MADAKO ELEMENTARY SCHOOL
VOL. 3 NO. 1 JUNE 2024; pp: 27-41
E-ISSN: 2964-5719

PROGRAM STUDI PENDIDIKAN GURU SEKOLAH DASAR (PGSD)
UNIVERSITAS MADAKO TOLITOLI
https://ojs.fkip.umada.ac.id/index.php/mes

The Effectiveness of Learning Sun Position and Shadow: *Picture and Picture Models* in Elementary Schools

[1] Marthazilla Febby Ahmad, [2] Ni'mah Fauziah, [3] Okta Rosfiani, [4] Saskia Rachman
[1] Universitas Muhammadiyah Jakarta, Indonesia, marthazillafebbyahmad@gmail.com
[2] Universitas Muhammadiyah Jakarta, Indonesia, nimahfauziah6103@gmail.com
[3] Universitas Muhammadiyah Jakarta, Indonesia, okta.rosfiani@umj.ac.id
[4] Universitas Muhammadiyah Jakarta, Indonesia, saskiarachman02@gmail.com

Article Info

Keywords:

Student Science Understanding; *Picture and Picture; Elementary School*

ABSTRACT

Science learning will always be relevant in developing students' science concepts that are measurable from the achievement of learning outcomes. The purpose of this study, designed with the classroom action research method, was to find out whether students' concepts of position and sun shadow material science improved by applying a picture and picture type cooperative learning model based on test analysis, documentation, observation, and field notes. Teachers and 26 grade II students of SDN Tanjung Barat 09 were involved in the research. The results of this study showed that the classical completeness of student learning outcomes became better from pre-cycle (42.30%), cycle-I (65.40%) to cycle-II (80.80%). This means that the application of the applied learning model helps students gain knowledge and understanding of science about the position and shadow material of the sun, which is part of the science material available in elementary schools. The contribution of the results then recommends teachers to maximize the application of the teaching model in strengthening students' understanding of science concepts regarding teaching material juxtaposed with the implementation of the model studied.

Informasi Artikel

Kata Kunci:

Pemahaman Sains Siswa; *Picture and Picture;* Sekolah Dasar

ABSTRAK

Pembelajaran IPA akan selalu relevan dalam mengembangkan konsep sains siswa yang terukur dari pencapaian hasil belajarnya. Tujuan penelitian ini, yang dirancang dengan metode Penelitian Tindakan Kelas (PTK), adalah untuk mengetahui apakah konsep sains materi posisi dan bayangan matahari siswa meningkat dengan menerapkan model pembelajaran kooperatif tipe *picture and picture* berdasarkan analisis tes, dokumentasi, observasi, dan catatan lapangan. Guru dan 26 siswa kelas II SDN Tanjung Barat 09 dilibatkan dalam penelitian. Hasil penelitian ini menunjukkan bahwa ketuntasan klasikal hasil belajar siswa menjadi lebih baik dari pra siklus (42,30%), siklus I (65,40%) ke siklus II (80,80%). Ini berarti bahwa penerapan model pembelajaran yang diterapkan membantu siswa memperoleh pengetahuan dan pemahaman sains tentang materi posisi dan bayangan matahari, yang merupakan bagian dari materi IPA yang tersedia di sekolah dasar. Konstribusi hasilnya kemudian merekomendasikan guru agar memaksimalkan penerapan model ajar tersebut dalam memantapkan pemahaman

konsep sains siswa mengenai materi ajar yang disandingkan dengan implementasi model yang diteliti.

Article History

Received : 23 January 2024
Revised : 25 April 2024
Accepted : 28 April 2024

✉ ***Corresponding Author:*** (1) Ni'mah Fauziah, (2) Pendidikan Guru Sekolah Dasar, (3) Universitas Muhammadiyah Jakarta, (4) Indonesia, (5) Email: nimahfauziah6103@gmail.com

How to cite:

Ahmad, M. F., Fauziah, N., Rosfiani, O. & Rachman, S. (2024). The effectiveness of learning sun position and shadow: Picture and picture models in elementary schools. *Madako Elementary School*, *3*(1), 27-41. https://doi.org/10.56630/mes.v3i1.229

INTRODUCTION

One of the main subjects taught at SDN Tanjung Barat 09 is the field of Natural Sciences. Science learning as a natural science learning concept that has a close relationship with human life (Lee et al., 2023). Of course, in exploring the concept of science depends on the results of empirical findings through the process of careful observation of a natural phenomenon (Coutinho & Almeida, 2014; Jagannathan et al., 2018). Success in teaching also depends on the competence played by the teacher in encouraging active participation of students in participating in every series of learning activities (Al-Hail et al., 2023).

The conceptualization of science teaching essentially helps students learn about themselves and the surrounding nature (Ruiz-Gallardo et al., 2011). They can also learn how to apply their scientific understanding in everyday life (Hamna & BK, 2023). In the teaching process in elementary schools, the results of teaching science concepts can be seen from changes in students' scientific mindsets. Mindset as a learning outcome in a broad sense will intersect with the development of students' science skills and science attitudes (Pratiwi et al., 2019).

Teaching science concepts will always require careful preparation from teachers, starting from preparing the material to be taught including determining qualified teaching strategies to teach clusters of material in science subjects (Koizumi, 2004). This readiness will always be at stake by teachers, in addition to adapting the pattern of presentation of their teaching to the support of existing facilities and infrastructure in schools (Yılmaz, 2021).

