Inornatus: Biology Education Journal
Volume 5, Issue 1 (2025): 48 – 63
DOI: 10.30862/inornatus.v5i1.833

The effect of the make a match learning model assisted by picture card media on students' cognitive learning outcomes in the human respiratory system topic

Feby Firmilia Dewi[1], Nanda Eska Anugrah Nasution[1,*], Chairany Rizka[2]

[1]Program Studi Tadris Biologi, UIN Kiai Haji Achmad Siddiq Jember, Indonesia
[2]Program Studi Tadris Biologi, Universitas Islam Negeri Sumatera Utara, Indonesia

*Corresponding author, email: nsteska@gmail.com

Submitted: 13-01-2025

Accepted: 22-02-2025

Published: 27-02-2025

Abstract: Biology education is essential for enhancing students' comprehension of intricate scientific topics and their practical applications. However, conventional teacher-centered approaches at MAN 2 Probolinggo City have led to diminished student involvement and inadequate cognitive learning outcomes, especially for the human respiratory system topic. This study aimed to assess the effectiveness of the Make a Match learning model, supplemented with picture card media, in enhancing cognitive learning outcomes for 11th grade students. A quasi-experimental design with a posttest-only approach was employed, involving 36 students in the experimental group and 36 in the control group, where both groups had equivalent initial learning outcomes based on their teacher-assigned scores. Independent sample t-test results showed a statistically significant improvement in the experimental group (M=89.11,SD=6.093) compared to the control group (M=83.78,SD=6.339), p=0.001. The Make a Match model enhanced by the use of picture card media promoted active engagement, collaboration, and visual learning, with the visual representations of respiratory organs and their functions significantly aiding comprehension of the system's intricate concepts. The findings highlight the model's potential as a dynamic instructional method that can improve cognitive learning outcomes.

Keywords: Cognitive learning outcomes, human respiratory system, picture card media

Abstrak: Pendidikan biologi sangat penting untuk meningkatkan pemahaman siswa terhadap topik-topik ilmiah terkai makhluk hidup dan lingkungannya serta penerapannya dalam kehidupan sehari-hari. Namun, pendekatan konvensional yang berpusat pada guru di MAN 2 Kota Probolinggo menyebabkan rendahnya keterlibatan siswa dan hasil belajar kognitif yang tergolong butuh ditingkatkan, terutama pada topik sistem pernapasan manusia. Penelitian ini bertujuan untuk mengevaluasi efektivitas model pembelajaran *Make a Match* yang dibantu dengan pemanfaatan media kartu bergambar dalam meningkatkan hasil belajar kognitif siswa kelas XI. Penelitian ini menggunakan desain kuasi-eksperimen dengan pendekatan *posttest-only*, melibatkan 36 siswa dalam kelompok eksperimen dan 36 siswa dalam kelompok kontrol, di mana kedua kelompok memiliki hasil belajar awal yang setara berdasarkan nilai yang diberikan guru. Hasil uji t independen menunjukkan peningkatan yang signifikan pada kelompok eksperimen (M=89,11; SD=6,093) dibandingkan dengan kelompok kontrol (M=83,78; SD=6,339), p=0,001. Model pembelajaran *Make a Match* yang dilengkapi dengan media kartu bergambar meningkatkan keterlibatan aktif, kolaborasi, dan pembelajaran visual, di mana representasi visual organ pernapasan dan fungsinya secara signifikan membantu pemahaman konsep-konsep kompleks pada materi tersebut. Temuan ini menunjukkan potensi model ini sebagai metode pembelajaran yang dinamis untuk meningkatkan hasil belajar kognitif siswa..

Kata kunci: Hasil belajar kognitif, sistem pernapasan manusia, media kartu bergambar

INTRODUCTION

Education is a critical component of the growth and advancement of any nation (Harahap et al., 2019; N. E. A. Nasution & Sofyan, 2024; Pranoto et al., 2023; Sanga & Wangdra, 2023; Sarwar et al., 2021). In accordance with the objectives of national development to improve the quality of life for all Indonesian citizens and establish a modern society governed by Pancasila, high-quality education is essential for the development of competent and productive human resources. Law on the National Education System (Undang-undang Republik Indonesia, 2003) posits that the purpose of national education is to cultivate the nation's civilization and develop the capabilities and character of its citizens. This necessity highlights the importance of effective learning processes in schools, where students acquire not only subject-specific knowledge but also essential life skills.

Learning in schools is anticipated to contribute to the development of competencies that improve societal life, cultivate character, and advance the nation, as a result of this legal foundation. The goal is for students to develop into responsible, independent, intelligent, noble, and devout citizens (Abidin, 2019; Nasution et al., 2023, 2024; Ratnaningrum, 2022; Sukatin et al., 2023). In biology, a discipline that is intimately associated with human life, plays a significant role. The objective of biology education is to cultivate responsible behavior, values, and competencies in relation to society and the environment (Andriani & Jumala, 2023; Irawati et al., 2024). It is an essential element of science education in institutions, covering a wide range of concepts and factual information.

