difficult*

(Hindriana, 2023)

The scores given by the students will be calculated using the following formula:

$$\% = \frac{\in score\ obtained}{\in maximum\ score} \times 100\%$$

Meanwhile, to determine the results of the students' response analysis, the following table 4 of student response criteria.

Table 3. Student resppons criteria

coeficient	criteria
80% -100%	*Very Positive*
60% -80%	*Positive*
40% -60%	*Fairly Positive*
20% -40%	*Less Positive*
< 20%	*Very Less Positive*

(Arikunto, 2010)

The indicators used to assess teachers' perceptions of the metaphor-based visual media include: the relevance of the content and material to the learning objectives, the appropriateness of the language used, and the accessibility of the media.

Table 4. Teachers respons indicator

Content Aspects	
a.	The material aligns with the learning objectives
b.	The material meets the students' needs
c.	The material is appropriate for the media and teaching materials
d.	The material suits the students' characteristics
Linguistic Aspects	
a.	Clarity of information presented in the media
b.	Appropriateness of the language used in the media
Material Aspects	
a.	Ease of understanding the concepts
b.	Students' learning motivation after using the media in instruction
c.	Clarity of the learning topics
d.	Scope of the material presented in the media
Media Aspects	
a.	Clear use of fonts (type and size) in the media
b.	Availability of attractive illustrations, graphics, images, and photos
c.	The overall appearance of the media is appealing

Then the analysis guideline used for the questionnaire is based on the Likert scale. The Likert scale guideline for the questionnaire can be seen in the following table:

Table 5. Assessment Scoring Guidelines

Coefficient	Criteria
5	*Very Good*
4	*Good*
3	*Enough*
2	*Quite Good*
1	*Not Very Good*

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The scores given by the students will be calculated using the following formula:

$$\% = \frac{\in score\ obtained}{\in maximum\ score} \times 100\%$$

Then, the scores obtained from the questionnaire are presented using the following criteria for the feasibility of the learning media:

Table 5. Product eligibility criteria

Percentage (%)	Feasibility Criteria
80% –100%	*Very Suitable*
66% –79%	*Suitable*
56% –65%	*Quite Suitable*
40% –55%	*Not Very Suitable*
0%- 39%	*Unsuitable*

3. RESULTS AND DISCUSSION

In this study, data were obtained regarding the perceptions of students and teachers toward instructional media, which play an important role in determining the success of an educational innovation. In the context of biology education, particularly in the topic of cell structure and function, the use of metaphorical visual media is considered an effective approach to bridge the understanding of microscopic and abstract concepts.

In students' perceptions, the following data were obtained:

Table 6. Student Response Results to Visual Metaphor Media

code	Respons score	percentage
A01	152	95,00 **%**
A02	146	91,25 **%**
A03	143	89,38 **%**
A04	146	91,25 **%**
A05	128	80,00 **%**
A06	151	94,38 **%**
A07	153	95,63 **%**
A08	153	95,63 **%**
A09	128	80,00 **%**
A10	128	80,00 **%**
average	**89,25 %**	

The metaphor-based learning approach is an effective strategy to help students grasp abstract concepts in biology, particularly regarding the structure and function of cells. One such approach is to conceptualize the cell as a *"house of life"*. Visual representation of student comprehension levels shows that a majority of students demonstrated a high level of understanding when the material was presented using this metaphor. The metaphor simplifies complex biological concepts by making them relevant and contextual to everyday life.

a. Very High Level of Understanding (Percentage ≥ 90%)

Six indicators showed a very high level of understanding:

- Visualization of the cell as a house (95%)
- Function of cell parts (91.25%)
- Function of mitochondria (91.25%)
- Cell membrane as a door (94.38%)
- Nucleus as the control center (95.63%)
- Lysosome metaphor (95.63%)

These high achievements indicate that students successfully internalized basic concepts of cell structure and function through the metaphorical approach. For instance, students easily understood the mitochondria as the powerhouse, much like a house needs a kitchen or power generator. The nucleus was comprehended as the brain or command center of the house, regulating all activities. This is in line with the findings of Jahic *et al*. (2024), which revealed that the use of metaphors such as 'carpet' for the cell membrane and 'toll gate' for membrane proteins emerged in teacher-student interactions and helped students understand the concept of nutrient transport.

