p-ISSN 2614-8250, e-ISSN 2614-5677
https://journal.uniku.ac.id/index.php/IJLI



p-ISSN: 2614-8250 e-ISSN: 2614-5677

Indonesian Journal of Learning & Instruction

Sekolah Pascasarjana
Universitas Kuningan,
Indonesia

IMPLEMENTATION OF VISUAL METAPHOR-BASED MEDIA ON CELL MATERIAL TOWARD STUDENTS' CRITICAL THINKING SKILLS AND LEARNING MOTIVATION IN GRADE VIII OF SMP NEGERI 6 MAJALENGKA

Atih Novila Windiyani[1]. Anna Fitri Hindriana[2]. Agus Yadi Ismail[3]
Postgraduate Biology Education, Universitas Kuningan, Indonesia

Corresponding author's email: harujisatianugrahaa@gmail.com

APA Citation: Windiyani, A. N., Hindriana, A. F., & Ismail, A. Y. (2025). Implementation of visual metaphor-based media on cell material toward students' critical thinking skills and learning motivation in grade VIII of SMP Negeri 6 Majalengka. *Indonesian Journal Learning and Instruction, 8*(2), 57-66. 10.25134/ijli.v8i2.4

Received: 04-06-2025 Accepted: 12-08-2025 Published: 30-10-2025

Abstract: Students' difficulties in understanding the abstract concept of cells, along with low learning motivation and critical thinking skills, prompted this study. The aim was to examine the implementation of metaphor-based visual learning media on cell material and its effects on the critical thinking skills and learning motivation of 8th-grade students at SMP Negeri 6 Majalengka. The study was conducted from February to April 2025 using a Research and Development (R&D) method with the ADDIE model. A sample of 52 eighth-grade students was selected through proportional random sampling. The media was developed in the form of a video titled *"The Cell as a Unique School of Life"*, integrating everyday life analogies through visual metaphors. Data were collected through expert validation, student and teacher questionnaires, pre- and post-tests on critical thinking skills, and learning motivation questionnaires. Results showed that the media was highly valid (average score of 90.75%), practical to use (teacher response: 93.77%, student response: 87.54%), and significantly improved students' critical thinking skills (mean rank of experimental group: 33.72; control group: 19.27). Learning motivation also increased, with extrinsic motivation at 92.30% and intrinsic motivation at 90.29%. Pearson correlation analysis indicated that the media had a stronger influence on learning motivation ($r = 0.744$) than on critical thinking skills ($r = 0.609$). Metaphor-based visual media effectively helps students understand abstract cell concepts, enhances critical thinking skills, and boosts learning motivation. This approach is recommended for science teachers as a meaningful, contextual learning strategy aligned with the Merdeka Curriculum.

Keywords: *visual metaphor media, cells, critical thinking skills, learning motivation, junior high school students.*

INTRODUCTION

In modern education, the development of students' critical thinking skills and learning motivation has become a key focus to shape a generation capable of competing in the era of globalization (Hernawanti, 2023). Critical thinking is a crucial element of 21st-century learning, as it helps students analyze information, solve problems, and make decisions based on logic and evidence (Padmarkisya, 2023). Learning motivation, on the other hand, is a major driving force behind students' academic success, encompassing cognitive, affective, and behavioral aspects in understanding a subject (Juliastary et al., 2024). However, both aspects remain challenges in biology learning, especially when it comes to abstract topics such as cells (Husein, 2017).

Cell material is one of the fundamental topics in science education, serving as the foundation for understanding other biological concepts such as tissues, organs, organ systems, and organisms. However, the microscopic nature of this topic often makes it difficult for students to grasp (Nasution, 2013). Students often resort to memorizing

terminology and functions of cell parts without truly understanding the concepts in depth (Nasution, 2013). This results in low critical thinking ability, which should be a key objective in science education.

Research by Safitri (2020) found that visual-based animations improved students' understanding of the respiratory system but did not address cell material. Another study by Windi Puspita Sari (2023) investigated the use of audiovisual media in teaching plant and animal cells but did not examine the influence of visual metaphor-based media on critical thinking skills. A study by Hendri et al. (2019) on the use of metaphor-assisted image media showed increased student engagement. This method helped clarify abstract concepts in a more concrete way, enhancing students' understanding. Meanwhile, Nugroho (2019) found that metaphor-based learning media was effective in improving students' critical thinking skills in physics. However, research specifically focused on the implementation of visual metaphor-based media for teaching cells remains very limited, particularly at the junior high school level. Thus, this study is important to address that research gap.