The objective of science education is to facilitate the application of students' knowledge in their daily lives (Kwangmuang et al., 2021; Widya et al., 2019). Nevertheless, the quality of education in Indonesia has encountered substantial obstacles in recent years (Jhon et al., 2021; Mutohhari et al., 2021), underscoring systemic issues that have resulted in suboptimal educational outcomes. These obstacles require a focus on the most critical components of educational implementation, such as inputs, processes, and outputs. To guarantee successful learning experiences, it is imperative to have high-quality inputs, engaging and effective processes, and impactful outputs. Students' cognitive learning outcomes are a critical output measure that reflect their comprehension, conduct, and abilities as assessed by academic institutions (Rao, 2020; Sıburıan et al., 2019).

On June 5, 2023, observations at MAN 2 Kota Probolinggo demonstrated that the teaching of biology frequently employs teacher-centered models, including lectures, which are supplemented by textbooks. However, this conventional model has failed to effectively engage students, as numerous students were observed to be dozing during lessons, disregarding explanations, or using devices instead of actively participating in class. Consequently, students encountered challenges in comprehending the material when they attempted to engage in discussions or practice queries. Many students score below the minimum competency criteria, indicating a lack of engagement and comprehension in their cognitive learning outcomes. The lecture method has been predominantly used by teachers

across various topics, including the locomotor system and the human respiratory system. However, periodic assessments reveal that students struggle to achieve satisfactory results, particularly in more conceptually dense subjects. For instance, on the locomotor system topic, four out of five students who took the periodic test attained an average score of 75, which is considered low. Similarly, in the previous academic year, students' average scores for the human respiratory system topic were also below the minimum competency criteria, indicating persistent learning difficulties. Given these challenges, this study specifically focuses on improving learning outcomes for the human respiratory system topic to explore more effective instructional strategies that enhance student engagement and comprehension.

The pressing need for innovative teaching models that can enhance the cognitive learning outcomes of students and transform the learning environment is underscored by the observed issues. A learning model that is interactive, pleasant, and engaging is necessary to improve the comprehension and participation of students (Mandasari & Wahyudin, 2021; Marougkas et al., 2023). As they prioritize active student engagement and the application of higher-order reasoning abilities, cooperative learning models present a promising solution (Chan et al., 2019; Qureshi et al., 2023). Among the numerous cooperative learning models, the Make a Match (Mam) model is distinguished by its capacity to establish a student-centered and dynamic learning experience (Khakim et al., 2019; Kusumaningtyas & Mirtasari, 2024; Sartika et al., 2024; Wibowowati, 2022).

In a cooperative learning strategy known as the MaM model, students are required to match cards that contain queries with their corresponding answers within a predetermined timeframe (Khakim et al., 2019; Wibowowati, 2022). Active engagement and collaboration among students are also fostered by this model, which also reinforces conceptual understanding (Kusumaningtyas & Mirtasari, 2024; Sartika et al., 2024). Recent research has demonstrated the effectiveness of the MaM model in enhancing the cognitive learning outcomes of students (Khakim et al., 2019; Sartika et al., 2024; Wibowowati, 2022). Previous research, including that conducted by Gosachi & Japa (2020), Syahriani & Hasruddin (2024), and Tania (2023), has shown that the implementation of the MaM model with supporting media, such as image cards or animation media, significantly enhances students' academic performance. Gosachi & Japa (2020) discovered that the model significantly improved mathematics learning outcomes. In the same vein, Tania's research indicates that the cooperative MaM model with picture card media substantially enhanced the learning outcomes of fifth-grade students in mathematics.

The MaM model's efficacy is rooted in constructivist learning theories, which underscore the significance of social interaction and active engagement in the learning process. Vygotsky's social constructivism emphasizes the importance of collaborative learning, in which pupils develop knowledge through peer interactions (Erbil, 2020; Adams & Hamm, 2019). The MaM model is consistent with this theory in that it encourages collaboration and communication among students as they collaborate to match cards.

Additionally, Piaget's cognitive development theory endorses the implementation of active learning strategies that require students to apply, evaluate, and analyze their knowledge (Fryirs, 2022; Waite-Stupiansky, 2022), as exemplified by the MaM activities.

The MaM model's capacity to enhance cognitive learning outcomes and encourage active participation is emphasized by these findings, particularly when combined with visual aides (Citra et al., 2023; Mashuri et al., 2021; Meilani & Aiman, 2021). Students are motivated to actively participate in the material, collaborate with their classmates, and cultivate their problem-solving abilities due to the interactive nature of the model. In addition, the gamified components of the model foster a competitive and enjoyable learning environment, which incentivizes students to maintain their concentration and achieve satisfactory results. However, the MaM model requires the use of picture media to optimize its effectiveness, as visual aids help students better understand abstract concepts, reinforce memory retention, and facilitate the matching process during learning activities.

Picture card media integration further enhances the model's efficacy by offering visual representations of concepts, thereby making the learning process more engaging and accessible (Endrawati et al., 2024; Febriyanty et al., 2024; Wahyudi, 2024). For instance, students may be able to more effectively comprehend and visualize intricate biological processes by utilizing image cards that illustrate the functions of respiratory organs during the examination of the human respiratory system.

In the specific context of biology education at MAN 2 Kota Probolinggo, the MaM model provides a potential remedy to the observed challenges. Through the transition from teacher-centered lectures to student-centered activities, the model may encourages students to actively participate in their own learning. Using picture card media also may improves the visual and interactive components of the lessons, rendering abstract concepts more tangible and simpler to understand. Students can, for example, reinforce their comprehension by matching cards that depict the structure of alveoli with their functions. This is achieved through a hands-on activity.

