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Implementation of Pascal's Law Learning Media with a Scientific Approach to High School Physics Learning

Ziyad Fadhlan Nabil[1*], Vivi Mardian[2], Bagus Putra Ramadhan[3], Dadi Rusdiana[4]
[1,2,3,4] Physics Education, FPMIPA, Universitas Pendidikan Indonesia

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ABSTRACT

Physics learning is inseparable from experiments. Some teachers have not been able to provide experimental tools in schools. One of the materials that requires experimental tools is Pascal's Law. The solution provided is in the form of developing a Pascal's law experimental tool using the R & D method. The development is using the ADDIE model which consists of the stages of analysis, design, development, implementation, and evaluation. The aim of this research is to investigate the results of the implementation of the Pascal's law experimental tool. Data collection instruments with pre-test, post-test, student worksheet, and student response questionnaires. The sample was taken from one class of 20 class 11 physics students at West Java. The questions on the pre-test and student worksheet totaled 7 items and 10 questions respectively. The student response questionnaire consisted of four aspects, namely aspects of ease of use, attractiveness, efficiency, and suitability of the material. Overall, the indicators totaled 11 items which were distributed using Google Form to students. The results of the analysis show that there is a change in the results of the students' pre-test and post-test with an N-Gain of 0.24 (low category). The results of the student response questionnaire analysis are 79.51%. This indicates that the tools developed are practical and can be used in learning physics, especially Pascal's law. Future research is expected to be able to see a comparison of student learning outcomes using the Pascal's law experimental tool directly with a virtual experiment with PhET.

Keywords: Implementation, Pascal's law, Learning media, Scientific approach

INTRODUCTION

The Indonesian government is improving the quality of education by implementing the Independent Curriculum (Rohmadi, 2022; Hamdi, 2022). Implementing the Independent Curriculum is a government effort to restore learning after the Covid-19 pandemic (Natashia & Abadi, 2022; Septiani et al., 2022; Hasibuan et al., 2022). Many studies have revealed the occurrence of learning losses during online learning (Sabates et al., 2021; Schuurman et al., 2021). The Independent Curriculum will help restore and improve student competence (Vidieyanti et al., 2022; Nelisma, 2022). To achieve maximum results, there are nine guidelines that must be completed, namely the basic framework, curriculum structure, learning outcomes, teaching tools, reinforcement projects, assessment learning, operational curriculum, mechanism, and evaluation. These guidelines are being implemented by the government, teachers, students, boards of education, and the community.

Physics learning is often considered difficult for students because learning physics is

***Correspondence:**
Ziyad Fadhlan Nabil, Pendidikan Fisika, FPMIPA, Universitas Pendidikan Indonesia.
✉ email : ziyadfadhlannabil@gmail.com
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related to real and abstract natural phenomena (Astra et al., 2015; Sadiah, 2021). Previous research reveals that students find difficulties in learning physics. Some of the reasons are that the teacher does not use interactive learning media in teaching, the teacher does not familiarize students with discovering concepts, the teacher only uses the lecture method in learning and so on (Japar et al., 2020; Telaumbanua et al., 2021). The proper method used by the teacher to explain Pascal's law material is the experimental method. Physics learning is more appropriate if students practice a lot of experimental activities (Anggerni & Yohandri, 2022). Experimental activities can train students' mastery of concepts, scientific skills, and scientific attitudes (Yulyanti & Pratiwi, 2022). Therefore, teachers should have solutions to make physics learning meaningful and fun for students.

Experimental activities can be carried out if the experimental tools and materials are available. In fact, only a few schools and teachers can provide experimental tools like Pascal's Law. Although, Pascal's Law simulation in PhET software is often used as an alternative to learning. But teachers can make simple experimental tools to make it easier for students to understand the concept of Pascal's Law. The advantage of using experimental tools is that students have real experience in measuring and retrieving experimental data. In addition, several scientific skills can be trained in students, such as science process, creativity, critical, problem-solving, collaboration and other skills. Thus, experimental tools have an important role in improving students' skills.

