

Analysis of Teachers' and Students' Perception of the Use of Metaphors in Biology

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Abstract: This study aims to investigate teachers' and students' perceptions of the use of metaphor in learning biology including the effectiveness of and the interest in using metaphor in learning biology. The investigation builds on assumption that metaphor is a potential method to alter the way teachers and students respond to abstract and complex concepts. The data in this study was obtained qualitatively using the triangulation method involving Focus Group Discussion (FGD) with an expert group and individual interviews. The instrument utilized in this study is a discussion guide and an interview guide containing open questions which later was transcribed and analyzed. The respondents of this study are 30 biology teachers and 71 senior high school students from three districts in West Java, Indonesia. The result shows that teachers and students respond positively to the use of metaphors in learning biology concepts. In addition, teachers express that metaphor helps in delivering abstract and complex biology concepts as well as developing creativity in teaching. Meanwhile, students express that metaphor has the potential to help them understand biology concepts, increase interest in learning biology, and build relevance to the concept.

Keywords: Biology concepts; Learning biology; Metaphor; Perception

Introduction

The learning process has an important role in developing students' overall potential through diverse learning experiences. One of the important learning processes is the development of students' ability to process information and meaning-making (Hogan & O'flaherty, 2021). This ability is supported by comprehension of concepts in various disciplines. However, in Biology classrooms, teachers often face hardships in teaching abstract and complex biology concepts which increase cognitive load and hinder students' cognitive process for meaning-making (Albus et al., 2021). The high cognitive load in the learning process would lead to stress and anxiety for students and potentially results in low learning quality wherein students are not able to retain knowledge from the learning (Tarnng et al., 2022). While this is the case, building on cognitive linguistic principle, the use of metaphor has been widely discussed to present and

deliver abstract and complex concepts (Stylianou et al., 2013). A metaphor is defined as a semantic that maps the characteristics of a source domain to a target domain (Presmeg, 1998). Usually, the source domain is a concept that is already familiar while the target domain is a concept to understand. To put it simply, the use of metaphors relates an unfamiliar concept to a more familiar concept based on similar characteristics which renders abstract concepts concrete leading to a deep understanding (Jahic Pettersson et al., 2020). Additionally, the process of comparing and contrasting characters to create a metaphor for an object would improve critical and creative thinking (Martin et al., 2000). Considering the potential to increase learning quality, the use of metaphors has been applied in various disciplines e.g., in the mathematics (Doğan & Sönmez, 2019), in Indonesian (Neal-Smith et al., 2023; Veliz & Véliz-Campos, 2022), in music (Hsu & Chiang, 2022) and in fisheries science (Margariti et al., 2022). This

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shows how the use of metaphor is applicable to various disciplines.

In regard to learning biology, the use of metaphors has been widely studied since the discipline covers fundamental concepts of life and organisms. For this reason, the use of metaphors in learning biology covers more than only the rhetorical use of language but also building connections between abstract and complex biology concepts with daily experiences of more familiar concepts for students (Hellsten & Nerlich, 2011). In other words, the use of metaphor in biology should not be limited to representing unfamiliar concepts with a more familiar concept but also involves the process of contextualizing concepts by relating to students' past experiences or knowledge. The process of contextualization supported by the natural characteristic of metaphors would potentially help students to construct strong mental images of the biology concept as well as decrease the cognitive load in the process of learning. This way, the use of metaphors in biology not only facilitates students in understanding complex and abstract biology concepts but also enables students to connect various concepts leading to a deep understanding of scientific phenomena.

However, despite having the potential to deliver effective biology teaching, the role and effect of metaphor have not been widely investigated (Lancor, 2015). Jahic Pettersson et al. (2020) warn that the use of metaphors may lead to implications attributed to diverse learning contexts, students' characteristics and the nature of biology concepts. Therefore, in light of the potentials and limitations, the discourse on the use of metaphors in biology learning is heavily relevant to the comprehensive development of effective and innovative teaching approaches highlighting the importance of effective information delivery methods for students' understanding. For that reason, this study aims to investigate teachers' and students' perceptions of the use of metaphors in learning biology. By analysing teachers' and students' perceptions, this study wishes to present information on how metaphors and may influence learning experiences and concept comprehension in learning biology. The result of this study would be referred to define how to best utilizing metaphors in learning biology at all school levels to enhance students' learning.