It is planned that the Make a Match model will be implemented at MAN 2 Kota Probolinggo to enhance the cognitive learning outcomes of students. The model can assist students in surmounting the obstacles they encounter in comprehending the human respiratory system. The objective of this research is to examine the influence of the Make a Match learning model, which is facilitated by picture card media, on the cognitive learning outcomes of students in the human respiratory system topic at MAN 2 Kota Probolinggo. This study aims to offer insights into effective instructional strategies by addressing the challenges in traditional biology teaching and employing an innovative models. It is anticipated that the results will provide educators with valuable information and facilitate the improvement of teaching practices in the field of biology education.

METHOD

This study used a quantitative quasi-experimental research design to investigate the effect of the Make a Match (Mam) learning model assisted by picture card media on students' cognitive learning outcomes in the human respiratory system topic. The research was carried out using a non-equivalent group posttest-only design, which involved two groups: an experimental group that received instruction using the MaM learning model with picture card media and a control group that was taught using conventional teaching models. The posttest-only design was chosen to focus on the students' cognitive learning outcomes after the intervention without including a pretest, thus avoiding potential biases that could arise from pretest exposure.

The population for this study comprised all 11th grade science students at MAN 2 Kota Probolinggo in the academic year 2023/2024. The population included five classes, each consisting of 36 students, for a total of 180 students. From this population, purposive sampling was employed to select two classes based on their similar academic abilities, particularly their average scores on a prior unit test covering the locomotor system. The XI IPA 5 class was designated as the experimental group, while XI IPA 3 served as the control group. Both classes had an identical average score of 82.5, ensuring comparable initial cognitive abilities between the two groups. This sampling strategy was further reinforced by recommendations from the biology subject teacher, confirming the suitability of these classes for the study.

Data collection in this study was conducted using testing. A multiple-choice test was designed, consisting of 30 questions developed from the curriculum indicators for the human respiratory system. These questions were crafted to assess various cognitive levels, ranging from simple recall (C1) to complex creation (C6), as outlined in the revised Bloom's Taxonomy (Anderson et al., 2001). To ensure the validity and reliability of the test, a rigorous instrument validation process was conducted. Out of the 30 initial questions, 25 were deemed valid through a Pearson correlation analysis, while the remaining five were discarded due to failing to meet the statistical significance threshold. The reliability of the test was confirmed using Cronbach's Alpha, which yielded a coefficient of 0.885, categorizing the instrument as highly reliable. The posttest was administered to both groups at the end of the intervention to measure the impact of the instructional models on students' cognitive learning outcomes.

The scoring criteria for the cognitive learning test were designed to reflect students' mastery of the material. Each correct answer was awarded four points, with no penalties for incorrect responses. The maximum possible score was 100, derived from 25 questions multiplied by the highest score per question. Scores were categorized into five levels: Excellent (86–100), Good (71–85), Fair (56–70), Poor (41–55), and Very Poor (<41). This scoring system facilitated the classification of students' cognitive achievements and provided a clear framework for analyzing their performance.

The data analysis in this study utilized both descriptive and inferential statistical methods. Descriptive analysis was employed to summarize the dataset, while inferential analysis was conducted to evaluate the study's hypotheses. Before hypothesis testing, prerequisite tests were performed to ensure data validity. The Kolmogorov-Smirnov test was used to assess data normality, applying a significance threshold of 0.05; data were considered normally distributed if the p-value exceeded this threshold. Variance homogeneity between the experimental and control groups was examined using Levene's test, also at a 0.05 significance level, where variances were deemed homogeneous if the p-value exceeded 0.05.

After confirming the prerequisites, hypothesis testing was conducted using an independent-sample t-test to compare the mean posttest scores between the experimental and control groups. The alternative hypothesis (Ha) proposed that a significant difference existed, indicating that the experimental group achieved higher scores than the control group. The hypothesis was tested at a 0.05 significance level, and the null hypothesis was rejected if the p-value was below 0.05, signifying a statistically significant difference between the two groups.

The MaM learning model is an active learning strategy that involves matching cards containing questions and answers or concepts and their explanations. In this study, the model was enhanced with picture card media to make the learning process more engaging and visually stimulating. The experimental group participated in learning activities where students were tasked with finding matching pairs of picture cards under timed conditions. This model was designed to promote active participation, collaboration, and deeper cognitive engagement with the material. The control group, on the other hand, experienced traditional instructional models, primarily consisting of lectures and note-taking, without the interactive or visual components provided by the MaM model.

RESULTS AND DISCUSSION

The results of the cognitive learning outcomes post-test analyzed using the Kolmogorov-Smirnov test, which revealed that the data for the two classes normally distributed (Control Class Sig = 0.118 > 0.05; Experiment Class Sig = 0.081 > 0.05), and also analyzed using the Levene's test for homogeneity, which revealed that the data for the two classes homogeneous (Sig = 0.869 > 0.05), displayed in Table 2. Mean and standard deviations of cognitive learning outcomes post-test scores displayed in Table 1.

Table 1. Mean and standard deviations of cognitive learning outcomes post-test scores

Class	N	Mean	Std. Deviation
Experiment Class	36	89.11	6.093
Control Class	36	83.78	6.339

As displayed in Table 1, the students in Experiment Class had a higher cognitive learning outcomes post-test score ($\bar{X}$=89.11, SD=6.093) than students in control Class ($\bar{X}$=83.78, SD=6.339). We used parametric methods to determine if the cognitive learning outcomes of the two classes differed significantly after the treatment was administered. The independent sample t-test result of cognitive learning outcomes posttest displayed in Table 2.