Many previous studies have developed experimental tools, especially Pascal's law. First, research by Reski et al. (2022) reveals that Pascal's law teaching aids are worth trying out in schools. The research is still in the validation stage. Second, Rofiqah et al.'s (2022) research discusses the development of Pascal's hydraulic law press teaching aids for class VIII students at junior high school. Similar to previous studies, the teaching aids developed are still at the validation stage. The validation results and student responses are 83% material validation, 88.3% material validation and 86.5% student responses. Third, research by Maliasih et al. (2015) also discusses the development of hydrolytic kit teaching aids and worksheets. The research results show an increase in students' concepts with an N-gain value of 0.65 (moderate category). Finally, the research by Pangke et al. (2021) shows that differences in the N-gain values in the small and large group tests are 0.90 and 0.92, respectively. This shows that the teaching aids developed can improve student learning outcomes in the concept of Pascal's law.

Based on previous research, there are some deficiencies, namely that there are no teaching aids developed for understanding the concepts of high school students. In addition, most research is still at the product validation stage, so it is necessary to develop visual aids for high school students that have been validated and tested on students. This study aims to develop experimental tools to improve students' understanding of Pascal's law material. The uniqueness of this research produces effective learning media and relevant student worksheets that make it easier for students to understand Pascal's law. In addition, this study describes the results of product development, deficiencies, and implications for further research.

METHODS

This study applied a research and development (R & D) method (He et al., 2021; Schüler-Meyer et al., 2019). The form of development carried out was the development of Pascal's law experimental tool. The development model used was the ADDIE model, which stands for analysis, design, development, and evaluation (Davis, 2013; Widyastuti & Susiana, 2019). The analysis phase was carried out to determine the students' constraints in learning Pascal's law. The design phase aims to design teaching aids that will be developed based on the problems found in the field. The development stage is important before the tool is tested on students. Next is the implementation stage to determine whether the tool can increase student understanding. Finally, the evaluation stage is needed to see the deficiencies from the previous stage that must be corrected.

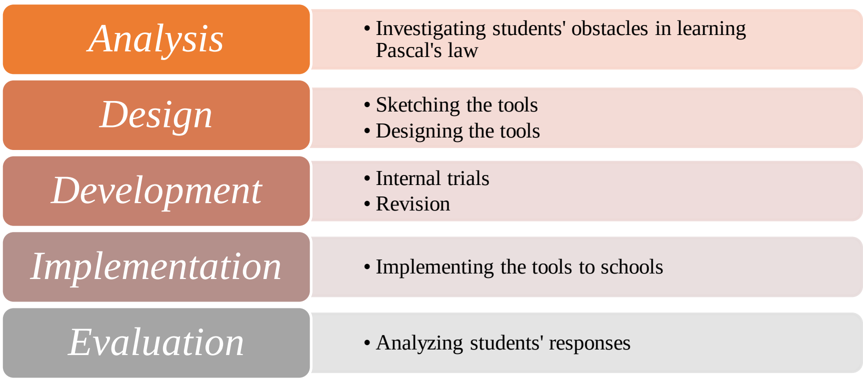

Figure 1. The ADDIE Model (Source: Molenda, 2015)

This study took a sample of 20 students in a high school in West Java. The sample consisted of 10 males and 10 females. Students were taken from different economic backgrounds. In addition, samples were taken from students who had previously studied Pascal's law material at both the junior high and high school levels. At the time of research, students had just studied Pascal's law material a week before the research was conducted. However, some students said they had forgotten the equations in Pascal's law. At that time, the school was still using the 2013 curriculum in learning, especially in class X. Each student was given a Student Worksheet to make it easier to do the experiments.

The data collection instrument used pretest and posttest assessment sheet. A pretest was given to determine students' initial skills before conducting experiments; meanwhile, post-tests would show students' skills after conducting experiments with experimental tools developed. Pretest and post-test questions in the forms of multiple choice and essay. Multiple choice questions consist of two items and essays of 4 items. These questions were taken from the results of research on the development of Pascal's legal assessment instruments that had previously been published. The data that has been collected was analyzed using Microsoft Excel and displayed in graphical form.