The application of the learning model is part of the strategy that must be matured by the teacher because it is a very important supporting component in the success of the learning objectives (Huang et al., 2020; Lijanporn & Khlaisang, 2015). There are several learning models that are recommended to be used in science learning, but the sorting and determination depends on the characteristics of the teaching material concept and student acceptance (Khan et al., 2022).

Departing from several previous studies, many views strongly support that success in teaching science concepts is determined in the application of learning models applied by teachers as in the results of research studies from Jundu et al. (2020) which concentrates the application of guided inquiry models in science teaching in disadvantaged areas, discovery learning models in science learning based on Tamansiswa teachings "*Tri Nga*" (Nurmawati et al., 2022), improving the concept of natural science through the example non example model (Pranoto, 2017), and the improvement can also be done through the inside outside circle model (Muyaroah, 2018).

There are even many previous studies that have discussed the effectiveness of picture and picture models in the development of science science, such as research that examines science learning achievement of elementary school students with picture and picture models (Marlina, 2020; Widyawati, 2019), increased motivation to learn science (Israil, 2019), Science learning outcomes increase as a result of implementing picture and picture models (Sriantini et al., 2021) and increased creative thinking skills (Lenggogeni & Roqoyyah, 2021), this model is also effective in improving the learning outcomes of material biology of the human reproductive system (Asmaniyah, 2022) and the material of human metabolism and its food digestive system (Zubaidah & Nurmaliah, 2015). A large number of researchers have examined the application of this model, but explicitly in teaching science concepts there is still less concentrated on teaching materials position and shadow of the sun. This material was chosen to answer the learning needs of students who are in the stage of concrete operational thinking, which sees everything as real so that students find the meaning of the material they learn. The meaning of learning will be known to children if what they learn has a connection with their lives, especially things that look visually concrete (Broca, 2023; Poinso et al., 2006; Zabalia, 2005).

The importance of strengthening students' understanding of science concepts in teaching the position and shadow of the sun material which is then taught based on the application of picture and picture models cooperatively is the main purpose of this research, so that it has implications for improving student science learning outcomes at SDN Tanjung Barat 09. The purpose of this study is also based on factual facts related to science learning conditions at SDN Tanjung Barat 09 after learning in class, with the position and shadow of the sun material, it was found that there were many students who had not mastered the subject matter. This is known from the average learning scores of students who have not reached the expected scores, even many of them still get scores below the minimum completeness criteria that have been determined.

The low science learning outcomes about the position and shadow of the sun material may be due to the fact that many students fail to understand what is conveyed by the teacher during learning activities. This may be due to the fact that the learning provided by the teacher is less interesting and is not supported by the effectiveness of the application of the learning model offered by the teacher. Misconceptions in teaching

science concepts are also a factor that causes low learning outcomes. The learning outcome in students is ultimately a change in behavior (Ackermann et al., 2024; Douma et al., 2024; Hamna & BK, 2023). It is hoped that the results of learning science will help students learn about themselves and the environment, as well as improve the application of the concept in everyday life.

The main contribution that is expected to occur after the application of this picture and picture model in teaching science concepts for the position and shadow of the sun is expected to help students learn to develop their science concepts which are reflected in cognitive, affective, and psychomotor aspects. Increased understanding of student concepts that can affect the improvement of science learning outcomes they learn. Although it is recognized that affective and psychomotor changes will occur during the learning process, but the focus of research is only to measure how effective the application of the model is from the point of view of students' cognitive understanding.

METHOD

This research is a type of classroom action research that aims to improve the learning process with a focus on achieving optimal, measurable, and high-quality learning outcomes (Sugiyono, 2011). The involvement of student subjects was taken from grade II SDN Tanjung Barat 09 which amounted to 26 students in semester 2 of the 2017/2018 academic year. Tests, observations, interviews, and documentation are given in each cycle, which includes planning, execution, observation, and reflection according to the Mc. Taggart version, to support the implementation of this research method. The cycle of learning improvement is carried out in one meeting. Researchers carry out these learning improvement activities with the help of their peers, who function as observers or supervisors. Cycle-I and cycle-II involve data analysis and interpretation of results. Based on the stages before the implementation of the cycle, initial observations were made on science learning carried out by grade II teachers of SDN Tanjung Barat 09.

The concept flow of implementing this classroom action research model is clear and easy to use, and makes it very easy to analyze the impact of the learning process that occurs. This makes it unique. Although this does not mean that other versions of the class action research model are unattractive, all versions of the model have certain advantages.