Table 2. The independent sample t-test result of cognitive learning outcomes posttest

	Levene's Test for Equality of Variances		**t-test**			
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**
Equal variances assumed	0.027	0.869	- 3.639	70	0.001	-5.333

As shown in Table 2, the obtained p (0.001) is smaller than 0.01. Thus, the test is significant at 0.01 level. This means that there is a significant difference of cognitive learning outcomes post-test result between the two classes, experiment class and control class.

The results of this study demonstrated that the Make a Match (Mam) learning model assisted by picture card media significantly improved students' cognitive learning outcomes in the human respiratory system topic. The posttest analysis revealed that students in the experimental group, who were taught using the MaM model assisted by picture card media achieved higher average scores compared to those in the control group who were taught using conventional models. Specifically, the experimental group attained an average score of 89.11, while the control group averaged 83.78. This difference was statistically significant, with a significance level of p=0.001 (less than 0.01). These findings underscore the effectiveness of the MaM learning model assisted by picture card media in enhancing students' cognitive achievements.

The MaM model consequently encourages active participation since students must identify matching pairs of cards carrying questions and answers or related concepts. This activity requires cognitive skills like observation, analysis, and decision-making. In contrast to passive listening in traditional teaching approaches, the MaM model involves students in a more active learning process. Matching cards requires physical movement, which helps kids retain their attention and concentrate, minimizing disengagement and boredom (Lhardy et al., 2022; Siburian et al., 2022).

The usage of image card media increased the MaM model's effectiveness. Picture cards give visual stimuli that aid students in comprehending abstract concepts more easily (Efendi, 2021; Palupi, 2020). In the human respiratory system material, the visual representation of organs, their architecture, and functions enhances comprehension of complex biological processes. The combination of visual and verbal information on the cards

accommodates to a variety of learning styles, especially for visual learners who may struggle with traditional text-based models. Furthermore, the use of colorful and engaging cards piques attention and motivation, making the learning process engaging and lasting (Syukri & Humaera, 2019).

Constructivist learning theories serve as the theoretical framework for this model's effectiveness. Vygotsky's social constructivism holds that meaningful learning is achieved through social contact and active engagement (Erbil, 2020; Adams & Hamm, 2019). The MaM model encourages student collaboration by having them work in pairs or groups to match cards, debate concepts, and clear up any misunderstandings. This peer contact not only enhances individual learning but also encourages the growth of communication and collaborative abilities. Furthermore, Piaget's theory of cognitive development emphasizes the value of hands-on activities and active exploration in promoting deeper comprehension (Fryirs, 2022; Waite-Stupiansky, 2022). The MaM model supports these objectives by encouraging students to actively connect with the information through matching exercises that require reasoning and problem-solving.

The findings of this study align with previous research that emphasizes the advantages of interactive and visual learning methods. For example, Juwantika et al. (2021) found that the MaM approach considerably enhanced biology learning results compared to traditional techniques. Similarly, Nisa et al. (2022) discovered that integrating the MaM model with visual media improved students' comprehension of environmental concepts. These studies back up the current findings, indicating that the MaM model, especially when supplemented with visual aids, is an effective instructional technique for increasing cognitive learning outcomes.

While previous studies have demonstrated the benefits of the MaM learning model and the use of visual aids, this study introduces a unique approach by tailoring the model specifically to the complexities of the human respiratory system topic. Unlike prior research that applied the MaM model to general biology or environmental concepts, this study focuses on intricate physiological processes, requiring deeper conceptual understanding. Additionally, the picture card media in this research were designed with detailed illustrations and structured question-answer pairs that emphasize key respiratory functions, making abstract biological mechanisms more accessible to students. Compared to other active learning methods, such as Think-Pair-Share or Jigsaw, the MaM model offers a unique combination of cognitive challenge and physical engagement. While Think-Pair-Share encourages verbal discussion and peer explanation, and Jigsaw fosters collaboration through content division, MaM balances structured peer interaction with immediate feedback, ensuring students can quickly self-correct misconceptions. The movement involved in physically matching cards also helps sustain engagement, particularly for kinesthetic learners.

One of the MaM model's significant features is its capacity to address different learning dimensions, such as cognitive, emotional, and psychomotor domains (Khakim et al.,

2019; Kusumaningtyas & Mirtasari, 2024; Nasution et al., 2017; Sartika et al., 2024; Siburian et al., 2022; Wibowowati, 2022). While this study was primarily concerned with cognitive outcomes, the observed increases in student involvement and participation suggest possible benefits in affective and psychomotor domains as well. For example, the model's collaborative character promotes a healthy classroom climate by encouraging students to help and learn from one another. The physical activity of matching cards addresses the psychomotor domain, as students actively move and handle things, which can improve their kinesthetic learning experience.

Due to the subject matter's complexity, the MaM model was particularly useful while learning about the human respiratory system. Understanding the respiratory system necessitates a thorough understanding of the numerous interactions between structures and functions, as well as an examination of factors that influence respiratory processes. The MaM approach aids comprehension by breaking down the material into manageable components shown on individual cards. Students can concentrate on specific ideas, such as the function of the alveoli or the mechanics of breathing, before integrating them into a more comprehensive understanding of the system.