Method

As an initial stage of a research project, this study collects qualitative data using Focus Group Discussion with an expert group (Tumen Akyildiz & Ahmed, 2021) and individual interviews. The reasons for using the methods are mention as follows: (1) socialization of the

research topic, aiming to collect suggestions from future respondents about the theme and research question proposed for designing better research design for the following stage of the project, (2) group interaction which covers direct interaction between group members having similar experiences and perceptions about metaphors in learning biology This interaction is important to gather and connect various ideas related to using metaphors in practice. (3) manageable time allocation and resources by collecting diverse ideas and insights in one session.

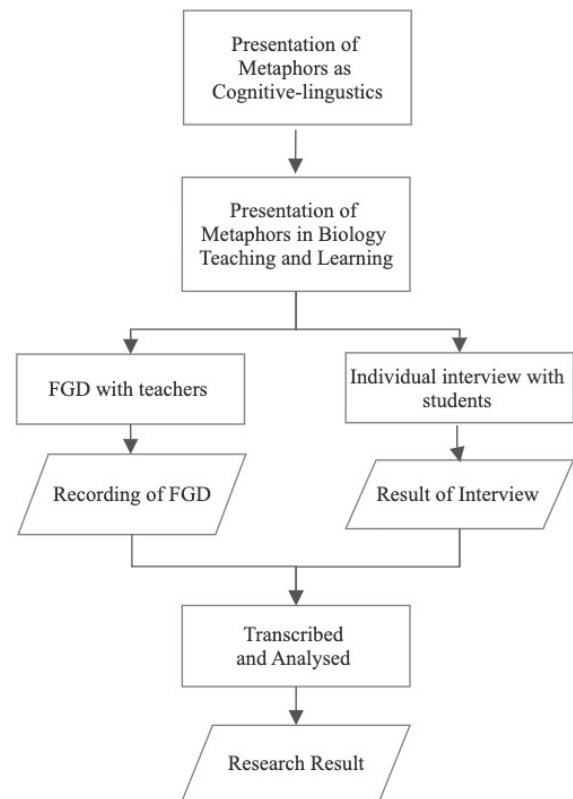


Figure 1. Research steps focus group discussion

The teachers' and students' opinions and responses about the use of metaphors in learning biology collected from the FGD and interview were transcribed and analyzed provide a deeper understanding of the role of metaphors for learning concepts in classroom practice. The respondents of this study are 30 biology teachers and 71 students from three districts namely *Kuningan* Regency, *Cirebon* Regency, and *Majalengka* Regency. The FGD was conducted with teachers with a minimum of five years' experience in teaching biology while the interview was conducted to collect opinions of students learning in Grade 12.

With regard to the method, the instruments used in this study are a discussion guide and an interview guide consisting of open questions that encourage discussion and reflection by the respondents. The questions cover

items related to the use of metaphors, the effectiveness of using metaphors, and the interest in using metaphors in biology. The step of obtaining the data is shown in Figure 1 while the documentation of the process is presented in Figure 2, Figure 3, and Figure 4.



Figure 2. The presentation of metaphors in biology teaching and learning (source: team research documentation)



Figure 3. The process of teacher's focus group discussion (source: team research documentation)



Figure 4. The process of teachers' individual interviews (source: Team research documentation)

The results of FGD and interviews were transcribed and analyzed inductively where the code is identified from frequent words or phrases in respondents' answers (Nyumba et al., 2018). This method aligns with the research questions that aim to interpret teachers' and

students' answers related to metaphors in learning biology. The result of this study would be then utilized to design effective pedagogical steps to facilitate deeper understanding as well as sustainable and effective biology teaching and learning.