Studies on the impact of visual media on students' learning motivation show that it helps students better understand the material, thereby increasing their motivation to learn (Rojanah, 2021). Further research confirms that visual media has a positive effect on learning outcomes and can enhance students' engagement in the learning process (Nurlaelah, 2023). Other studies indicate that visual media can support students' understanding of complex topics (Ermailis, 2023). According to Mayer's Multimedia Learning Theory (2009), the combination of text, images, and illustrations can facilitate student learning by increasing engagement and comprehension (Setiawan, 2023). However, many visual media tools used in schools are still conventional, such as static images or simple animations that lack concrete analogies for abstract concepts. In this regard, the visual metaphor-based approach offers an innovative solution (Hindriana, 2023). Visual metaphors can bridge students' understanding of abstract concepts by connecting them to real-life experiences or familiar ideas (Nirmala, 2021). For example, a cell can be compared to a "factory" where organelles function as "machines" with specific roles. This approach not only helps students understand organelle functions but also develops their critical thinking through analysis of the analogy.

Although the benefits of metaphors in learning have been widely discussed, research specifically examining the implementation of visual metaphor-based media on cell material is still limited, especially in the context of education in Indonesia (Nikmah et al., 2020). Most studies focus on the development of visual media in general, without exploring the use of metaphor as a central element (Nikmah et al., 2020). In addition, existing research rarely integrates this approach with simultaneous measurement of critical thinking skills and learning motivation, despite the importance of these two aspects in supporting science learning. This is especially relevant to the goals of the *Kurikulum Merdeka*, which emphasizes project-based learning, character development, and 21st-century skills (Nurdiyanti et al., 2024).

Based on the problems described above, it is essential to conduct more in-depth and contextual research on the development and implementation of visual metaphor-based media for teaching abstract concepts such as cells. Therefore, the author is interested in conducting a study entitled: "The Implementation of Visual Metaphor-Based Media on Cell Material to Enhance Critical Thinking Skills and Learning Motivation of Grade VIII Students at SMP Negeri 6 Majalengka."

METHOD

The design and approach used in this research is the Research and Development (R&D) model, which aims to develop and produce products or models that can be applied in educational contexts. This method is particularly suitable for creating or testing the effectiveness of instructional media, modules, or innovative learning models, such as the development of visual metaphor-based media in this study. The product developed is a visual metaphor-based learning media application, specifically designed to support learning on cell material.

The development model used in this study is the ADDIE development model by Lee (2004). The ADDIE model is suitable for the development of visual-based learning media as part of an effort to create educational tools (Pranada et al., 2020). Its systematic and easy-to-understand steps make it ideal for developing instructional media. According to Branch (2009), the ADDIE model consists of five stages: Analyze, Design, Develop, Implement, and Evaluate.

The first stage in the ADDIE model is Analysis.

p-ISSN 2614-8250, e-ISSN 2614-5677
https://journal.uniku.ac.id/index.php/IJLI

At this stage, the researcher analyzes the need for new instructional media and gathers the necessary data. The development begins by identifying problems with the current instructional media. The researcher also examines the learning needs and context of using visual metaphor-based media. Data collection is carried out through classroom observation during science lessons on cell material in Grade VIII using only pictures and teacher explanations. Interviews were also conducted with the principal and science teachers at SMP Negeri 6 Majalengka, along with journal analysis related to metaphor-based media development. The findings show that the current media are no longer relevant to the learning objectives, the key concepts in cell material, and the characteristics of today's students, who belong to Generation Alpha. Furthermore, students' motivation in learning cell material with static images was also analyzed.

The second stage is Design. In this stage, a visual metaphor-based media is designed using a metaphorical story where the cell is represented as a school. The researcher used Canva to create the visuals and Audacity to add voiceovers. The theme of the video is "the cell as a school," combining narration and sound effects to make students feel engaged and better understand the content, thereby increasing motivation to learn.

The design phase involved several key steps:

(1) Writing a clear and detailed script presenting the cell as a school, using language and structure that students can easily understand.

(2) Designing the product by selecting visual elements that support the understanding of cell concepts, such as using a storyboard to visualize the metaphor (e.g., nucleus = principal). (3) Creating a learning video based on the script with attractive illustrations and sound effects to form a conceptual framework of how the learning media will be developed.

The third stage is Development. In this stage, the visual metaphor-based media titled "The Cell as a Unique School of Life" was developed according to the design. First, the concept and storyboard were created, portraying cell components as parts of a school (e.g., nucleus as the principal). Storyboards were used to organize the flow and visuals. During the production phase, metaphorical illustrations and animations were created, accompanied by engaging narration to explain cell concepts simply.

The video was then reviewed by a language expert, media expert, and content expert to evaluate its feasibility for classroom use. A limited trial was also conducted with students and teachers to gather feedback on clarity, appeal, and content appropriateness. Based on this feedback, the video was revised to improve visual quality, audio, and alignment with learning objectives. The final product was then ready for classroom use.

