Jurnal Pendidikan dan Konseling
Volume 4 Nomor 6 Tahun 2022
E-ISSN: 2685-936X dan P-ISSN: 2685-9351
Universitas Pahlawan Tuanku Tambusai

Learning Computer Programming Using Pimca Model: Project Assignments

Sandy Salomo Saruan[1], Anetha L. F. Tilaar[2], Sylvia J. A. Sumarauw[3]
[1, 2, 3]Mathematics Education Department, Manado State University
Email: sandysaruan27@gmail.com[1],sylviasumarauw@unima.ac.id[3]

Abstrak
Model pembelajaran PIMCA dapat memicu peserta didik untuk mengkonstruksi konsep dengan benar. Penelitian ini bertujuan untuk mengetahui bagaimana peningkatan rata-rata hasil belajar peseta didik pada pembelajaran pemrograman komputer dasar pada materi *looping* dengan menggunakan model pembelajaran PIMCA. Penelitian ini menggunakan metode penelitian campuran khususnya *embedded design* dengan teknik pengumpulan data melalui tes dan studi dokumentasi. Penelitian ini dilakukan di Jurusan Pendidikan Matematika Universitas Negeri Manado dengan subjek penelitian sebanyak 24 orang mahasiswa. Berdasarkan hasil penelitian, perhitungan hasil *pretest* dan *posttest* peserta didik menunjukkan peningkatan dari 9,58 menjadi 65,38 dari skala 0-100 dan skor *n-gain* diperoleh peningkatan rata-rata hasil belajar sebesar 62,13% dan rata-rata persentase peningkatan pemahaman konsep sebesar 83,86%. Peserta didik masih mengalami kesalahan sintaks pada *code* yang dibuat pada tugas proyek, namun sebanyak 83,3% subjek penelitian tidak memiliki masalah dalam memahami semantik, oleh karena itu pengajar harus lebih fokus dalam memahami sintaks.
Kata Kunci: *Hasil Belajar; Model Pembelajaran PIMCA; Pemrograman Komputer; Tugas Proyek*

Abstract
The PIMCA learning model can trigger students to construct concepts correctly. This research aims to find out how the average increase in student learning outcomes in basic computer programming learning in looping material using the PIMCA learning model. This research uses mixed research methods, especially embedded design with data collection techniques through tests and documentation studies. This research was conducted in the Mathematics Education Department, Manado State University with the research subject of 24 students. Based on the results of the study, the calculation of student pretest and posttest results showed an increase from 9.58 to 65.38 from 0-100 scale and the n-gain score obtained an average increase in learning outcomes of 62.13% and the average percentage increase in concept understanding is 83.86%. Students still encounter syntax errors in the code made in project assignments, but as many as 83.3% of research subjects have no problems in understanding semantics, therefore the teacher should focus more on understanding syntax.
Keyword*: Learning Outcomes; PIMCA Model; Computer Programming; Project Assignments*

INTRODUCTION

The 21st century is marked by innovation and change that massively changes systems and orders to new levels. This phenomenon causes changes in the world of education. Learning activities tend to be more informal where learning resources through MOOC (Massive Open Online Course) are becoming more popular (Poluakan & Katuuk, 2022). In the 21st century, technological developments are unavoidable. Technology that is developing in every aspect of life, including aspects of education, requires humans to keep abreast of technological developments (Megahantara, 2018). The Covid-19 pandemic that has hit various parts of the world, including Indonesia, is very influential in various fields including education. Based on Circular Letter of the Minister of Education and Culture Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period of the Spread of Corona Virus Disease (Covid-19), the teaching and learning process is carried out online (Nafrin & Hudaidah, 2021). In

Mathematics Education, which are faced by teachers in carrying out online learning, among others: limitations in presenting material, especially in the section of subjects or courses that have many mathematical similarities and programming languages. In addition, most teachers are not good at making videos and animations using animation software. mostly in presenting material using PowerPoint and text only.