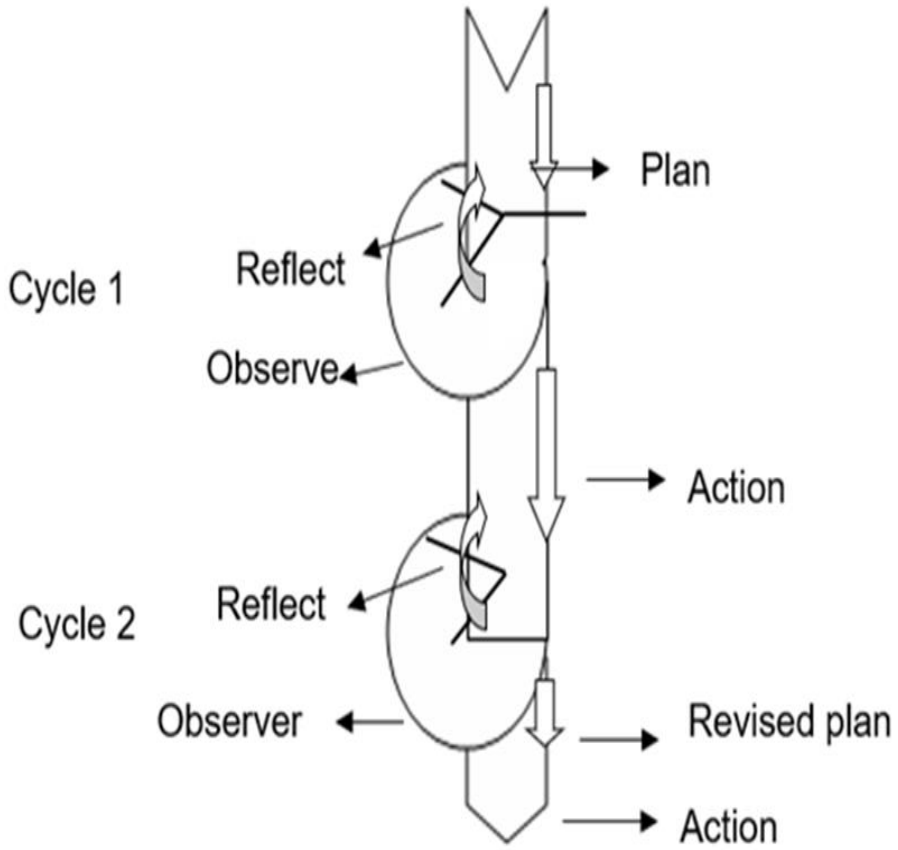

Figure 1. Kemmis and Mc. Taggart's Model Action Research Method (Boonchom et al., 2012)

RESULTS AND DISCUSSION

A. Result

The study included cycle-II, which began with pre-cycle learning. In each cycle, systematic planning is carried out with the aim of achieving learning outcomes in accordance with the minimum completeness criteria. The evaluation results of pre-cycle learning determine the next learning outcome.

Table 1. Students Science Initial Knowledge Test Results

Respondents	Number of Scores / Grades	Achieved / Not Achieved
RS_01	50	Not Achieved
RS_02	80	Achieved
RS_03	63	Not Achieved
RS_04	63	Not Achieved
RS_05	90	Achieved
RS_06	56	Not Achieved
RS_07	50	Not Achieved
RS_08	90	Achieved
RS_09	63	Not Achieved
RS_10	50	Not Achieved
RS_11	73	Achieved
RS_12	56	Not Achieved

RS_13	73	Achieved
RS_14	40	Not Achieved
RS_15	80	Achieved
RS_16	80	Achieved
RS_17	50	Not Achieved
RS_18	40	Not Achieved
RS_19	80	Achieved
RS_20	56	Not Achieved
RS_21	73	Achieved
RS_22	73	Achieved
RS_23	63	Not Achieved
RS_24	56	Not Achieved
RS_25	56	Not Achieved
RS_26	80	Achieved
Number of Values	**1684**	
Average rating	**64,77**	
Maximal Value	**90**	**11 Students**
Minimum Value	**40**	**15 Students**
Achieved	**42,30%**	
Not Achieved	**57,70%**	

It is known that, of the 26 students who participated in the learning, it turned out that 11 students with a percentage of 42.30% (achieved completeness). A total of 15 other students with around 57.70% did not meet the completeness in learning. This can be caused by the unvaried implementation of learning models, thus stimulating student learning saturation and potentially avoiding learning. In this case, teachers have not used the right science teaching pattern in stimulating student learning activity, so that the learning process that occurs seems less pleasant for students and not in accordance with their learning needs.

Figure 2. Visualization of Learning Material Position and Shadow of the Sun

Table 2. Distribution of Early Study Learning Outcomes

No.	Values	Frequencies	Percentage	Information
1	40	2	7,69%	Not Achieved
2	50	4	15,38%	Not Achieved
3	56	5	19,23%	Not Achieved
4	63	4	15,38%	Not Achieved
5	70	0	0,00%	Not Achieved
6	73	4	15,38%	Achieved
7	76	0	0,00%	Not Achieved
8	80	5	19,23%	Achieved
9	90	2	7,69%	Achieved
10	100	0	0,00%	Not Achieved

A total of 26 students who participated in the learning were known to have the highest score of 90 and the lowest score of 40, while the completion requirement was at least a score of 70. The learning outcome score is further confirmed through the following graphic data tabulation.