Result and Discussion

The use of Metaphors in Learning Biology

The results of FGD and interviews reveal that both teachers and students' express difficulty not only in understanding concepts but also in using scientific names and subject-specific language in teaching and learning biology. This is because biology is the discipline that covers difficult concepts to be understood by students due to non-observable biological processes (e.g., cell division and protein synthesis) (Wang et al., 2007; Yang et al., 2019). Moreover, the biological system is essentially complex due to functional tissues that interact differently with diverse components and processes at different levels of organization to maintain the growth, development, and reproduction potential of an organism (Martin et al., 2000; Subramaniam, 2014). In relation to learning biology in the classroom, the topic of cells and genetics is frequently mentioned as the hardest topic by teachers and students. The teachers state that the difficulty is attributed to the abstract concept due to non-observable phenomena. Meanwhile, students attribute the difficulty to the number of interrelated elements to memorize. This is explained by previous study stating that abstract concepts commonly are interrelated; therefore, an understanding of a concept is more likely needs understanding from a number of other related concepts which leads to a challenge for both teachers and students especially when there is insufficient learning media support (Doyan et al., 2018; Fajriyanti & Sayekti, 2022; Laelandi et al., 2022; Wang et al., 2007). When introduced to the concept of metaphors to translate abstract and complex concepts into more familiar concepts, the teacher and student respondents responded positively to the use of metaphors in biology learning. For instance, at the beginning of the FGD and interview sessions, an example of the use of "life recipe" as a metaphor for DNA was presented. Considering that the topic of cells is one of the topics deemed to be difficult, teachers and students were enthusiastic with the example of the metaphor to help understand abstract and complex concepts like DNA. Teachers expressed that the use of metaphors potentially makes the teaching and learning process more interactive and interesting. Moreover, the process also enables teachers to build communication and involve students in constructing knowledge leading to a more meaningful learning experience. This perception aligns with the study by

Shaw et al. (2008) and Stylianou et al. (2013) stating that teachers become more confident in teaching using metaphor due to flexibility in explaining concepts as well as involving students in the learning process.

Additionally, students agree that the use of metaphors makes them interested in being actively involved in making metaphors for learning scientific concepts since students enjoy relating unfamiliar concepts to familiar concepts. Hellsten et al. (2011) and Kupferman (2018) explain that metaphor which is a process of using familiar words and phrases is able to influence perception and students' affective when learning abstract and difficult concepts. The engagement in the process of contextualizing abstract concept lowers students' cognitive load to store information and help them to modify their understanding of the concept leading to a more comprehensive understanding. Thus, it can be implied that the teachers and students perceive the use of metaphor as a potential tool to increase students' engagement attributed to interesting and interactive learning leading to better concept comprehension and meaningful learning.

Effectiveness of Using Metaphors

The data about the effectiveness of metaphors from teachers and students shows that most teachers and students predict that the use of metaphors is able to help the process of biology learning. Some teachers stated that they have applied metaphors in the classroom aiming for students to pay attention to the learning process and increase students' active involvement to implement the concept in daily life. Teachers stated that students are more interested in learning a concept when the concept is delivered in a storyline with familiarity with daily life experiences. However, teachers also stated that the use of metaphors is not applicable to all concepts due to the risk of misconception and ambiguity without a proper metaphor. Moreover, teachers reveal that the use of metaphors may simultaneously also develop students' critical thinking skills since students need to do critical and creative thinking for meaning-making and contextual thinking in processing the metaphors. Likewise, (Abawy, 2013; Afrannisah et al., 2021; Pradana et al., 2020) agrees that metaphor can be used as a thinking tool for students because it guides learners to visualize and summaries essential ideas into a more familiar concept that is easier to understand.

Likewise, based on the results of the interview, most of the students stated that the use of metaphors in biology classrooms would be effective in facilitating thinking. However, students also warn that the metaphors used should be relevant to the concept to avoid misconception and confusion. While students are still confused between metaphors and analogy since the

term analogy is more familiar to them, after an explanation of metaphors, students are optimistic about the effectiveness of using metaphors for understanding difficult and complex concepts especially when the metaphors are presented in a creative and interesting way. Students also express their willingness to do independent study when the topic is presented in interesting and accessible media. This aligns with a study about visual metaphors stating that the effectiveness of the use of metaphors in biology learning is based as well with the way the teachers deliver the metaphors and how far the metaphors suit students' level of understanding (Bravo & Bohemia, 2021; Margariti et al., 2022). Besides, students might also have different preference for learning thus the teachers need to try different approaches to know what work best for their classes (Matahari et al., 2023; Ovbiagbonhia et al., 2019; Rasmi et al., 2023; Wang et al., 2007). Therefore, this study concludes that the use of metaphors might effectively facilitate deeper concept understanding due to the critical and creative thinking process involved if only the use of metaphor considers the risk of ambiguity and the diverse students' learning preferences.