Research by Orgill and Bodner (2004) also supports these findings, noting that familiar and well-structured analogies help students build more accurate mental models of scientific concepts. In this case, the "house of life" serves as a concrete and meaningful thinking framework.

b. Moderate to Good Level of Understanding (80% – 89%)

Four indicators fall within this category:

- Interrelation between cell parts (89.38%)
- Chloroplast as solar panels (80%)
- Ribosome metaphor (80%)
- Alternative metaphors beyond the house concept (80%)

While students still demonstrated good understanding, some likely faced difficulties in

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relating the functions of certain organelles to everyday objects. For example, ribosomes as protein factories might remain abstract in the context of a household metaphor. Similarly, chloroplasts, although described as solar panels, may be unfamiliar to students from areas without widespread use of such technology.

For the indicator on the interrelation among cell parts, understanding was relatively high but not optimal. This suggests that although students grasp the individual functions of organelles, they struggle to envision the dynamic interaction among these components within a coordinated cell system. This observation is consistent with Treagust *et al*., (2006), who stressed the need for systemic metaphors that highlight relationships between parts, rather than just individual descriptions.

Furthermore, a study by Coll, France, & Taylor (2005) found that students often face difficulties in transferring understanding from analogy to actual scientific concepts without adequate teacher guidance. Hence, the role of the teacher is crucial in clarifying the boundaries and appropriateness of each metaphor (Ozdemir, 2022).