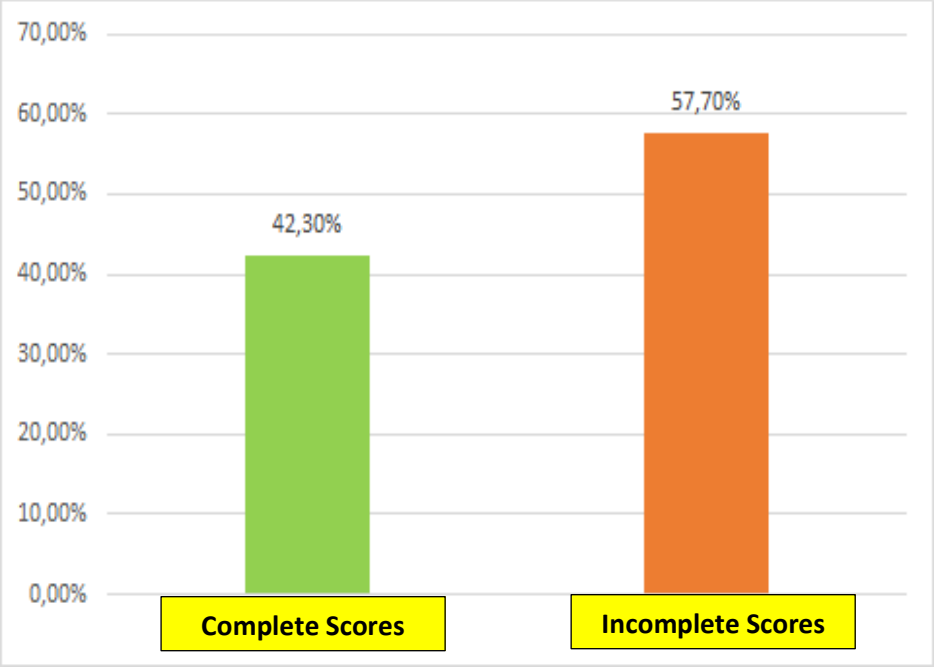

Figure 3. Diagram of Completeness and Incompleteness of Early Study Students

Based on graph visualization data that shows the achievement of mastery of student science concepts as a result of applying the model studied. In fact, a large number of students in the cycle-I still do not achieve science learning outcomes that meet learning completeness. Then it is necessary to continue this research by continuing to the next cycle. This demands the need for re-improvement of learning such as utilizing the use of teaching aids and learning videos that are integrated in the implementation of the model focused in this study.

B. Discussion

Learning activities are a series of processes of achieving the results of a teaching and learning activity where the results become a benchmark for the success of these learning activities. The learning process can be considered complete if the student's grades meet the classical completeness requirements. Conversely, if the student's grades do not meet this requirement, the learning process has not been completed.

Researchers are teachers at SDN Tanjung Barat 09 who have carried out learning activities in class II in the field of natural sciences with material position and shadow of the sun. Of the 26 students, 57.70% still did not achieve the minimum completion score, according to student scores. Therefore, researchers should look for recommended learning models to achieve the required standardization of completeness. Therefore, by using two cycles, researchers improve the learning process through the implementation of the model.

1. Pre-Cycle

Analysis of pre-cycle activities, where researchers only used lecture and question and answer methods, as many as 42.30% (11 students) had achieved learning completion, and 57.70% (15 students) had not achieved learning completion. This can happen because students get bored with repetitive subject matter. They can also be because the teacher uses uninteresting learning methods or because they do not understand the material.

The lecture method is the most common method applied by teachers, even often in one learning finding dominated by lecture activities, this is evidenced by the results of research showing a high percentage with categories often related to general methods that are often relied on by teachers in teaching (Rildwiani Putri Utama, 2023). In a different view, the lecture method is not entirely good in driving student learning activities in the classroom but needs to be connected with teaching variations that invite student learning enthusiasm and trigger the presence of learning motivation (Wahidi & Wirdati, 2022; Zhou et al., 2023).

Although learning is designed with a learning model that has a clear implementation flow, the sensitivity of teachers in encouraging their students to participate with enthusiasm so that learning objectives can be achieved properly. Nuralan et al., (2022) and Utamajaya et al. (2020) suggest that motivation as an internal self-motorization that encourages behavior to achieve learning goals, as well as motivation to learn science concepts that arise from the results of model implementation, will motivate to do things related to achieving these goals. In this case, after pre-cycle learning, researchers self-reflect and then plan better learning activities to motivate students to achieve better science learning outcomes. Researchers are trying to improve students' science concepts by using image-based learning models to be better than before (Fries et al., 2006).

2. Cycle-I

Cycle-I uses picture and picture-based learning to follow up on pre-cycle results. Interestingly, student learning outcomes improved, 65.40% (17 students) achieved learning completion, and 34.60% (9 students) still did not achieve it. To provide an explanation of learning, image media are used in the implementation of the selected model. Strengthening students' science concepts showed signs of good understanding after students were asked to sort pictures logically and explain the reasons why they sorted them in groups. After changing the way they learned, researchers found that although some students had not yet completed their lessons, their learning outcomes improved significantly. As a result, researchers decided to continue learning to the cycle-II to improve student learning outcomes. According to Haworth et al. (2022), reinforcement of scientific ideas driven by the selection of learning approaches that are considered effective. But the application of only one experiment does not guarantee optimal results because it needs to be familiarized repeatedly (Geng et al., 2024; Kononov et al., 2023).

3. Cycle-II

The results of learning improvements in the second cycle are in line with expectations; 80.80% (21 students) achieved learning completion, while 19.20% (5 students) still failed to achieve the minimum score standardization. Starting from the main purpose of this classroom action research, which is to improve student learning outcomes through the application of the model studied. From the findings of cycle-I, it has actually shown the effectiveness of this model and is even more effective after the model is applied to cycle-II. The results of reflection from cycle-II show that success indicators have been achieved, so this class action research will continue only until cycle-II.