The fourth stage is Implementation. At this stage, the research employed a quasi-experimental design using a non-equivalent control group design involving two groups:

- The experimental group used the metaphor-based media *"The Cell as a Unique School of Life."*
- The control group used conventional teaching methods.

The procedure began with a pretest for both groups to measure students' critical thinking skills and learning motivation. Then, the intervention was conducted—where the experimental group was taught using the visual metaphor media, while the control group continued with traditional methods. After the treatment, observations of teacher implementation and student responses were conducted. A posttest was administered to both groups to assess changes. The pretest-posttest results were analyzed to compare improvements in critical thinking and learning motivation, and to determine the effectiveness of the metaphor-based media.

In the Evaluation stage, several aspects were considered to assess the visual metaphor-based media *"The Cell as a Unique School of Life."*

Clarity of Content: Ensures the cell concepts presented via metaphors are understandable to students. Evaluated using questionnaires and observations to detect misconceptions.

Visual Appeal and Animation: Assesses whether illustrations and animations capture students' attention and are relevant. Feedback from students, teachers, and media experts was used.

Interactivity and Student Engagement: Measured through classroom observations and student interviews to explore their experience with the media.

Instructional Effectiveness: Assessed by analyzing pretest and posttest results and comparing the experimental and control groups to evaluate gains in critical thinking and motivation.

Curriculum Alignment: Ensures content matches learning objectives and national curriculum standards, confirmed by subject teachers and curriculum document reviews.

Technical Usability and Practicality: Evaluates ease of access and usage by both teachers and students, based on trials using typical classroom devices and user feedback.

User Satisfaction: Measured via Likert-scale questionnaires and interviews to capture students' and teachers' satisfaction levels in using the media.

RESULTS AND DISCUSSION

In the Analysis stage of the ADDIE development model, it was found that the topic of cell structure and function remains a challenge for Grade VIII junior high school students. The abstract, microscopic, and invisible nature of the topic contributes to students' low conceptual understanding and interest in learning (Nasution, 2013). Initial observations and interviews with teachers revealed that many students struggle to visualize the structure and function of cell organelles, as they cannot directly observe these objects. Since cells are the smallest units of life with structures and functions that are invisible to the naked eye, this makes them difficult to grasp (Rais, 2017). As a result, students' critical thinking skills—which should be a main goal in science learning—remain underdeveloped. Low student motivation in science learning leads to an unconducive and ineffective teaching-learning process, thus hindering students from actively understanding the material (Rosna, 2023).

The learning media used in schools tend to be text-heavy and lack contextualization. Therefore, the researcher believes that visual learning media is necessary to help students learn abstract material in a more contextual and tangible way. Research suggests that the process of comparing and contrasting characteristics to create metaphors for an object can enhance both critical and creative thinking (Martin et al., 2000, in Hindriana et al., 2023). A study by Safitri (2020) found that the use of visual-based animation improved students' understanding of respiratory system concepts. Another study on the use of metaphor-assisted picture media showed increased student engagement in learning (Hendri et al., 2019). This method helps explain abstract concepts more concretely, enhancing student understanding of the lesson. Furthermore, research by Nugroho (2019) showed that metaphor-based learning media effectively improves students' critical thinking skills in physics topics.

Based on these various research findings, the researcher is interested in developing metaphor-based visual media for the topic of cells and examining its effects on students' critical thinking skills and learning motivation at the junior high school level, considering their cognitive development stage, which aligns with Piaget's formal operational stage. At this stage, students begin to think logically and abstractly but still need concrete media to understand difficult concepts (Fadli R, 2024).

In the Design stage, a visual approach based on metaphor was chosen because it is considered capable of connecting scientific concepts with students' concrete experiences. Research shows that visual media can transform abstract ideas into more concrete and understandable forms (Junanah, 2025) and can provide links between lesson content and the real world (Ilarmin, 2024). Based on this, the researcher designed a metaphorical visual media concept that analogizes the cell as a school, because school is a familiar and contextual environment for students. The metaphorical visual media titled *"The Cell as a Unique School of Life"* was designed to offer more meaningful understanding by equating cell components with parts of a school that students encounter in daily life.

The choice of visual format is based on the learning characteristics of Grade VIII junior high school students, who belong to Generation Alpha—typically visual learners who absorb information more effectively through images and color rather than verbal text (Haruman, 2025). Therefore, visual elements in the media were developed to be communicative and closely related to students' real-life contexts to enhance comprehension and memory. The concept included an analogy table of cell organelles with school-related elements and their functions, followed by the creation of a storyboard, engaging narration, and the production of metaphor-based visual media in the form of an educational video.