On Wednesday, October 13, 2021, in the Event of Briefing of the President of the Republic of Indonesia to the Participants of PPSA XXIII and PPRA LXII of 2021 LKNRI, President Joko Widodo said that for language, not only English, but coding language is even more important in the future. That is, He predicts in the future that the programming language for computer programming is much more important than English.

Learning basic computer programming at the Mathematics Department of Manado State University is in the Compulsory Courses of the even semester Mathematics Department, namely Algorithms and Programming, followed by three Computer Elective Courses in the Mathematics Department. Data obtained from around 180 students in the 2018 batch, there were only 4 students who were interested in continuing on the Computer Elective Course, then around 140 students from the 2019 batch, there were only 14 students who continued to take the Computer Elective Course. This means that, respectively only 2.2% and 10% of the total number of students in the 2018 and 2019 batches continue their Computer Elective Courses. In other words, 2018 and 2019 students are still less interested in continuing the Computer Elective Course. Based on the results of interviews with students who have taken the Algorithm and Programming course, this course is one of the most difficult courses because it requires a deeper understanding the concept of program algorithms, what is meant by the program and requires high accuracy in writing programs.

Basic Programming Course is one of the subjects that require students to think at a higher level. Basic Programming is a course that learns how to understand and analyze a problem, then think sequentially and systematically to solve problems and make it happen in the form of a programming language (Panggayuh, 2017). Some of the students who take the Basic Programming Course find difficulties in programming and it is difficult to master the core concepts of programming (Elpizochari et al., 2019). When learning basic computer programming, students' misconceptions include syntax errors, semantic errors, and other difficulties in typing or writing correct programs to solve problems (Qian et al., 2020). Syntax errors occur when the typed program does not match the programming grammar used, for example, there is no semicolon (;), uses undeclared variables, mismatched brackets or curly braces, and others. Semantic errors can occur when a program is syntactically valid but doesn't do what the programmer did. The compiler generally analyzes the code and checks for syntax errors so that the compiler can pinpoint the errors made by the programmer so that the programmer can correct the syntax errors. In many cases, the compiler will not be able to catch semantic errors because the compiler is designed to check the grammatical program, not the program in question. This makes semantic errors more difficult to handle because they are not easy to find just by looking at the code (Alex, 2020). A common misconception of beginner programmers is in their minds with the term "hidden mind", which is their mistaken assumption that computers are intelligent enough to guess the intentions of programmers. (Kwon, 2017). With difficulties in programming and difficulties in mastering the core concepts of programming experienced by students, it can lead to low student learning outcomes.

PIMCA (Presentation, Idea Mapping, Conceptualization, Assessment Formative*)* learning model is a new alternative learning model developed by Prof. Cosmas Poluakan and built on constructivism theory or Vygotsky's theory of social construction to improve problem-solving skills. The PIMCA learning model is adaptive to today's demands because the PIMCA learning model provides opportunities to use multimedia and information technology so research on the PIMCA model needs to be continued in the field of STEM (Science, Technology, Engineering, and Mathematics). The MR (Multi-Representation)-based PIMCA learning model consists of four stages, namely: (1) Presentation, (2) Idea Mapping, (3) Conceptualization, and (4) Formative Assessment which can trigger students to construct concepts correctly. In the Conceptualization stage, the ideas built in the previous stage are clarified through experiments, discussions, project assignments, and others (Poluakan & Katuuk, 2022).