The interactive component of the model plays a crucial role in fostering an engaging and dynamic learning environment. By encouraging students to ask questions, seek clarification, and test their knowledge in real-time, the model promotes active participation and deeper cognitive engagement. For instance, when a student makes an incorrect match in a card-based activity, the immediate feedback they receive from peers or the teacher allows them to quickly recognize their mistake and correct it. This instant feedback loop not only helps solidify their understanding but also enhances their ability to reflect on their learning process. As errors are corrected and concepts are reinforced through multiple attempts, students develop greater confidence in their knowledge. This iterative trial-and-error approach closely aligns with Kolb's experiential learning theory, which emphasizes that meaningful learning occurs through a continuous cycle of direct experience, reflective observation, abstract conceptualization, and active experimentation (Almalag et al., 2022; Pamungkas et al., 2019). By engaging in hands-on activities, students are not merely passive recipients of information but are actively involved in constructing their own understanding, making the learning process more impactful and memorable.

Another key factor contributing to the effectiveness of the MaM model in this study is its alignment with Bloom's Revised Taxonomy (Anderson et al., 2001). The process of matching cards is not a simple rote memorization task but rather an activity that engages multiple cognitive domains. At the foundational level, students recall and comprehend key concepts, such as the names and functions of respiratory organs. However, as they progress, they begin to apply their knowledge, analyze relationships between concepts, and evaluate different possibilities, thus engaging in higher-order thinking. This structured cognitive progression ensures that students move beyond mere factual recall and develop essential

skills in reasoning, analysis, and problem-solving. The incorporation of such critical thinking exercises into the learning process is particularly valuable in modern education, where the ability to assess information critically and make informed decisions is indispensable. By integrating these principles, the MaM model not only enhances content mastery but also nurtures intellectual curiosity and independent thinking, which are essential for lifelong learning and academic success.

On the contrary, the control group's conventional teaching models were devoid of the interactive and engaging components of the MaM model. Despite the fact that lectures and note-taking are effective models of information transmission, they frequently fail to engage students in the student learning process (Hasanah, 2019; Kurniawati, 2022). In comparison to the experimental group, students in the control group may have had fewer opportunities to implement their knowledge, resulting in lower cognitive gains. Adopting innovative teaching strategies that prioritize student-centered learning is crucial, as this research points out.

These discoveries have substantial practical implications for educators, particularly those who instruct intricate scientific subjects such as the human respiratory system. The MaM model offers a straightforward yet effective models for transforming conventional instruction into a student-centered and interactive experience. Teachers can further improve the model's efficacy by incorporating visual aids such as picture cards, which make abstract concepts more engaging and accessible for students. Moreover, the collaborative and experiential nature of the model supports the development of essential 21st-century skills, such as critical thinking, teamwork, and communication, which are crucial for students' future achievements.

This study offers compelling evidence that the MaM learning model in conjunction with picture card media is a potent instructional strategy for enhancing the cognitive learning outcomes of students. The model's emphasis on visual learning, collaboration, and active engagement is consistent with established educational theories and accommodates the requirements of a wide range of learners. In addition to improving academic performance, the results underscore the potential of this model to improve the overall learning experience, motivation, and engagement. In order to establish a more dynamic and effective learning environment, educators are encouraged to incorporate and modify the MaM model into their classrooms. This study suggests that in the future, the MaM model can be integrated with various educational technologies, such as Google Classroom (Okoli & Ukala, 2025), WhatsApp (Okoli & Ukala, 2025), Quizizz (Wismiati et al., 2025), or other learning media that have been proven in previous studies to support students' biology learning. Utilizing these technologies can enhance the effectiveness of the MaM model by providing more flexible, interactive, and collaborative learning experiences.

However, this study has certain limitations, particularly the short implementation period, which may have influenced long-term retention and a deeper understanding of the

material. Teacher involvement, classroom conditions, and social factors such as student motivation and prior knowledge could have also influenced the results. Future research should explore longer-term applications, assess effectiveness in varied classroom settings, and investigate how different facilitation styles impact the learning process.

CONCLUSION

This study concludes that the Make a Match (MaM) learning model, supported by picture card media, is a highly effective method for improving students' cognitive learning results regarding the human respiratory system. The experimental group's notable performance enhancement relative to the control group illustrates the model's capacity to actively engage students, promote collaboration, and elucidate complicated material using visual aids. This model's compatibility with constructivist theories and Bloom's Revised Taxonomy underscores its pedagogical significance. The findings underscore the need for implementing interactive and student-centered learning paradigms to enhance academic performance and cultivate 21st-century competencies, positioning the MaM model as an invaluable asset for educators. However, the results of this research cannot be generalized to broader populations due to the purposive sampling method, which limits the study's external validity.