In the Development stage, the metaphorical visual media—an animated video—was validated by experts. The results of the validations from language, media, and instructional experts showed an average score of 90.75%, indicating the media is of very high quality and suitable for use in science education for the cell topic. Some of the characteristics of the developed visual metaphor media are:

Contextual Metaphorical Visual Media
The metaphorical visual media is familiar and contextual. According to research, metaphors are used to describe or analogize one concept using another based on similarities in characteristics. In visual media, metaphors can be represented through images or illustrations that relate abstract concepts to more concrete or familiar objects (Widyastuti, 2022).

As a Learning Support Tool: Student Worksheet (LKPD) According to Hindriana et al. (2023), the use of metaphors received positive responses from both teachers and students. Teachers recognized that metaphors help convey complex concepts more clearly and enhance teaching creativity. Students felt that metaphors help them understand concepts better, increase interest in biology, and make learning more relevant. This shows that metaphors can be a potential strategy to improve biology learning quality.

Applicable Across Other Subjects Metaphors can be applied to almost any subject but are particularly effective in science education. Teachers often build personal images or representations of teaching and learning environments through metaphor use (Ritchie & Russell, 2007).

In the Implementation stage, the metaphor-based visual media was tested in an actual Grade VIII classroom for the topic of cells, and the resulting data were analyzed. Based on teacher observations over two sessions, the average effectiveness score reached 91.25%, indicating that the media is highly effective for use in teaching. Student responses after the implementation were also very positive, with an average response score of 87.54%. The analysis suggests that the use of metaphorical visual media in teaching the cell topic had a significant positive impact. This was reflected in the improvement of students' critical thinking skills—particularly in the experimental class, which showed a higher gain score of 30.35 points, compared to 23.11 points in the control class. These findings indicate that the media effectively encourages students to think more analytically and deeply about the topic being taught.

Moreover, there was a significant increase in students' learning motivation—intrinsic motivation reached 90.26%, while extrinsic motivation was even higher at 92.64%. This shows that the media successfully increased students' interest and external drive, even more than their internal motivation during the learning process. This research is further supported by correlational analysis, which revealed a positive relationship between media usage, critical thinking skills, and learning motivation. The highest correlation was found with learning motivation (0.744), followed by critical thinking (0.609), indicating that metaphorical visual media had a greater impact on improving learning motivation, though it also significantly contributed to enhancing critical thinking skills.

Finally, in the Evaluation stage, the metaphorical visual media received very positive feedback from teachers. The average teacher response reached 93.77%, further reinforcing that this media is highly feasible and should be developed further. This is supported by previous studies showing that metaphors received positive responses from both teachers and students. Teachers considered metaphors effective in conveying complex concepts, fostering creativity in teaching, and making learning more engaging. Meanwhile, students found metaphors helpful in understanding material, increasing interest in biology, and making learning more relevant (Hindriana, 2023).

Based on all stages of the ADDIE model, this research is considered important because it successfully addresses the need for more concrete, meaningful learning that aligns with the characteristics of junior high school students.

Table 1. *Table of student responses by indicator to learning with visual metaphor media*

No.	Indicator	Code Item	Respons score	Persentase
1.	Media helps understand cell concepts	R01	114	87,68%
2.	Ease of explanation through analogy	R02	109	83,34%
3.	Student activity and interest	R03	112	86,15%
4.	Media encourages critical thinking	R04	109	83,85%
5.	Media increases learning motivation	R05	116	89,23%
6.	Visualization helps remember material	R06	116	89,23%
7.	Support for the Independent Curriculum	R07	113	86,92%
8.	Media as a teaching aid	R08	117	90,00%
9.	Teacher interest in using a similar approach	R09	115	88,46%
10.	Suitability with the characteristics of grade VIII students	R10	117	90,00%
	Rate			87,54 %

Based on the data obtained, the analysis of responses from 10 students indicates that, overall, students demonstrated a very high level of understanding of cell concepts through the metaphor approach, with an average score of 87.54%. The highest indicator was seen in the ability to evaluate the effectiveness of the visual metaphor-based media and to develop general representations of the cell using other metaphors, scoring 90.00%. Meanwhile, the lowest indicator was in understanding the functions of each cell organelle through the "school" metaphor, which scored 83.34%. These findings confirm that the use of metaphor-based media is effective in enhancing critical thinking skills related to cells and the functions of their components.

Table 2. *Results of the use of metaphor media on critical thinking skills*

Indicator	Score	Persentase
Basic Clarification	127	81,41%
The Bases for a decision	42	80,76%
Inference	54	69,23%
Advanced Clarification	43	82,69%
Supposition and integration	36	69,23%

Based on the data on students' critical thinking skills according to Ennis' five indicators, the highest achievement was in Advanced Clarification, with a percentage of 82.69%, followed by Basic Clarification at 81.41%, and The Bases for a Decision at 80.76%. These three indicators demonstrate that students already have strong abilities in understanding information, exploring deeper meanings, and providing clarification for decisions. However, the other two indicators—Inference and Supposition and Integration—both received a lower percentage of 69.23%, indicating that students' abilities to draw conclusions and to develop and integrate information still need improvement.