Project assignments are activities carried out outside of class hours. Project assignments can be done in groups. Project assignments are effective in helping students understand, apply, and master a topic. Project assignments can increase students' mastery of 21st-century skills, such as higher-order thinking, communication, collaboration, creativity, and innovation, and can improve academic achievement (Goodman & Stivers, 2010). The PIMCA Learning Model is very effective and suitable for the learning process, using PIMCA makes it easier for students to understand physics concepts with the steps in the PIMCA Model. Based on his research, the average pretest score is 45 and the average posttest score with a score of 93 shows the difference before and after the application of the PIMCA model (Lampeang et al., 2021). The results of data analysis show that using the MR-SR-based PIMCA Model is very useful in improving understanding of physics concepts. It is also shown where student learning outcomes increase in the topic of optical eye material. With an average pretest score of 43.75 and an average posttest score of 77.08. The results of this study indicate that the MR-SR-based PIMCA Model is very effective in the learning process of Natural Sciences, including biology, mathematics, chemistry, engineering and especially physics (Mamengko et al., 2021). Students who practice physics using the Phypox application with the PIMCA Model can effectively and efficiently improve students' understanding of concepts. With an average pretest score of 11.33 and an average posttest score of 18.11 (Mayampoh et al., 2021). The PIMCA Learning Model is very well used in the learning process topic magnetic field material, and can be a reference for teachers in the learning process. PIMCA is a simple learning model to use in learning physics and also for other science concepts. The results of the research he did showed an increase in the results shown in the small group there was an increase from 0.2 to 2.2 and for the large group there was an average increase from 0.7 and 2.5 (Patol et al., 2021). The research that was carried out on learning the SPLTV material using the PIMCA learning model was very effective in improving student learning outcomes from 6 to 65 in 22 respondents (Londo et al., 2022). Research on learning the limits of algebraic functions was carried out using the PIMCA model. the pretest average score was 12.57 and the posttest average score was 58.57. The increase in understanding of the concept from Idea Mapping to Concept Maps increased by 80.71%. Students' skills in presenting, mastering the material, and solving problems where the average student gets a very good assessment. There was an increase in student learning outcomes. The PIMCA learning model can help students understand correct mathematical concepts (Felyciana et al., 2022).

Based on the theory and studies that are in line with the above, using the PIMCA model through project assignments can increase students' understanding of a concept so that mastering the concept can improve student learning outcomes. Therefore, the researcher is interested and also considers that it is necessary to conduct this research. The purpose of this research is to find out how the average increase in student learning outcomes with Computer Programming Learning with the PIMCA Model: Project Assignments in the Algorithm and Programming course is looping material.

METHOD

In this research, the type of research used is mixed research (Mixed Methods) and research design using embedded design. The embedded design uses a quantitative method (experimental study) with a one-group pretest protest design. This research was conducted at the beginning of the even semester of the 3rd week of March in the 2021/2022 academic year at the Mathematics Department, Manado State University with a total of 24 students as respondents.

The learning model used is the PIMCA learning model. (1) Presentation, at this stage, the delivery of information is based on multi-representation such as learning videos, pictures, and graphics related to looping material (repetition) repeatedly. This stage will start with the concept of mathematics. Example: "$4 \times 3 = 3 + 3 + 3 + 3$" or "$2^3 = 2 \times 2 \times 2$". This mathematical concept will further develop the concept of lines and series. Example: "1, 3, 5, 7, ..." and it will get more complex. It can be seen from the mathematical concept above that there is a repetition that occurs. This concept is easy to implement in programming languages by using loops. For learning in this study, researchers followed the programming language that was applied and taught in the Algorithms & Programming Subjects, namely the Pascal Programming Language. (2) Idea Mapping, at this stage based on the Presentation stage, the researcher asks students to write down ideas that students can develop by seeing and/or listening to previous presentations. Researchers compiled the number of ideas written as many as four ideas with one idea consisting of 1 to 3 words. (3) Conceptualization, at this stage, the researcher gives project assignments to improve students' understanding of the looping of material. The researcher gave two questions and made an explanatory video for the project assignment. The first problem is in the form of everyday problems using an analogy approach so that students can apply the information obtained with ideas to solve problems and implement them in the form of computer programs. The computer program that will be generated is in the form of a file in Pascal format (.pas). The second problem is a piece of a computer program and is solved by the students by explaining the differences in the structure of the loop. Then students are asked to make a concept map that has been received in the previous stage. (4) Assessment Formative, at this stage, the researcher provides practice questions and is done by students individually by creating programs in order to get used to typing programs. Followed by a discussion of practice questions as well as a discussion of questions on project assignments in order to strengthen concepts in the looping material.