REFERENCES

Abidin, A. M. (2019). Penerapan Pendidikan Karakter pada Kegiatan Ekstrakurikuler melalui Metode Pembiasaan. *DIDAKTIKA : Jurnal Kependidikan*, *12*(2), 183–196. https://doi.org/10.30863/didaktika.v12i2.185

Adams, D., & Hamm, M. (2019). Collaborative learning. In D. Adams & M. Hamm, *Collaboration, communications, and critical thinking: A STEM-inspired path across the curriculum* (pp. 43–58). Rowman & Littlefield. https://s.id/3aIXX

Almalag, H. M., Saja, M., Abouzaid, H. H., Aljuffali, L., Alzamil, H., Almater, L., Alothman, L., & Alzamel, F. (2022). Evaluation of a Multidisciplinary Extracurricular Event Using Kolb's Experiential Learning Theory: A Qualitative Study. *Journal of Multidisciplinary Healthcare*, *Volume 15*, 2957–2967. https://doi.org/10.2147/JMDH.S389932

Anderson, L. W., Krathwohl, D. R., & Bloom, B. S. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. Pearson, Allyn & Bacon. http://books.google.com/books?id=JPkXAQAAMAAJ&pgis=1

Andriani, D., & Jumala, Z. (2023). Membangun Siswa Sadar Lingkungan Melalui Integrasi Pendidikan Lingkungan Hidup ke Dalam Pembelajaran IPA di SDN 1 Tegaldlimo sebagai Alternatif Mewujudkan Sekolah Bersih dan Hijau. *Indonesian Journal of Science Learning (IJSL)*, *4*(1), 48–60. https://jurnalftk.uinsa.ac.id/index.php/IJSL/article/view/2326

Chan, S. C. H., Wan, C. L. J., & Ko, S. (2019). Interactivity, active collaborative learning, and learning performance: The moderating role of perceived fun by using personal response systems. *The International Journal of Management Education*, *17*(1), 94–102. https://doi.org/10.1016/j.ijme.2018.12.004

Citra, I. W. Y., Fanani, A., & Rosidah, C. T. (2023). Aktivitas Guru dan Respons Siswa dalam Pembelajaran Menggunakan Model Make A Match Berbantuan Multimedia. *Progressive of Cognitive and Ability*, *2*(4), 327–337. https://doi.org/10.56855/jpr.v1i4.667

Efendi, M. A. (2021). The Use of Pictures as Media to Improve Students' Reading Comprehension. *Journal of English Teaching, Literature, and Applied Linguistics*, *2*(2), 84. https://doi.org/10.30587/jetlal.v2i2.2467

Endrawati, E., Ihlas, I., & Retnoningsih, R. (2024). Improving the Ability to Read Beginning through Picture Word Card Media in Children. *Waniambey: Journal of Islamic Education*, *5*(2), 330–345. https://e-journal.iainfmpapua.ac.id/index.php/waniambey/article/view/1296

Erbil, D. G. (2020). A Review of Flipped Classroom and Cooperative Learning Method Within the Context of Vygotsky Theory. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.01157

Febriyanty, Y., Suratno, S., & Widagdo, A. (2024). Development of Picture Word Card Media using Modeling the Way Method in Learning English Vocabullary to Improve Class 4 Learning Outcomes. *English Review: Journal of English Education*, *12*(3), 911–922. https://doi.org/10.25134/erjee.v12i3.10404

Fryirs, K. (2022). A pedagogy of fluvial geomorphology: Incorporating scaffolding and active learning into tertiary education courses. *Earth Surface Processes and Landforms*, *47*(7), 1671–1679. https://doi.org/10.1002/esp.5368

Gosachi, I. M. A., & Japa, I. G. N. (2020). Model Pembelajaran Make A Match Berbantuan Media Kartu Gambar Meningkatkan Hasil Belajar Matematika. *Jurnal Pedagogi Dan Pembelajaran*, *3*(2), 152. https://doi.org/10.23887/jp2.v3i2.25260

Harahap, F., Nasution, N., & Manurung, B. (2019). The Effect of Blended Learning on Student's Learning Achievement and Science Process Skills in Plant Tissue Culture Course. *International Journal of Instruction*, *12*, 521–538. https://doi.org/10.29333/iji.2019.12134a

Hasanah, S. U. (2019). Studi Komparasi Penerapan Metode Active Learning Model Reading Aloud Dan Metode Konvensional Model Ceramah Dalam Pembelajaran Bahasa Arab Dan Pengaruhnya Terhadap Respon Siswa Kelas V Mi Ma'arif 01 Pahonjean Majenang. *Jurnal Tawadhu*, *3*(1), 804–822. https://s.id/StudiKomparasi

Irawati, H., Aprilia, N., & Saifuddin, M. F. (2024). Literasi Lingkungan Mahasiswa Keguruan. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *7*(2), 91. https://doi.org/10.32502/dikbio.v7i2.5801

Jhon, W., Sugito, Zubaidah, E., & Mustadi, A. (2021). Challenges in the implementation of character education in elementary school: experience from Indonesia. *İlköğretim Online*, *20*(1). https://doi.org/10.17051/ilkonline.2021.01.130

Juwantika, I. C., Hendri, W., & Deswati, L. (2021). Pengaruh Penerapan Model Pembelajaran Kooperatif Tipe Make a Match untuk Meningkatkan Hasil Belajar Biologi Siswa di SMAN 4 Bukittinggi. *Jurnal Edukasi Dan Sains Biologi*, *3*(1), 8–13. https://doi.org/10.37301/esabi.v3i1.5

Khakim, M. A., Roesminingsih, M. V., Murigi, P. N., Suprijono, A., & Subroto, W. T. (2019). The Implementation of Cooperative Learning Make a Match to improve Social science learning activities and learning outcomes. *International Journal of Scientific and Research Publications (IJSRP)*, *9*(3), p8750. https://doi.org/10.29322/IJSRP.9.03.2019.p8750