Tabel 4. *Pearson correlation test and significance of multiple regression test*

		Visual Media Metaphor	Critical thinking skills	Motivation to learn
Pearson correlation	Visual media metaphor	1.00	0.609	0.744
	Critical thinking skills	0.609	1.000	0.656
	Motivation to learn	0.744	0.656	1.000
Sig. (1- tailed)	Visual Media Metaphor		<0.001	<0.001
	Critical thinking skills	0.000		0.000
	Motivation to learn	0.000	0.000	

Based on the Pearson correlation coefficient, the influence of metaphorical visual media is greater on learning motivation (0.744) compared to critical thinking skills (0.609). The higher correlation value indicates a stronger relationship, thus it can be concluded that metaphor-based media tends to be more effective in enhancing students' learning motivation than their critical thinking skills.

In this study, the metaphor-based visual media effectively facilitated all five indicators of students' critical thinking skills. For the basic clarification indicator, visual metaphors helped students grasp cell concepts more concretely, enabling them to identify and clearly explain fundamental information. Regarding the providing reasons for a decision indicator, the use of analogies encouraged students to think logically in supporting their opinions or decisions based on the relationships between cell parts and their functions in real life.

For the inference indicator, the metaphorical media enabled students to draw structured conclusions by comparing scientific concepts with the presented metaphorical representations. As for advanced clarification, the media challenged students to delve deeper into information and evaluate the accuracy of the relationships between analogies and the original concepts. Lastly, for the supposition and integration indicator, students were facilitated in developing new hypotheses and integrating various concepts they had learned through metaphorical visual mapping, thus effectively promoting higher-order critical thinking skills.

p-ISSN 2614-8250, e-ISSN 2614-5677
https://journal.uniku.ac.id/index.php/IJLI

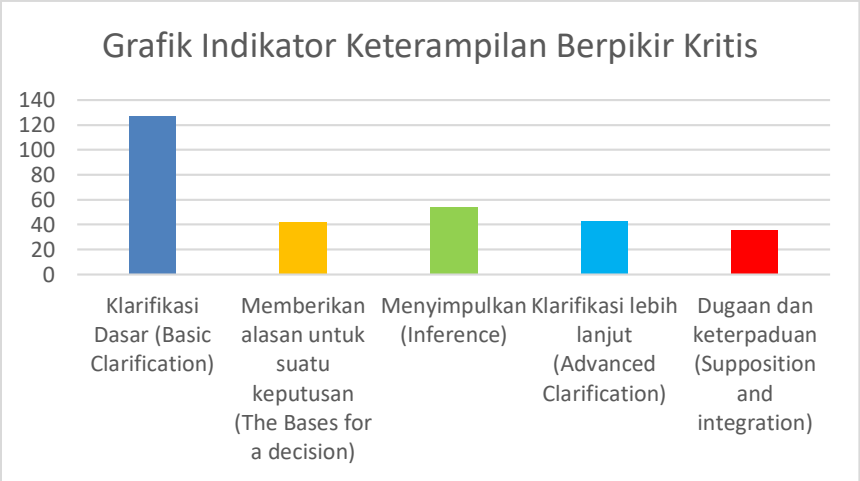


Figure 1. *Graph of students' critical thinking skill indicators*

Based on the graph of critical thinking skill indicators, students demonstrated strong abilities in understanding basic information and drawing conclusions. Conversely, their abilities were still low in the indicators of supposition and integration, advanced clarification, and providing reasons for decisions. This indicates that although students have a good initial understanding, they still need improvement in higher-order critical thinking skills such as making inferences and integrating information.

In this study, students' learning motivation levels were measured after the implementation of visual metaphor media using a motivation questionnaire instrument, which was developed based on the learning motivation theory by Uno (2017). According to Uno's theoretical framework, learning motivation is classified into two categories: intrinsic motivation and extrinsic motivation. The indicators for each category are as follows: (a) the desire and will to succeed, (b) the drive and need to learn, (c) hopes and future aspirations, (d) recognition in learning, (e) interest in learning, and (f) a conducive learning environment. The first three indicators fall under intrinsic motivation, while the latter three are categorized as extrinsic motivation (Hamzah B. Uno, cited in Rahman S., 2021).