The data obtained from the research instrument were in the form of description tests for the pretest and posttest, idea mapping sheets, concept map sheets, and algorithm understanding sheets that had been validated and tested. Quantitative data were analyzed using the normalized gain test and calculating the percentage increase in concept understanding. The data obtained in the form of pre-test and post-test values were then analyzed by calculating the normalized gain (n-gain) with the help of the SPSS 26.0 application. The normalized gain test (n-gain) was carried out to determine the increase in students' cognitive learning outcomes after being given treatment. Normalized gain or abbreviated as n-gain is a comparison of actual scores with maximum gain scores. The actual gain score is the gain score obtained while the maximum gain score is the highest gain score that can be obtained by students.
Calculation of the n-gain score can be expressed in the following formula:

$$g = \frac{S_f - S_i}{S_{max} - S_i} \times 100\% \qquad (1)$$

g is the normalized gain value.
S_f is the post-test score.
S_i is the pre-test score.
S_{max} is the maximum score that a student can get.

Table 1. n-gain value category (Hake, 1998)

n-gain Value	Category
$\mathbf{g > 0,7}$	High
$\mathbf{0,3 \leq g \leq 0,7}$	Medium
$\mathbf{g < 0,3}$	Low

Quantitative data on idea mapping sheets and concept maps sheets that have been obtained, are then analyzed by calculating and knowing the increase in the results of students' understanding of concepts after being given project assignments. Calculation of scores for student understanding of concepts can be expressed in the following formula:

$$I = \frac{S_1 - S_0}{S_1} \times 100\% \qquad (2)$$

I is the percentage increase.
S_1 is the score obtained on the Concept Maps sheet.
S_0 is the score obtained on the Idea Mapping sheet.

Qualitative data in the form of documentation studies were analyzed qualitatively. By analyzing students' understanding of concepts in programming algorithms based on program documents typed by students in the Pascal computer document format (.pas) for solving problem in project assignments, it can support quantitative data in the process of increasing average results student learning. Researchers carry out data reduction in order to summarize, choose the main points, and focus on the systematic algorithms constructed by students. That way the reduced data makes it easier for researchers and provides a clearer picture. Followed by the presentation of qualitative data. This data is presented in the form of brief descriptions, relationships between categories, charts, and the like. By presenting the data, the data can be easily understood what has happened. Then from the data that has been presented a conclusion will be drawn, but this conclusion is still temporary.

RESULTS AND DISCUSSION

This study used a pretest as a test before treatment, then used a posttest after being given treatment. In this case, the treatment in question is the PIMCA learning model.

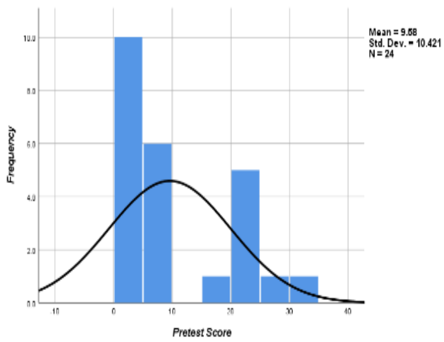

Figure 1. Histogram Pretest

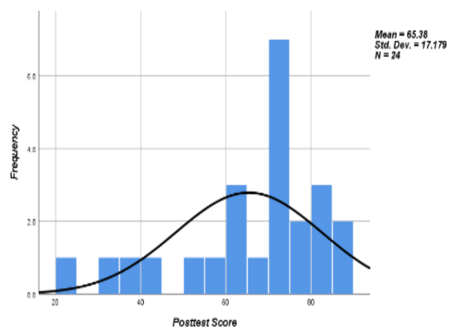

Figure 2. Histogram Posttest

Figure 1. and Figure 2. visual distribution of data with histograms of pretest and posttest values can be seen, especially the distribution of pretest value data that does not follow the bell curve pattern. The value of the pretest data is centered on the 0-10 interval, while the posttest data is centered on the 60-80 interval.

Table 2. Descriptive Statistics Results

Test	N	Minimum	Maximum	Sum	Mean
Pretest	24	0	34	230	9.58
Posttest	24	22	88	1569	65.38

From Table 2. the average pretest score obtained is 9.58 from a maximum score of 100. Then after being given treatment, the researcher gives a posttest to students after the implementation of the PIMCA model. The average posttest score was 65.38 out of a maximum score of 100. From these results, the range between the average pretest and posttest scores was 55.8.