Kurniawati, L. N. (2022). Meningkatkan Hasil Belajar Siswa pada Materi Perkalian Menggunakan Papan Perkalian. *PTK: Jurnal Tindakan Kelas*, *2*(2), 113–119. https://doi.org/10.53624/ptk.v2i2.52

Kusumaningtyas, D. A., & Mirtasari, S. (2024). Enhancing Elementary Students' Learning Interest in Science with the "Make-a-Match" Cooperative Learning Model. *International Journal of Learning Reformation in Elementary Education*, *3*(02), 80–89. https://doi.org/10.56741/ijlree.v3i02.552

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, *7*(6), e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

Lhardy, C., García-Ortega, H., Gracia-Mora, J., Marín-Becerra, A., Reina, A., & Reina, M. (2022). Unit Kemps: A Matching Card Game to Learn Physical Quantities, Units, and Symbols. *Journal of Chemical Education*, *99*(9), 3170–3176. https://doi.org/10.1021/acs.jchemed.2c00482

Mandasari, B., & Wahyudin, A. Y. (2021). Flipped Classroom Learning Model: Implementation and Its Impact on EFL Learners' Satisfaction on Grammar Class. *Ethical Lingua: Journal of Language Teaching and Literature*, *8*(1), 150–158. https://www.ethicallingua.org/25409190/article/view/234

Marougkas, A., Troussas, C., Krouska, A., & Sgouropoulou, C. (2023). Virtual Reality in Education: A Review of Learning Theories, Approaches and Methodologies for the Last Decade. *Electronics*, *12*(13), 2832. https://doi.org/10.3390/electronics12132832

Mashuri, I., Faishol, R., & Rofiq, A. (2021). Komparasi Hasil Belajar Siswa Kelas X MAN 2 Banyuwangi dalam Pembelajaran Materi Akidah Akhlak menggunakan Metode Pembelajaran Make A Match dan Picture and Picture. *INCARE, International Journal of Educational Resources*, *2*(1), 39–53. https://doi.org/10.59689/incare.v2i1.234

Meilani, D., & Aiman, U. (2021). Penerapan Model Pembelajaran Make A Match Berbasis 4C Berbantuan Media Kartu Bilangan untuk Meningkatkan Hasil Belajar Matematika di Sekolah Dasar. *Jurnal Basicedu*, *5*(5), 4146–4151. https://doi.org/10.31004/basicedu.v5i5.1522

Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, A. (2021). Difficulties in implementing 21st century skills competence in vocational education learning. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1229. https://doi.org/10.11591/ijere.v10i4.22028

Nasution, N. E. A., AlMuhdhar, M. H. I. A., Sari, M. S., & Balqis, B. (2023). Relationship between Critical and Creative Thinking Skills and Learning Achievement in Biology with Reference to Educational Level and Gender. *Journal of Turkish Science Education, 20(1), 66-83*. https://doi.org/10.36681/tused.2023.005

Nasution, N. E. A., & Sofyan, M. (2024). Development of Pisces Diversity E-Module based on Fish Identification Research in Plalangan Village, Jember. *Indonesian Journal of Mathematics and Natural Science Education*, *5*(1), 1–15. https://doi.org/10.35719/mass.v5i1.142

Nasution, N. E. A., Yasin, R., & Rizka, C. (2024). Development of An RPG Maker Mv-Based Interactive Game as Learning Media on Virus Materials for Grade X Students at Nurul Islam Jember Senior High School. *Jurnal Pendidikan Matematika Dan IPA*, *15*(3), 457. https://doi.org/10.26418/jpmipa.v15i3.74029

Nasution, N. E., Harsono, T., Rizka, C., & Almeda, R. (2017). The Effect of Index Card Match Model on Students Learning Outcomes and Activity in Ecosystem Topic for Grade X SMA N 8 Medan. *Journal of Education and Practice*, *8*(33), 68–74. https://www.iiste.org/Journals/index.php/JEP/article/view/39744

Nisa, Z. K., Muhibbuddin, Andayani, D., Huda, I., & Abdullah. (2022). Pengaruh Penerapan Model Pembelajaran Make A Match Dipadu dengan Media Gambar terhadap Hasil Belajar Siswa pada Materi Ekosistem di SMA Negeri 5 Banda Aceh. *Jurnal Ilmiah Mahasiswa Pendidikan Biologi FKIP USK*, *7*(3), 21–25. https://jim.usk.ac.id/pendidikan-biologi/article/view/21797

Okoli, J. N., & Ukala, G. (2025). Relative effectiveness of Google classroom and WhatsApp in enhancing biology interest among Nigerian university students. *Inornatus: Biology Education Journal*, *5*(1), 1-15. https://doi.org/10.30862/inornatus.v5i1.731

Palupi, A. N. (2020). Use of manipulative media as a stimulation of ability to understand the concept of early children's age. *Early Child Res J*, *3*(2), 41â. https://journals.ums.ac.id/ecrj/article/view/11414 Pamungkas, S. F., Widiastuti, I., & Suharno, S. (2019). Kolb's Experiential Learning as an Effective Learning Model in Creative Product and Entrepreneurship Subjects. *Journal of Mechanical Engineering and Vocational Education (JoMEVE)*, *2*(1), 27. https://doi.org/10.20961/jomeve.v2i1.28352