Interest in Using Metaphor

In regard to the interest in using metaphors, from the FGD result, teachers showed high interest in trying to use metaphors in their teaching. The teachers stated that the use of metaphors is interesting because the use of metaphors can help them translate difficult scientific terms into more understandable terms. Additionally, teachers believe that the use of metaphors can bridge the topic of discussion to students' initial knowledge. However, the use of metaphors should pay attention to the concept construction to avoid misconception.

The interest in using metaphors is also related to the easiness in choosing a learning model or strategy that is interactive and supportive to develop students' reasoning skills and literacy which is highly related to the *Merdeka* Curriculum (the latest Indonesian National Curriculum). Therefore, this study concludes that the use of metaphors enables teachers to be more creative in delivering science topics, and makes the learning process more interesting for both students and teachers. Thus, the use of metaphors not only potential to improve students' understanding, but also make learning interesting and relevant. It is also asserted that the use of metaphor provides significant influence in facilitating students' understanding, helps students to mitigate the problem in learning, and encourage teachers to be more creative in delivering concept leading to innovative teaching (Allolangi & Kurniati, 2023; Gruyter, 2003; Hellsten & Nerlich, 2011; Hogan & O'flaherty, 2021;

Nursamsu & Rachmatsyah, 2021). Thus, metaphor has significant potential to increase learning quality.

Meanwhile, based on the interview with students, students also respond very positively to the use of metaphors for learning biology concepts. They state that metaphors can reduce the stress of learning difficult topics. They also state that metaphors would provide them with joy in learning biology which is heavy with concepts that need to be memorized. In relation to the use of metaphors, students state that metaphors are essentially present in daily and casual communication; however, students are not yet familiar with how to use metaphors to support learning. Nevertheless, students believe that the use of metaphors will always relate to their experiences. From the interview, this study concludes that students are interested in using metaphors to learn because they see the potential of metaphors to make learning more interesting and decrease their stress to memorize all biology concepts. The metaphors also serve as a foundation to construct mental framework that would ease the process of connecting new concepts with memorized concepts. This statement is supported by past research stating that metaphor can bridge between culture and concept comprehension, and provide insight on how student process information, connects concepts, and develop concept understanding (Bravo & Bohemia, 2021; Brdar & Brdar-Szabó, 2020; Capriconia & Mufit, 2022; Lancor, 2015). Based on the result of the research, it can be implied that teachers and students have varied perception about the use of metaphors in learning biology. Overall, they focus on the effectiveness of using metaphors for learning difficult concepts that would maintain students' motivation in learning biology. Overall, both students and teachers respond positively to the use of metaphors in biology learning especially in relation to improving students understanding, student's interest in biology and increasing learning quality for subjects with abstract concepts.

Conclusion

Based on the result of this research, the use of metaphors receives positive responses from teachers and students. Teachers realize that metaphors help to deliver complex concepts in a way that is easy to understand by students. Teachers perceive metaphors as a tool to increase creativity in teaching and make learning more interesting. Meanwhile, students perceive metaphors as a tool to help them with concept understanding, increase interest to biology, and make learning more relevant. The interest in using metaphors is reflected in their understanding of the effectiveness and benefits of using metaphors therefore the use of

metaphors can be a potential strategy to increase learning quality in biology learning.

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Author Contributions

A.F.H, Z.A and I.S devised the project, the main conceptual ideas and proof outline.; A.F.H and I.S methodology. ; A.F.H, I.S, and Z.A validation and formal analysis.; I.S, A.A investigation.; I.S, L.K data curation.; A.A, L.K, A.F.H, I.S and Z.A.; writing – original draft preparation, A.F.H and I.S; writing – review and editing, Z.A.; visualization, A.F.H.; supervision, Z.A.; project administration, I.S.; funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest and the funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results”.

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