In addition to improving learning outcomes, there are other impacts on learning activity, such as students being able to sort and explain each image shared with each group. By using the picture and picture type cooperative learning model during the learning process, the process of receiving lessons of students becomes better and they understand science concepts better. They can also see and pay attention to what is shown during learning. Jones et al. (2022) and Neuman et al. (2021) said that teaching with new methods or strategies needs to be followed up with habituation in order to produce optimal impacts well.

4. Development of Student Academic Scores

Students' grades tend to improve with each cycle. However, not all students tend to have improved grades on each cycle, as some students do not improve on each cycle. Because the value of student learning outcomes does not reach the minimum requirement of 70, so students still need additional guidance.

Table 3. Development of Student Academic Scores

Respondent	Scores		
	Pre-Cycle	Cycle-I	Cycle-II
RS_01	50	56	63
RS_02	80	100	100
RS_03	63	76	80
RS_04	63	70	76
RS_05	90	100	100
RS_06	56	63	63
RS_07	50	56	63
RS_08	90	100	100
RS_09	63	73	76
RS_10	50	63	73
RS_11	73	80	90
RS_12	56	63	73
RS_13	73	76	80
RS_14	40	50	56
RS_15	80	90	100
RS_16	80	90	90
RS_17	50	63	73
RS_18	40	50	50
RS_19	80	90	90
RS_20	56	73	73
RS_21	73	76	80
RS_22	73	80	90
RS_23	63	73	73
RS_24	56	70	73
RS_25	56	63	73
RS_26	80	90	90
Sum	**1684**	**1934**	**2048**
Average Class	**64,77**	**74,385**	**78,769**
Maximum Value	**90**	**100**	**100**
Minimum Value	**40**	**50**	**50**
Achieved	**42,30%**	**65,40%**	**80,80%**
Not Achieved	**57,70%**	**34,60%**	**19,20%**

The table shows student learning outcomes during each cycle. As expected, students' learning scores increase during pre-cycle, cycle-I, and cycle-II. But there are also some students who have not improved. Some things that affect students who do not experience an increase in learning value include:

1. Lack of concentration, students easily switch their concentration so that when the teacher explains they do not pay attention to the learning process.
2. Students have cognitive weaknesses and have low intelligence so they have difficulty learning.

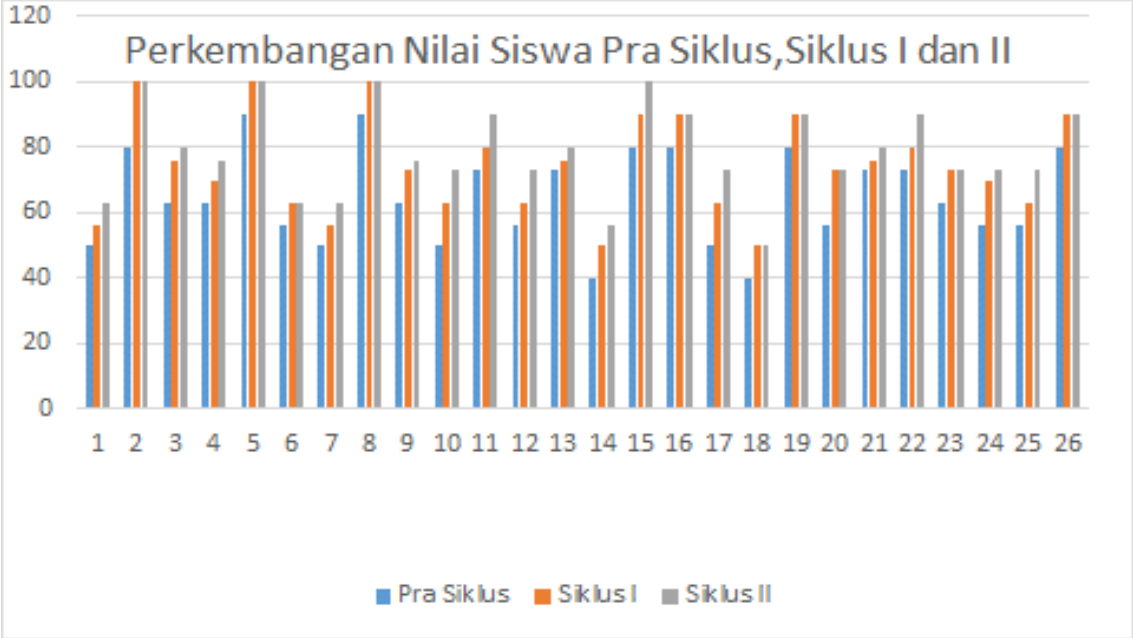

Figure 4. Student Value Development

Figure 4 shows changes in science learning outcomes for positional material and sun shadow. A graph of the development of students' grades from all cycles is shown there. Only five students did not achieve the minimum completion, with a percentage of 19.20%, while 21 students achieved minimum completeness of learning, with a percentage of 80.80%. Relevant to this finding, Xie et al. (2024) and Haryana et al. (2022) said that other accompaniment impacts will be found in addition to producing good learning outcomes, when the learning design is adaptive to the learning situation, the accompaniment impact can be in the form of changes in student learning attitudes that may not have been thought of before (Alty et al., 2006; Liu et al., 2023; Wartella et al., 2019).