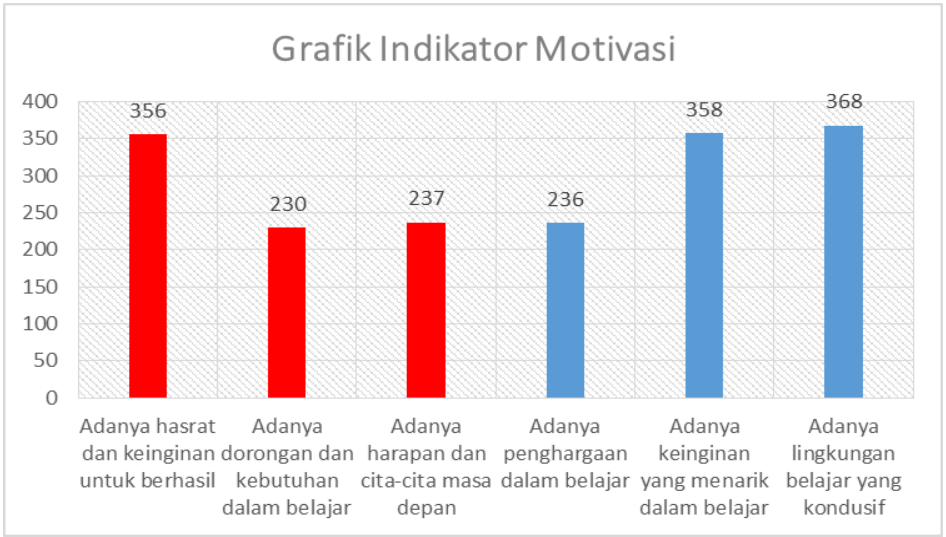


Figure 2. *Graph of students' motivation indicators*

Based on the graph of student motivation indicators after using the visual metaphor-based media, the highest scores were observed in the conducive learning environment (368) and interest in learning (358). These results suggest that the media successfully created an enjoyable learning atmosphere and effectively captured students' interest. The desire and will to succeed also showed a high score of 356, indicating a strong internal drive among students to achieve success.

Meanwhile, the indicators drive and need to learn (230), hopes and future aspirations (237), and recognition in learning (236) received relatively lower scores, although still considered high overall. These findings imply that students' motivation is highly influenced by external and

emotional factors, while internal aspects such as awareness of learning needs and long-term goals still require reinforcement through reflective approaches and a strengthened sense of learning purpose.

The increase in student motivation in this study can be interpreted as evidence of the effectiveness of visual metaphor media in creating an engaging, meaningful, and contextual learning experience. This aligns with the findings of L. Xu et al. (2022), who indicated that the use of metaphors—whether verbal or visual—can shape learners' perceptions of the learning process as something positive, dynamic, and motivating.

Metaphorical representation turns learning into an enjoyable and personal discovery process, thereby fostering enthusiasm and intrinsic motivation.

In the context of science education, especially biology, the visual metaphor media that portrays the cell as a school provides a narrative that resonates with students' everyday lives. This makes previously abstract concepts more accessible and appreciated, encouraging students to actively engage in the learning process. This interpretation reinforces the view that metaphorical approaches can stimulate students' emotional engagement, ultimately having a direct impact on their learning motivation.

CONCLUSION

Based on the results and discussion of the study, it can be concluded that the visual metaphor-based media with the concept "The Cell as a Unique School of Life" has excellent characteristics and is highly feasible for use. This is supported by validation results from language experts, media experts, and instructional experts, with an average score of 91.67%, indicating that the media meets standards in terms of language quality, visual design, synchronization, content appropriateness, and instructional effectiveness.

The metaphorical characteristics successfully bridge complex biological concepts—particularly the structure and function of cell organelles—with students' everyday experiences in the school environment. This creates a more contextual and meaningful understanding.

The implementation of visual metaphor-based media in teaching cell material had a positive impact on students' critical thinking skills. Quantitative data showed improvements in students' abilities to observe, analyze, interpret, and draw conclusions. Students were able to identify relationships between parts of the cell using analogies with school components, such as the principal representing the nucleus and the cafeteria representing the mitochondria, demonstrating the development of their critical thinking skills.

In addition, students' learning motivation significantly increased after using the media. Questionnaire results showed high average scores across motivation indicators such as attention, relevance, confidence, and satisfaction. The visual metaphor media made learning more enjoyable, easier to understand, and more relevant to students' experiences. This suggests that metaphorical approaches contribute not only to cognitive development but also to fostering students' emotional engagement with the subject matter.

The responses from both students and teachers toward the media were also very positive. They stated that the media helped them understand the material more easily, increased their interest in science learning, and made the learning process more engaging.

Therefore, visual metaphor-based media has proven to be an effective alternative for innovative and contextual instructional strategies, enhancing the quality of science learning—particularly in the topic of cells.