Pranoto, I., Ediantes, E., & Siahaan, V. D. (2023). Filsafat Pendidikan Sebagai Konsep Pengembangan Kurikulum Pendidikan Seni di Indonesia. *ENGGANG: Jurnal Pendidikan, Bahasa, Sastra, Seni, Dan Budaya*, *3*(2), 307–317. https://doi.org/10.37304/enggang.v3i2.8326

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, *31*(4), 2371–2391. https://doi.org/10.1080/10494820.2021.1884886

Rao, N. J. (2020). Outcome-based Education: An Outline. *Higher Education for the Future*, *7*(1), 5–21. https://doi.org/10.1177/2347631119886418

Ratnaningrum, W. A. (2022). Dasar-Dasar Yuridis Sistem Pendidikan Nasional. *Educational Technology Journal*, *2*(2), 22–28. https://doi.org/10.26740/etj.v2n2.p22-28

Sanga, L. D., & Wangdra, Y. (2023). Pendidikan Adalah Faktor Penentu Daya Saing Bangsa. *Prosiding Seminar Nasional Ilmu Sosial Dan Teknologi (SNISTEK)*, *5*, 84–90. https://doi.org/10.33884/psnistek.v5i.8067

Sartika, S. H., Harahap, R. I., & Sadiah, A. (2024). Enhancing economics learning outcomes through the make-a-match cooperative learning model. *Educenter : Jurnal Ilmiah Pendidikan*, *3*(1), 82–91. https://doi.org/10.55904/educenter.v3i1.1175

Sarwar, S., Streimikiene, D., Waheed, R., & Mighri, Z. (2021). Revisiting the empirical relationship among the main targets of sustainable development: Growth, education, health and carbon emissions. *Sustainable Development*, *29*(2), 419–440. https://doi.org/10.1002/sd.2156

Siburian, . . S. G. B. ., Marcella, M., Silalahi, D. E. ., & Pakpahan, C. . (2022). The Application of Index Card Matching Method in Improving Students' Listening Ability at First Grade of SMPN 1 Labuhan Deli. *Jurnal Pendidikan Dan Konseling (JPDK)*, *4*(5), 1897–1904. https://doi.org/10.31004/jpdk.v4i5.6879

Sıburıan, J., Corebıma, A. D., . İ., & Saptasarı, M. (2019). The Correlation Between Critical and Creative Thinking Skills on Cognitive Learning Results. *Eurasian Journal of Educational Research*, *19*(81), 99–114. https://dergipark.org.tr/en/pub/ejer/issue/45577/572934

Sukatin, S., Munawwaroh, S., Emilia, E., & Sulistyowati, S. (2023). Pendidikan Karakter dalam Dunia Pendidikan. *ANWARUL*, *3*(5), 1044–1054. https://doi.org/10.58578/anwarul.v3i5.1457

Syahriani, A., & Hasruddin, H. (2024). The effect of make-a-match learning assisted by animation media on students' higher-order thinking skills of human respiratory system material. *Inornatus: Biology Education Journal*, *4*(2), 103-112. https://doi.org/10.30862/inornatus.v4i2.659

Syukri, S., & Humaera, I. (2019). Gaining Motivation on English Learning for Special Need Students Using Flashcards, Foldable Books and Posters in EFL Context. *Langkawi:*

Journal of The Association for Arabic and English, *5*(2), 91. https://doi.org/10.31332/lkw.v5i2.1303

Tania, D. M. (2023). *Pengaruh Model Pembelajaran Kooperatif Tipe Make a Match Dengan Media Kartu Gambar Terhadap Hasil Belajar Matematika Peserta Didik Kelas V* [Unpublished Undergraduate Theses]. Universitas Lampung. Repository. https://digilib.unila.ac.id/71259/

Undang-undang Republik Indonesia. (2003). Undang-Undang Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional. Lembaran Negara Republik Indonesia Tahun 2003 Nomor 20. Retrieved from https://peraturan.bpk.go.id/details/43920/uu-no-20-tahun-2003

Wahyudi, A. (2024). Use of Picture Card Media to Improve Beginning Reading Skills of Elementary Students. *Journal of Childhood Development*, *4*(1), 154–160. https://doi.org/10.25217/jcd.v4i1.3971

Waite-Stupiansky, S. (2022). Jean Piaget's constructivist theory of learning. In L. P. Cohen & S. Waite-Stupiansky (Eds.), *Theories of early childhood education: Developmental, behaviorist, and critical* (pp. 3–18). Routledge. https://doi.org/10.4324/9781315641560

Wibowowati, L. (2022). Increasing Students' Interest and Learning Outcomes with the Make a Match Learning Model in Junior High School Physics Science Learning. *Impulse: Journal of Research and Innovation in Physics Education*, *2*(1), 16–26. https://doi.org/10.14421/impulse.2022.21.02

Widya, W., Rifandi, R., & Rahmi, Y. L. (2019). STEM education to fulfil the 21 st century demand: a literature review. *Journal of Physics: Conference Series*, *1317*(1), 012208. https://doi.org/10.1088/1742-6596/1317/1/012208

Wismiati, I., Suzanti, F., & Daryanes, F. (2025). Improving students' cognitive learning outcomes through quizizz learning media. *Inornatus: Biology Education Journal*, *5*(1), 37-47. https://doi.org/10.30862/inornatus.v5i1.735