Table 3. n-gain Score

Name	Score		n-gain Score	n-gain Score (%)
	Pretest	Posttest		
Respondent 1	23	79	0.727	72.73
Respondent 2	0	71	0.710	71.00
Respondent 3	0	61	0.610	61.00
Respondent 4	5	51	0.484	48.42
Respondent 5	3	75	0.742	74.23
Respondent 6	7	88	0.871	87.10
Respondent 7	15	86	0.835	83.53
Respondent 8	2	84	0.837	83.67
Respondent 9	34	80	0.697	69.70
Respondent 10	3	74	0.732	73.20
Respondent 11	21	61	0.506	50.63
Respondent 12	28	73	0.625	62.50
Respondent 13	22	70	0.615	61.54
Respondent 14	5	70	0.684	68.42
Respondent 15	20	69	0.613	61.25

Respondent 16	7	61	0.581	58.06
Respondent 17	7	55	0.516	51.61
Respondent 18	8	80	0.783	78.26
Respondent 19	0	38	0.380	38.00
Respondent 20	0	34	0.340	34.00
Respondent 21	20	73	0.663	66.25
Respondent 22	0	71	0.710	71.00
Respondent 23	0	43	0.430	43.00
Respondent 24	0	22	0.220	22.00
Average	**9.58**	**65.38**	**0.621**	**62.13**

From the results of the pretest-posttest scores of each student, the n-gain test was carried out to determine the increase in student cognitive learning outcomes. From the results of the n-gain test in table 3. it is found that there are 9 students in the high category, 14 students in the medium category, and 1 student in the low category, so the n-gain score on average increases in learning outcomes by 62.13% in the medium to high category.The increase in the average student learning outcomes was also passed by the application of the PIMCA model in the Algorithm and Programming course in Looping material through 4 stages of the PIMCA model.

4.1. Presentation

Researchers conveyed information based on multi-representation using learning videos, pictures and graphics related to the material. This is in accordance with Cognitive Theory of Multimedia Learning (CTML) which says that a student can learn better by paying attention to the combination of words and pictures rather than just words (Opfermann et al., 2017). That way students can learn better.

4.2. Idea Mapping

Researcher asked the students to write down the ideas built from the previous stage on the Idea Mapping sheet. The results of the scores can be seen in table 4. There were 4 students who got a score of 0 out of a maximum score of 4, 19 students who got a score of 1, and 1 student who got a score of 2 out of a maximum score of 4. This means that the ideas developed by students are still not right in support of the average student score at this stage is 0.88.

4.3. Conceptualization

Researchers straighten ideas or concepts that were built by students in the previous stage where there are still students who experience misconceptions. By straightening out the concepts that are not right, the researcher gives project assignments to students. Through project assignments, students find solutions to real-world problems by asking open-ended questions, designing and conducting investigations, gathering information, drawing conclusions, and reporting results (Çakici & Türkmen, 2013). The researcher was interested after seeing the results of the project assignment answers from the student groups in the form of program codes in the form of Pascal format (.pas) and in the learning videos made by the group. The results of the qualitative assessment can be seen in Table 4.

Table 4. Results of Understanding Syntax and Semantics on Project Assignments

Group		Syntax Understanding	Semantic Understanding
1	Respondent 1	Medium	High
	Respondent 7		
	Respondent 13		
	Respondent 19		
2	Respondent 2	Medium	High
	Respondent 8		
	Respondent 14		
	Respondent 20		
3	Respondent 3	Medium	High
	Respondent 9		
	Respondent 15		
	Respondent 21		
4	Respondent 4	High	High
	Respondent 10		
	Respondent 16		
	Respondent 22		
5	Respondent 5	Medium	High
	Respondent 11		
	Respondent 17		
	Respondent 23		
6	Respondent 6	Medium	Low
	Respondent 12		
	Respondent 18		
	Respondent 24		

Group 4 has a good understanding of syntax and semantics. Algorithm preparation, program typing, program neatness, and a good selection of repetition structures. Group 6, experienced semantic errors so this group did not optimally answer questions on project assignments. The other 4 groups experienced a similar case of syntax misunderstanding, which made researchers interested in the creativity and innovation of students

in problem-solving, for example by changing the color of the writing in the program code result window, adding group names, and student names, and making lines as delimiters. it could make the program experience a syntax error or semantic error as shown in Figure 3.