Particularly in setting clear goals, monitoring progress, and effectively planning their studies. These metacognitive strengths reflect their systematic approach to learning. However, their ability to evaluate performance, while solid, shows room for growth in reflective practices.

In terms of motivation, students maintained interest in learning activities, but self-efficacy emerged as a weaker area, indicating the need for initiatives to boost confidence and resilience. Behaviorally, students managed time efficiently, optimized their learning environments, and utilized digital resources, though improved digital literacy could enhance their resource use.

Qualitative insights highlighted the flexibility and cost-effectiveness of online learning, but also noted challenges such as reduced social interaction and limited access to physical resources. Many students preferred offline learning for its structure and collaborative opportunities. Overall, while students demonstrate strong SRL, improving self-efficacy and integrating hybrid learning models could further support their academic success.

REFERENCES

Akgül, G. (2021). Teachers' metaphors and views about gifted students and their education. *Gifted Education International*, *37*(3), 273–289.

Amanda, D. R. (2024). Analisis penggunaan media berbasis visual terhadap hasil belajar Bahasa Indonesia siswa. *Jurnal Pendidikan Bahasa dan Budaya*, *3*(2). https://doi.org/10.55606/jpbb.v3i2.3181

Anthonysamy, L., Koo, A. C., & Hew, S. H. (2020). Self-regulated learning strategies in higher education: Fostering digital literacy for sustainable lifelong learning. *Education and Information Technologies*, *25*(4), 2393–2414.

Arifin, M., dkk. (2022). *Media pembelajaran*. UMSU Press.

Arikunto, S. (2014). *Prosedur penelitian suatu pendekatan praktik*. Rineka Cipta.

Arisandhi, G. A., Wibawa, I. M., & Yudiana, K. (2023). Flipbook: Media pembelajaran interaktif untuk meningkatkan kognitif IPA siswa sekolah dasar. *MIMBAR PGSD Undiksha*.

Asrijanti, & Hadiana, D. (2019). *Panduan penulisan soal HOTS (Higher Order Thinking Skill)*. Pusat Penilaian Pendidikan.

Blanco, M., & Mihaela Cristea, D. (2023). La metáfora visual en el universo del fotógrafo Tatsuya Tanaka. *Fotocinema. Revista Científica de Cine y Fotografía*.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality*, *19*, 109–134.

Dewi, A. P., & Hidayat, M. T. (2022). Persepsi guru sekolah dasar tentang pengajaran yang efektif. *Jurnal Basicedu*.

Dewi, N., & Putro, A. A. Y. (2023). Implementasi penggunaan media pembelajaran pada kemampuan berpikir kritis siswa kelas IV sekolah dasar. *Pendekar: Jurnal Pendidikan Berkarakter FKIP UMM*.

Ermailis, E. (2023). Penggunaan media visual untuk meningkatkan pemahaman konsep irisan bidang dengan bangun ruang pada siswa kelas IX MTsN 4 Kota Jambi. *Jurnal Literasiologi*.

Fadli, R. (2024). *4 Tahap perkembangan kognitif anak sesuai teori Piaget*. Halodoc. https://www.halodoc.com/artikel/4-tahap-perkembangan-kognitif-anak-sesuai-teori-piaget

Fahmi, et al. (2023). Critical thinking skills of junior high school students in the city of a thousand rivers based on local wisdom. *Journal of Banua Science Education*.

Fang, Z., Gresser, V., Cao, P., & Zhang, H. (2022). Genre and register features of sixth-grade students' factual writing. *Written Communication*, *39*(3), 426–461. https://doi.org/10.1177/07410883221085993

Fenancy, S. D. (2017). *Perancangan boardgame sistem pernafasan manusia sebagai media pendukung pembelajaran untuk siswa kelas 5 SD dengan konsep metafora* [Tugas Akhir/Skripsi].

Gal, M. (2022). *Visual metaphor and aesthetics*. Bloomsbury Publishing.

Gal, M. (2020). Visuality of metaphor: Formalist ontology of metaphor. *Cognitive Linguistic Studies*, *7*(1), 58–77. https://doi.org/10.1075/cogls.00049.gal

Haruman, F. H., & Noviana, E. (2025). Dampak media digital dalam membangun literasi keuangan bagi generasi Alpha. *Magenta | Official Journal STMK Trisakti*, *9*(1), 1352–1364.

Hendri, P., et al. (2019). Penerapan metode metafora berbantu media gambar pada pelajaran PAI untuk meningkatkan keaktifan belajar siswa kelas V SD Negeri 013 Pulau Kalimanting. *Al-I'tibar: Jurnal Pendidikan Islam*.