CONCLUSIONS

The results of learning science material cycle-I using a model integrated in learning showed an increase in average scores from 74.38 to 78.76 and an increase in completeness from 65.40% to 80.80% after the application of a learning model based on reinforcement of visualized image media. This shows that this learning model is effective. The results were comparable to changes in students' learning attitudes, such as increased student enthusiasm for learning and their involvement in class when using props and watching learning videos. The use of image and image models as an effective way to support the application of this model contributes to improving science learning outcomes of grade II students at SDN Tanjung Barat 09. The results of its effectiveness analysis show that this model is very effective in encouraging increased cognitive understanding of students because it touches students' thinking patterns at the level of concrete operational thinking. Based on the effectiveness of the process and the results,

this learning can be suggested to science teachers in elementary schools to help students think more realistically.

REFERENCES

Ackermann, D. M., Hersch, J. K., Janda, M., Bracken, K., Turner, R. M., & Bell, K. J. L. (2024). Using the Behaviour Change Wheel to identify barriers and targeted strategies to improve adherence in randomised clinical trials: The example of MEL-SELF trial of patient-led surveillance for melanoma. *Contemporary Clinical Trials*, *16*(4), 107543–107557. https://doi.org/10.1016/j.cct.2024.107513

Al-Hail, M., Zguir, M. F., & Koç, M. (2023). University students' and educators' perceptions on the use of digital and social media platforms: A sentiment analysis and a multi-country review. *IScience*, *26*(8). https://doi.org/10.1016/j.isci.2023.107322

Alty, J. L., Al-Sharrah, A., & Beacham, N. (2006). When humans form media and media form humans: An experimental study examining the effects different digital media have on the learning outcomes of students who have different learning styles. *Interacting with Computers*, *18*(5), 891–909. https://doi.org/10.1016/j.intcom.2006.04.002

Asmaniyah. (2022). Peningkatan motivasi dan hasil belajar biologi materi sistem reproduksi manusia melalui penerapan model pembelajaran kooperatif tipe picture and picture pada siswa kelas XI IPA MAN Bangkalan. *Jurnal Pendidikan Lampu*, *8*(2), 36–44. https://doi.org/10.34557/jpl.v8i2.198

Boonchom, S., Nuchwana, L., & Amorn, M. (2012). The development of standards, factors, and indicators for evaluating the quality of classroom action research. *Procedia - Social and Behavioral Sciences*, 220–226. https://doi.org/10.1016/j.sbspro.2012.11.402

Broca, A. de. (2023). 8 - Développement psychoaffectif et cognitif. *Le Développement de l'enfant (7e Édition)*, *55*(8), 93140. https://doi.org/10.1016/B978-2-294-77720-2.00008-3

Coutinho, M. J., & Almeida, P. A. (2014). Promoting student questioning in the learning of natural sciences. *Procedia - Social and Behavioral Sciences*, 3781–3785. https://doi.org/10.1016/j.sbspro.2014.01.841

Douma, E. R., Wirtz, S., Fernandez, M. S., Schäfer, H., Widdershoven, J. W. M. G., Habibović, M., Gil, C. P., Bosch, J. A., Schmitz, B., & Kop, W. J. (2024). Patient-reported preferences in eHealth-based cardiac rehabilitation: A qualitative investigation of behavior change techniques, barriers and facilitators. *Internet Interventions*, *35*(4), 35544–35555. https://doi.org/10.1016/j.invent.2024.100728

Fries, S., Horz, H., & Haimerl, C. (2006). Pygmalion in media-based learning: Effects of quality expectancies on learning outcomes. *Learning and Instruction*, *16*(4), 339–349. https://doi.org/10.1016/j.learninstruc.2006.07.005

Geng, S., Zhai, S., & Li, C. (2024). Swin transformer based transfer learning model for predicting porous media permeability from 2D images. *Computers and Geotechnics*, *168*(4), 441–462. https://doi.org/10.1016/j.compgeo.2024.106177

Hamna, & BK, M. K. U. (2023). Model pembelajaran guided inquiry di era merdeka belajar: Efektivitas projek sains IPA siswa di sekolah dasar. *Madako Elementary School*, *2*(2), 121–136. https://doi.org/10.56630/mes.v2i2.209

Haryana, M. R. A., Warsono, S., Achjari, D., & Nahartyo, E. (2022). Virtual reality learning

media with innovative learning materials to enhance individual learning outcomes based on cognitive load theory. *The International Journal of Management Education*, *20*(3), 690–704. https://doi.org/10.1016/j.ijme.2022.100657

Haworth, C. M. A., Kovas, Y., Dale, P. S., & Plomin, R. (2022). Science in elementary school: Generalist genes and school environments. *Intelligence*, *36*(6), 694–701. https://doi.org/10.1016/j.intell.2008.04.002

Huang, S.-Y., Kuo, Y.-H., & Chen, H.-C. (2020). Applying digital escape rooms infused with science teaching in elementary school: Learning performance, learning motivation, and problem-solving ability. *Thinking Skills and Creativity*, *37*(9), 3223–3321. https://doi.org/10.1016/j.tsc.2020.100681