Figure 3. Work Group Assignments Results

In most cases, the compiler will not be able to catch semantic errors because the compiler is designed to examine the grammatical program, not the program in question. This makes semantic errors more difficult to handle because they are not easy to find just by looking at the code (Alex, 2020). For example, the compiler used in the Computer Olympiad, Coding Competition, and others. The creativity and innovation of students in typing programs and creating programs may explain that the answers from the programs made are not in accordance with the questions because the input and output requested by the questions do not match the syntax of the code made. For understanding the semantics of the group, the average group is already good in completing the tasks given by the researcher.

Table 5. Percentage Increase in Concept Understanding

Name	Score		Increase Percentage (%)
	Idea Mapping	Concept Maps	
Respondent 1	0	9	100.00
Respondent 2	1	9	88.89
Respondent 3	1	3	66.67
Respondent 4	0	9	100.00
Respondent 5	1	5	80.00
Respondent 6	1	7	85.71
Respondent 7	1	9	88.89
Respondent 8	0	9	100.00
Respondent 9	1	9	88.89
Respondent 10	1	9	88.89
Respondent 11	1	9	88.89
Respondent 12	1	2	50.00
Respondent 13	1	8	87.50
Respondent 14	1	7	85.71
Respondent 15	1	7	85.71
Respondent 16	1	9	88.89
Respondent 17	1	7	85.71
Respondent 18	1	6	83.33
Respondent 19	1	5	80.00
Respondent 20	1	5	80.00
Respondent 21	2	7	71.43
Respondent 22	0	9	100.00
Respondent 23	1	8	87.50
Respondent 24	1	2	50.00
Average			**83.86**

Then the researcher gave Concept Maps sheets for students to answer. The score on the Concept Maps sheet for each student is as shown in table 5. so the percentage increase in students' understanding of concepts is 83.86%.

4.4. Formative Assessment

Researchers provide exercises on looping material as concept reinforcement for students.

CONCLUSIONS

Learning Programming Using Presentation, Idea Mapping, Conceptualization, Assessment Formative Model are able to increase the average student learning outcomes. It is proven by the calculation of the results of the pretest and posttest there is an increase from 9.58 to 65.38. The n-gain test also shows a score of 0.62 or 62.12% (medium category). The percentage calculation from the Idea Mapping to the Conceptualization stage shows an increase of 83.86%. Students' understanding in completing assignments, and syntax, still have errors in the code made, but as many as 83.3% of research subjects have no problems in semantic understanding. Errors are easier to handle than semantic errors because the compiler cannot track semantic errors. Therefore, in handling misconceptions, there is a Formative Assessment stage in the PIMCA Model to strengthen the concepts that have been built.

The PIMCA learning model can be an alternative model to be used in order to increase the average student learning outcomes in the scope of mathematics and computers. In improving learning algorithms and programming, students are active in learning, creating or creating computer programs, and understanding mathematical relationships that are implemented in the form of code in computer programs.

REFERENCES

Alex. (2020). Syntax and semantic errors.

Çakici, Y., & Türkmen, N. (2013). An Investigation of the Effect of Project-Based Learning Approach on Children's Achievement and Attitude in Science. www.tojsat.net

Elpizochari, A., Supianto, A. A., & Rahayudi, B. (2019). Prediksi Kinerja Akademik Mahasiswa Pada Mata Kuliah Pemrograman Dasar dengan Algoritme Backpropagation (Vol. 3, Issue 5). http://j-ptiik.ub.ac.id

Felyciana, C., Kamagi, C., Salajang, S. M., & Pesik, A. (2022). Pembelajaran Limit Fungsi Aljabar Dengan Strategi Diskusi Kelompok Terintegrasi Eksibisi Dengan Model PIMCA. Educatioanl Journal: General and Specific Research, 2, 355–3

Goodman, B., & Stivers, J. (2010). Project-Based Learning.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics, 66(1), 64–74.