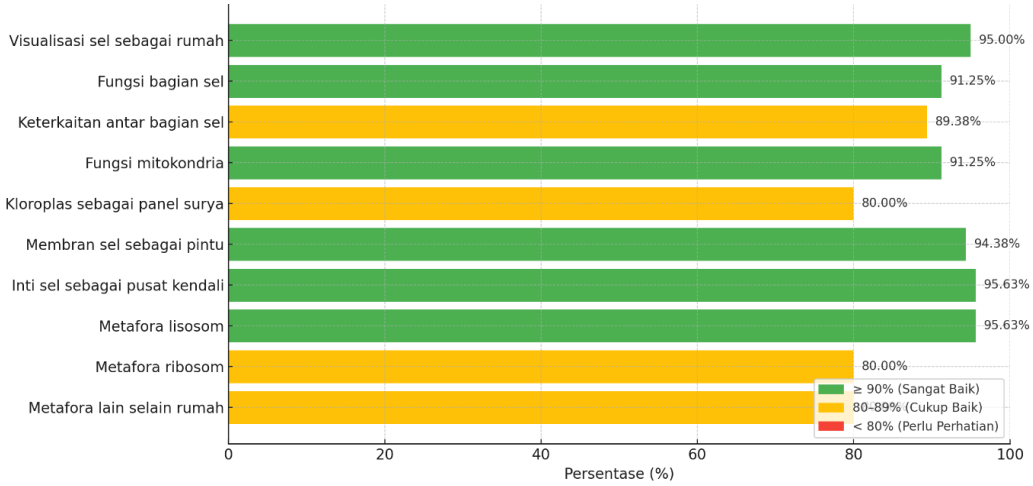


Figure 1. Student's responses according to criteria

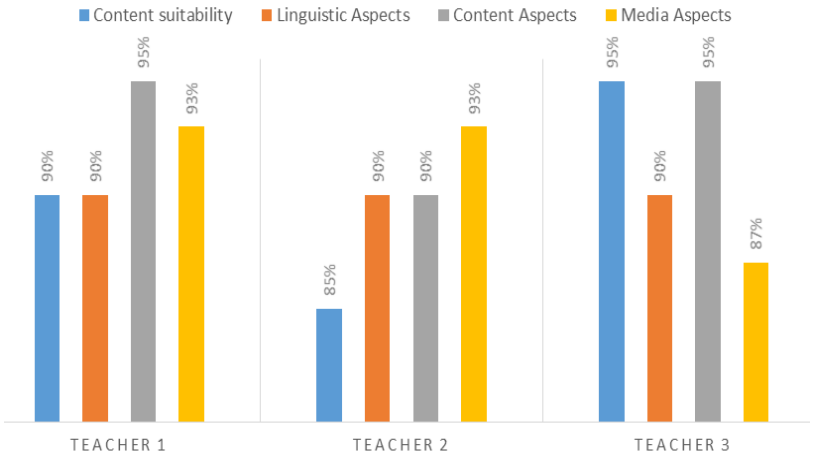


Figure 2. Teacher responses according to criteria

The results of the validity test of the learning media by three teachers indicate that the developed media has a high level of feasibility across the four assessed aspects: content relevance, language, material quality, and media design. This suggests that the designed visual

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media meets the required quality standards to effectively support the learning process. For the content relevance aspect, the average scores given by the three teachers ranged from 85% to 95%. Teacher 1 and Teacher 3 gave high ratings (90% and 95%), while Teacher 2 gave a slightly lower score (85%). This score still falls under the "highly feasible" category, although it indicates that some content areas could be reviewed to better align with the curriculum and students' needs. Content alignment is a key indicator in developing curriculum-based learning media. As stated by Mahdum *et al*. (2019), the relevance of the material to the context and students' needs significantly influences the media's effectiveness in improving learning outcomes.

The linguistic aspect received a consistent score of 90% from all three teachers. This consistency shows that the language used in the media adheres to proper linguistic standards and is easily understood by students. The use of communicative and contextual language is considered effective in helping students understand abstract scientific concepts more concretely. As emphasized by Fadhilah and Mardapi (2019), clarity of language in visual media significantly contributes to students' comprehension of scientific concepts.

The content aspect also received very high scores, ranging from 90% to 95%. Teacher 1 and Teacher 3 gave the highest scores, indicating that the material presented is aligned with learning indicators, comprehensive, and scientifically accurate. This supports the conclusion that the substance included in the media contributes effectively to achieving learning objectives in a comprehensive manner. Research by Putra and Maryani (2021) supports this finding, showing that media with accurate content and systematic material structure can significantly improve students' scientific literacy.

Meanwhile, the media design aspect received scores between 87% and 93%. Although still categorized as excellent, Teacher 3 gave the lowest score (87%), which may reflect perceptions of visual quality, readability, or media appeal that could still be improved. This aligns with findings by Nurrahmawati and Fauzi (2020), who state that disproportionate or overly dense visual design can reduce students' learning comfort, even when the content itself is adequate.

Overall, the validation results show that the developed visual learning media meets the eligibility criteria based on evaluations by practitioner experts (teachers). These findings reinforce the view that metaphorical-visual-based learning media have great potential to enhance learning effectiveness, especially in science topics that are complex and abstract. This also supports the concept of contextual learning within the framework of the *Pancasila Student Profile*, which encourages deep understanding through representative and interactive media (Kemdikbudristek, 2022).

4. CONCLUSION

The implementation of this research provided valuable insights into the importance of innovative, contextual, and humanistic learning media. Through the development and application of metaphor-based visual media for the topic of cell structure and function in Grade VIII of junior high school, the researcher found that this approach effectively bridged the gap between abstract scientific concepts and students' real-life experiences.

Metaphor-based visual media not only helped students understand concepts more concretely but also contributed positively to improving scientific literacy, particularly in their ability to explain scientific phenomena in their own words and interpret visual information. Furthermore, students' engagement in reflective thinking about their own understanding indicated the development of metacognitive skills, as they became more aware of, evaluated, and directed their own learning strategies. Metaphor-based visual media provided students with the space to construct personal and creative understanding, fostering confidence in the learning process and making the information more meaningful.

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