Israil, I. (2019). Implementasi model pembelajaran cooperative learning tipe STAD untuk meningkatkan motivasi belajar siswa dalam pembelajaran IPA di SMP Negeri 1 Kayangan. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *5*(2), 117. https://doi.org/10.33394/jk.v5i2.1807

Jagannathan, R., Camasso, M. J., & Delacalle, M. (2018). The effectiveness of a head-heart-hands model for natural and environmental science learning in urban schools. *Evaluation and Program Planning*, *66*(2), 53–62. https://doi.org/10.1016/j.evalprogplan.2017.09.001

Jones, M. G., Chesnutt, K., Ennes, M., Macher, D., & Paechter, M. (2022). Measuring science capital, science attitudes, and science experiences in elementary and middle school students. *Studies in Educational Evaluation*, *74*(9), 12005–12018. https://doi.org/10.1016/j.stueduc.2022.101180

Jundu, R., Tuwa, P. H., & Seliman, R. (2020). Hasil belajar IPA siswa sd di daerah tertinggal dengan penerapan model pembelajaran inkuiri terbimbing. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *10*(2), 103–111. https://doi.org/10.24246/j.js.2020.v10.i2.p103-111

Khan, P. A., Johl, S. K., Akhtar, S., Asif, M., Salameh, A. A., & Kanesan, T. (2022). Open innovation of institutional investors and higher education system in creating open approach for SDG-4 quality education: A conceptual review. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(1), 49–66. https://doi.org/10.3390/joitmc8010049

Koizumi, H. (2004). The concept of 'developing the brain': a new natural science for learning and education. *Brain and Development*, *26*(7), 434–441. https://doi.org/10.1016/j.braindev.2003.09.011

Kononov, E., Tashkinov, M., & Silberschmidt, V. V. (2023). Reconstruction of 3D random media from 2D images: generative adversarial learning approach. *Computer-Aided Design*, *158*(5), 241–265. https://doi.org/10.1016/j.cad.2023.103498

Lee, M., Lee, S. Y., Kim, J. E., & Lee, H. J. (2023). Domain-specific self-regulated learning interventions for elementary school students. *Learning and Instruction Journal*, *88*(12), 1–18. https://doi.org/10.1016/j.learninstruc.2023.101810

Lenggogeni, L., & Roqoyyah, S. (2021). Penggunaan media video animasi berbantuan scratch melalui model pembelajaran picture and picture terhadap kemampuan berfikir kreatif siswa pada mata pelajaran IPA materi daur hidup hewan kelas IV. *Journal of Elementary Education*, *04*(02), 249–256. https://doi.org/10.22460/collase.v4i2.5687

Lijanporn, S., & Khlaisang, J. (2015). The development of an activity-based learning model using educational mobile application to enhance discipline of elementary school students. *Procedia - Social and Behavioral Sciences*, 1707–1712.

https://doi.org/10.1016/j.sbspro.2015.01.825

Liu, B., Wang, D., Wu, Y., Gui, W., & Luo, H. (2023). Effects of self-directed learning behaviors on creative performance in design education context. *Thinking Skills and Creativity*, *49*(9), 3542–3556. https://doi.org/10.1016/j.tsc.2023.101347

Marlina, L. (2020). Kajian pengaruh penggunaan model pembelajaran picture and picture terhadap prestasi belajar IPA siswa sekolah dasar. *Ainara Journal (Jurnal Penelitian Dan PKM Bidang Ilmu Pendidikan)*, *1*(2), 56–61. https://doi.org/10.54371/ainj.v1i2.14

Muyaroah, S. (2018). Efektifitas model pembelajaran inside outside cirle terhadap hasil belajar siswa pada mata pelajaran IPA SD Fransiskus Baturaja. *Pedagogia: Jurnal Ilmu Pendidikan*, *16*(2), 99. https://doi.org/10.17509/pdgia.v16i2.12052

Neuman, S. B., Samudra, P., & Wong, K. M. (2021). Two may be better than one: Promoting incidental word learning through multiple media. *Journal of Applied Developmental Psychology*, *73*(4), 665–677. https://doi.org/10.1016/j.appdev.2021.101252

Nuralan, S., BK, M. K. U., & Haslinda. (2022). Analisi gaya belajar siswa berprestasi kelas V di SD Negeri 5 Tolitoli. *Jurnal Pendekar PGSD: Pengembangan Pendidikan Dan Pembelajaran Sekolah Dasar*, *1*(2), 13–24. https://ojs.fkip.umada.ac.id/index.php/pendekar/article/view/4/2

Nurmawati, A. D., Nisa, A. F., Rosianawati, A., Artopo, B., Erva, R. A. L., & Nizhomi, B. (2022). Implementasi ajaran Tamansiswa "Tri Nga" melalui model pembelajaran discovery learning dalam pembelajaran IPA kelas IV sekolah dasar. *TRIHAYU: Jurnal Pendidikan Ke-SD-An*, *8*(2), 1366–1372. https://doi.org/10.30738/trihayu.v8i2.11832

Poinso, F., Fonseca, D. Da, E. Camera a, C. Z., Guelfi, J., Duverger, H., & Vialettes, B. (2006). Étude du développement cognitif et de la pensée logique dans l'anorexie mentaleStudy of the development of formal thought in anorexia nervosa. *Neuropsychiatrie de l'Enfance et de l'Adolescence*, *54*(5), 289–296. https://doi.org/10.1016/j.neurenf.2006.09.007