Jimenez-Cardenas, M., Linan-Cuello, Y. I., & Cujia-Berrio, S. E. (2018). Association between demographic factors, motivation and self-regulation of learning from a Vygotskian perspective in engineering students. Contemporary Engineering Sciences, 11(19), 925–934. https://doi.org/10.12988/ces.2018.8381

Kwon, K. (2017). Novice programmer misconception of programming reflected on problem-solving plans. International Journal of Computer Science Education in Schools, 1(4), 14–24. https://doi.org/10.21585/ijcses.v1i4.19

Lampeang, N. S., Mondolang, A. H., Tumangkeng, J. v., Makahinda, T., Umboh, I., & Poluakan, C. (2021). Use of the four-tier diagnostic test with PIMCA model on learning of microscope. Journal of Physics: Conference Series, 1968(1). https://doi.org/10.1088/1742-6596/1968/1/012039

Londo, V. F. E., Sumarauw, S. J. A., & Regar, V. E. (2022). Optimalisasi Tahap Presentasi Model PIMCA Pada Pembelajaran Matriks Materi Spltv. Educatioanl Journal: General and Specific Research, 2, 364–371.

Mamengko, C. Q., Poluakan, C., Mondolang, A. H., Taunaumang, H., & Mongan, S. W. (2021). The use of the MR-SR based PIMCA learning model in eye as optical tools subject. Journal of Physics: Conference Series, 1968(1). https://doi.org/10.1088/1742-6596/1968/1/012043

Mayampoh, L. B., Tulandi, D. A., Rende, J., Poluakan, C., & Komansilan, A. (2021). Phyphox application with PIMCA learning model. Journal of Physics: Conference Series, 1968(1). https://doi.org/10.1088/1742-6596/1968/1/012042

Nafrin, I. A., & Hudaidah, H. (2021). Perkembangan Pendidikan Indonesia di Masa Pandemi Covid-19. Edukatif: Jurnal Ilmu Pendidikan, 3(2), 456–462. https://doi.org/10.31004/edukatif.v3i2.324

Opfermann, M., Schmeck, A., & Fischer, H. E. (2017). Multiple representations in physics and science education–why should we use them? In Multiple representations in physics education (pp. 1–22). Springer.

Panggayuh, V. (2017). Pengaruh Kemampuan Metakognitif Terhadap Prestasi Akademik Mahasiswa Pada Mata Kuliah Pemrograman Dasar.

Patol, R., Tulandi, D. A., Umboh, I., Poluakan, C., Komansilan, A., & Tumimomor, F. (2021). Development of PIMCA learning model on magnetic field. Journal of Physics: Conference Series, 1968(1). https://doi.org/10.1088/1742-6596/1968/1/012034

Poluakan, C., & Katuuk, D. (2022). PIMCA: A New Alternatives to Physics Learning Model. Journal of Physics: Conference Series, 2165(1), 012013. https://doi.org/10.1088/1742-6596/2165/1/012013

Qian, Y., Hambrusch, S., Yadav, A., Gretter, S., & Li, Y. (2020). Teachers' Perceptions of Student Misconceptions in Introductory Programming. Journal of Educational Computing Research, 58(2), 364–397. https://doi.org/10.1177/0735633119845413

Sansaka Megahantara, G. (2018). Pengaruh Teknologi Terhadap Pendidikan di Abad 21.

Sirait, J., & Mursyid, S. (2018). Students' understanding of forces: Force diagrams on horizontal and inclined plane. Journal of Physics: Conference Series, 997(1), 012030.

Wilson, L. O. (2016). Anderson and Krathwohl–Bloom's taxonomy revised. Understanding the New Version of Bloom's Taxonomy.