Herwanti, K. (2023). Pengembangan keterampilan berpikir kritis dan kreatif melalui pendekatan STEM untuk meningkatkan hasil belajar kimia pada materi sel elektrokimia. *Trisala: Jurnal Ilmiah Pendidikan*.

Hindriana, A. F., Setiawati, I., Abidin, Z., Atâ, A., & Karlina, L. (2023). Analysis of teachers' and students' perception of the use of metaphors in biology. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8124–8130.

Humar, M. (2021). Metaphors as models: Towards a typology of metaphor in ancient science. *History and Philosophy of the Life Sciences*, *43*(3), 101.

Husen, A. (2017). *Penerapan Problem Based Learning dipadu Think Pair Share untuk meningkatkan kemampuan berpikir kritis, keterampilan proses sains, dan karakter siswa pada mata pelajaran biologi* [Tugas Akhir/Skripsi].

Ilham, S. M., Ramadhani, D. M., Hasanah, U., Kafrawi, K., & Nurfitri, N. (2023). Workshop media pembelajaran interaktif bagi guru sekolah dasar. *Journal of Community Service and Society Empowerment*.

Islam, J. P., et al. (2024). Peran teknologi pendidikan dalam kemajuan pendidikan Islam di abad 21. *IHSAN: Jurnal Pendidikan Islam*.

Jahic Pettersson, A., Danielsson, K., & Rundgren, C. J. (2020). 'Traveling nutrients': How students use metaphorical language to describe digestion and nutritional uptake. *International Journal of Science Education*, *42*(8), 1281–1301.

Jeong, S. H. (2008). Visual metaphor in advertising: Is the persuasive effect attributable to visual argumentation or metaphorical rhetoric? *Journal of Marketing Communications*, *14*(1), 59–73. https://doi.org/10.1080/14697010701717488

Juliastari, J., Wahyuningsih, R., & Jamaluddin, J. (2024). Upaya meningkatkan motivasi belajar biologi melalui penerapan model pembelajaran Problem Based Learning (PBL) pada materi perubahan lingkungan. *Jurnal Ilmiah Profesi Pendidikan*.

Keller, E. F. (2020). Cognitive functions of metaphor in the natural sciences. *Interdisciplinary Science Reviews*, *45*(3), 249–267.

Kogan, N., Connor, K., Gross, A., & Fava, D. (1980). Understanding visual metaphor: Developmental and individual differences. *Monographs of the Society for Research in Child Development*, *45*(1), 1–78.

Kusuma, J. W., dkk. (2023). *Dimensi media pembelajaran: Teori dan penerapan media pembelajaran pada era Revolusi Industri 4.0 menuju era Society 5.0*. Sonpedia Publishing Indonesia.

Murnihati, S. (2021). *Biologi sel: Modul singkat sel dalam perkembangannya*. Lutfi Gilang.

Muspikawijaya, M., Iswari, R. S., & Marianti, A. (2017). Analisis kesulitan peserta didik SMA/MA kabupaten Luwu Timur dalam memahami konsep pada materi metabolisme sel. *Journal of Innovative Science Education*, *6*, 252–263.

Nurlaelah. (2023). Pengaruh penggunaan media audio visual terhadap peningkatan hasil belajar Ilmu Pengetahuan Alam siswa kelas IV. *Metafora: Jurnal Pembelajaran Bahasa dan Sastra*.

Padmakrisya, M. R., & Meiliasari, M. (2023). Studi literatur: Keterampilan berpikir kritis dalam matematika. *Jurnal Basicedu*.

Rahayuningsih, N. E., Purwati, A. S., & Sudibyo, E. (2024). Pengaruh penggunaan media simulasi game online pembelajaran IPA terhadap motivasi siswa kelas VII. *EDUPROXIMA: Jurnal Ilmiah Pendidikan IPA*.

Syarifudin, A. (2023). Pengaruh penggunaan media pembelajaran berbasis visual terhadap prestasi belajar mata pelajaran Aqidah Akhlak siswa di MIN Kapuas Hulu. *Al Qalam: Jurnal Ilmiah Keagamaan dan Kemasyarakatan*.

Tortora, G. J., & Derrickson, B. H. (2021). *Principles of anatomy & physiology*. Wiley.

Tresnawati, C. I. T. A., Rahmat, A., & Rahman, T. (2022). Cognitive system profile of prospective teachers in cell biology learning. *Journal of Engineering Science and Technology*, *17*, 58–66.

Yu, Y., Krebs, L., Beeman, M., & Lai, V. T. (2024). Exploring how generating metaphor via insight versus analysis affects metaphor quality and learning outcomes. *Cognitive Science*, *48*(8), e13488.

Zakiah, L., & Lestari, I. (2019). *Berpikir kritis dalam konteks pembelajaran*. Erzatama Karya Abadi.