Pranoto, H. (2017). Peningkatan hasil belajar siswa melalui model pembelajaran examples non examples pada mata pelajaran IPA siswa kelas VI B semester 1 SD Negeri Turitempel tahun pelajaran 2016/2017. *Malih Peddas (Majalah Ilmiah Pendidikan Dasar)*, *7*(1), 42–51. https://doi.org/10.26877/malihpeddas.v7i1.1765

Pratiwi, D. I., Kamilasari, N. W., Nuri, D., & Supeno. (2019). Analisis keterampilan bertanya siswa pada pembelajaran IPA materi suhu dan kalor dengan model problem based learning di SMP Negeri 2 Jember. *Jurnal Pembelajaran Fisika*, *8*(4), 82–95. https://doi.org/10.19184/jpf.v8i4.15236

Rildwiani Putri Utama. (2023). Analisis metode ceramah pada pengajaran pendidikan agama islam di Sekolah Dasar Negeri 15 Pematang Panjang Kecamatan Sijunjung Kabupaten Sijunjung. *Pedagogika: Jurnal Ilmu-Ilmu Kependidikan*, *3*(2), 53–67. https://doi.org/10.57251/ped.v3i2.1146

Ruiz-Gallardo, J.-R., Castano, S., Gomez-Alday, J. J., & Valdes, A. (2011). Assessing student workload in Problem Based Learning: Relationships among teaching method, student workload and achievement. A case study in Natural Sciences. *Teaching and Teacher Education*, *27*(3), 619–627. https://doi.org/10.1016/j.tate.2010.11.001

Sriantini, N. P. A., Bayu, G. W., & Margunayasa, I. G. (2021). Dampak model pembelajaran picture and picture terhadap hasil belajar IPA siswa di sekolah dasar. *Mimbar Pendidikan Indonesia*, *2*(2), 83–92. https://doi.org/10.23887/mpi.v2i2.40204

Sugiyono. (2011). *Metode penelitian pendidikan; pendekatan kuantitatif, kualitatif, dan R&D*. Bandung: Alfabeta.

Utamajaya, J. N., Manullang, S. O., Mursidi, A., Noviandari, H., & BK, M. K. U. (2020). Investigating the teaching models, strategies and technological innovations for classroom learning after school reopening. *Palarch's Journal Of Archaeology Of Egypt/Egyptology*, *17*(7), 13141–13150. https://archives.palarch.nl/index.php/jae/article/view/5063

Wahidi, F., & Wirdati, W. (2022). Pengembangan metode pembelajaran Ceramah Plus Tanya Jawab dan Tugas (cptt) pada materi meyakini hari akhir dan mengakhiri kebiasaan buruk mata pelajaran pai dan budi pekerti kelas IX di SMP Negeri 13 Padang. *Jurnal As-Sabiqun*, *4*(4), 87–102. https://doi.org/10.36088/assabiqun.v4i4.2104

Wartella, E. A., Lovato, S. B., Pila, S., Lauricella, A. R., MPP, R. E., MSW, J. E., & Hightower, B. (2019). Chapter 16 - digital media use by young children: Learning, effects, and health outcomes. In *Child and Adolescent Psychiatry and the Media* (pp. 173–186). https://doi.org/10.1016/B978-0-323-54854-0.00016-3

Widyawati, W. Y. (2019). Keefektifan model pembelajaran picture and picture dalam keterampilan menulis untuk tingkat universitas. *KREDO : Jurnal Ilmiah Bahasa Dan Sastra*, *2*(2), 226–241. https://doi.org/10.24176/kredo.v2i2.3027

Xie, Z., Liu, L., & Chen, Z. (2024). Image Compressed Sensing: From Deep Learning to Adaptive Learning. *Knowledge-Based Systems*, *26*(4), 3245–3258. https://doi.org/10.1016/j.knosys.2024.111659

Yılmaz, A. (2021). The effect of technology integration in education on prospective teachers' critical and creative thinking, multidimensional 21st century skills and academic achievements. *Participatory Educational Research*, *8*(2), 163–199. https://doi.org/10.17275/per.21.35.8.2

Zabalia, M. (2005). Autoévaluation de la douleur : la théorie de Jean Piaget comme cadre interprétatif de l'expression de la douleur chez l'enfant : mise au point et perspectivesSelf-assessment of pain: the Jean Piaget's theory as an interpretative framework of the expressio. *Journal de Pédiatrie et de Puériculture*, *18*(4), 176–181. https://doi.org/10.1016/j.jpp.2005.03.002

Zhou, Y., Liu, Y., Xiao, J., Liu, M., Li, X., & Liu, A.-A. (2023). Unsupervised self-training correction learning for 2D image-based 3D model retrieval. *Information Processing & Management*, *60*(4), 215–228. https://doi.org/10.1016/j.ipm.2023.103351

Zubaidah, M., & Nurmaliah, C. (2015). Penerapan model pembelajaran picture and picture dengan bantuan media power point untuk meningkatkan hasil belajar siswa pada materi alat pencernaan makanan pada manusia di SD Negeri 54 Banda Aceh. *Jurnal Biologi Edukasi*, *7*(1), 29–33. https://jurnal.usk.ac.id/JBE/article/view/5490