After conducting the experiment, students were given a practical questionnaire to see their responses after doing the experiment. The practicality questionnaire consists of 4 aspects: easy to use, attractive, efficient, and suitability of the material. The total number of questionnaires was 11 indicators which were distributed through Google Form to students. The questionnaire was given online through Google Form.

RESULTS AND DISCUSSION

Results

Results of the Analysis Stage

The first stage in this research is problem analysis. The problem is related to students' obstacles in learning Pascal's law. The results of interviews and observations with one of the physics teachers at the research school indicate that no real Pascal's law experimental tool is available in the laboratory. In addition, the results show that some students still experience misconceptions about Pascal's law material, as mentioned in the background. The development of this experimental tool is expected to increase students' interest in learning physics.

Results of the Design Stage

The second stage in this research is the design of the tool. At this stage, the criteria for tools and materials are also considered because this tool is a form of development from previous research. The tools and materials used include glass syringes, acrylic glue, sandpaper, bottle caps, pipettes, hose clamps, weights, scissors, acrylic, and hoses. All of these materials are in accordance with the project development design.

Figure 2. Equipment and materials

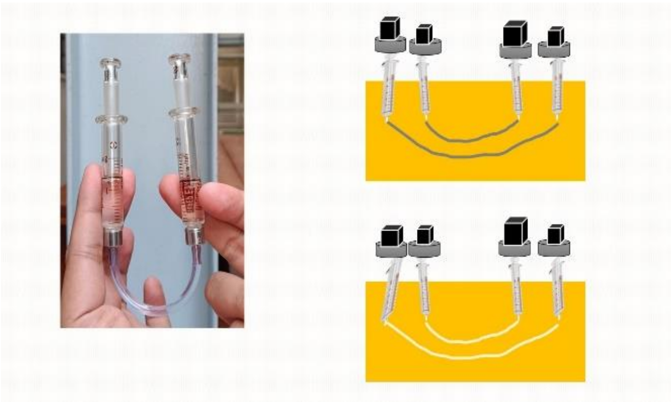

Figure 3. Initial Design

The initial design of the tool can be seen in Figure 3. The design of the tool uses the usual Microsoft PowerPoint. Initially, researchers will develop two sets of tools, each consisting of 2 pairs of tubes. The first set consists of 1 tube with different diameters and oil fluid. The second set consists of a larger weight mass, and the fluid is water. After that, an initial prototype is made, as shown on the left. However, in this case, constraints are found on the capillary pipe, so the pipe is replaced with a plastic pipe, not a capillary pipe.

Results of the Development Stage

At this stage, the tool is tested internally. The trial of the experimental tool does not only look physically but also at it in terms of conformity with Pascal's law.

Figure 4. Pascal's Law Experiment Tool

The final results of the development of the experimental tool can be seen in Figure 4. Based on the suggestions and input from the supervisor, the original piston from the plastic injection is replaced with glass syringe to reduce the frictional force between the piston and the tube. In addition, previously, the force on the second cross-sectional area is given a load but replaced with a dynamometer. This aims to obtain more accurate data, prove the concept of Pascal's law, and make it easier for students to measure the force on each piston cross-section.

Results of the Implementation Stage

The next stage is the use of tools that have been developed for schools. The sampling students have studied Pascal's law before. To find out the student's skills, seven questions are given as a pretest. Then, after conducting the experiment, processing the data, and concluding the experiment, the students are given the same question again as a posttest. The results of the students' pretest, posttest, and N-Gain analysis can be seen in Table 1.

Table 1. Analysis of Students' Pre-test dan Post-test

Student	Gender	Pre-test	Post-test	N-Gain	Category
S1	P	90	90	0.00	Low
S2	P	80	85	0.25	Low
S3	P	80	90	0.50	Medium
S4	P	90	90	0.00	Low
S5	L	85	90	0.33	Medium
S6	P	80	95	0.75	High
S7	P	80	95	0.75	High
S8	P	70	80	0.33	Medium
S9	P	75	75	0.00	Low
S10	L	70	80	0.33	Medium
S11	L	75	85	0.40	Medium
S12	P	75	85	0.40	Medium
S13	P	75	80	0.20	Low
S14	P	65	80	0.43	Medium
S15	P	65	75	0.29	Low
S16	P	90	80	-1.00	Low
S17	L	60	65	0.13	Low
S18	P	85	65	-1.33	Low
S19	P	75	80	0.20	Low
S20	L	75	85	0.40	Medium

Pre-test	77
Post-Test	82.5
N-Gain	0.24

The results of the two tests show a difference, although not significant. The average pretest and posttest scores of students are 77 and 82.5. The N-Gain calculation results obtain 0.24 in the low category. However, it can be seen that the maximum and minimum scores of the students are 90 and 60. If we look again, there are two students who receive high N-Gain categories, 8 students who receive medium N-gain categories, and 10 students who receive low N-Gain categories. The students' N-Gain scores varied quite a bit, ranging from -1.33 to 0.75. A total of three male students obtains N-Gain in the medium category while two other male students are in the low N-Gain category. Meanwhile, for female students, two students receive N-Gain in the high category. Four female students are in the medium category, and the remaining students are in the low N-Gain.

This implementation is equipped with worksheets to make it easier for students to obtain experimental data. A worksheet is designed as attractive as possible for one Pascal's law experiment. The worksheet is equipped with 10 data analysis questions. The results of the worksheet analysis can be seen in Figure 5.

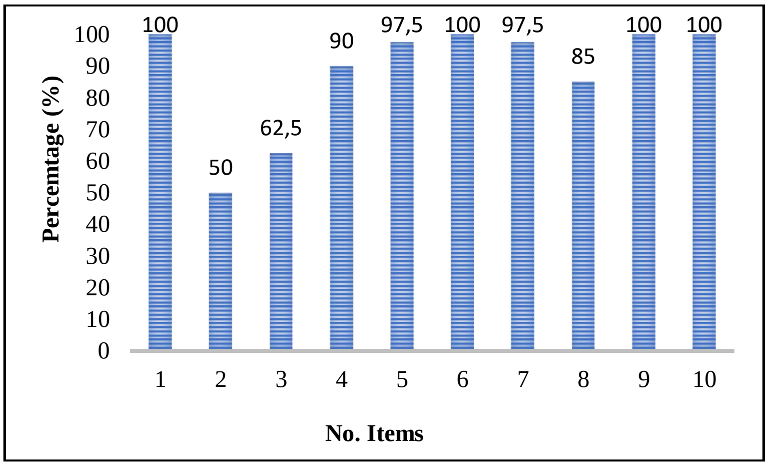

Figure 5. The Results of Students' Worksheet Analysis

The results of processing student data on the worksheet can be seen in Figure 5. Three questions were answered correctly by all students. This question relates to the identification of independent, dependent and control variables in the experiment. The other two questions deal with graph interrogation and experimental conclusions. All students have answered correctly so that the points get full points on the three questions. However, in question number 2, which is related to the factors that affect the pressure in a closed system, only 50% of them are correct. It is necessary to apply the concept of pressure in closed and open systems to students.

The title of the worksheet designed is Pascal's Law Experiment Student Worksheet. Then, it is followed by student identities such as student name, absent number, class, and day/date of experiment. After that, the experiment aims to investigate the factors that affect the pressure in a closed system and determine Pascal's law equation from the experimental results. The tools and materials consist of props developed and variations in load (5 grams, 10 grams, 20 grams). Then, work instructions are given to facilitate students in retrieving data. The observation table consists of two tables for the same cross-sectional area and different cross-sectional areas. Students are asked to complete the calculated force column, the force measured by the spring balance, and the calculated force must be on a large cross-sectional area, followed by data analysis and conclusions, which consist of 5 questions each.

Results of the Evaluation Stage

The last stage is the evaluation stage of the tools that have been developed. At this stage, 11 indicator questionnaires were distributed to determine the practicality of the tools developed based on student responses. The questionnaire consists of 4 aspects, as shown in Figure 6.

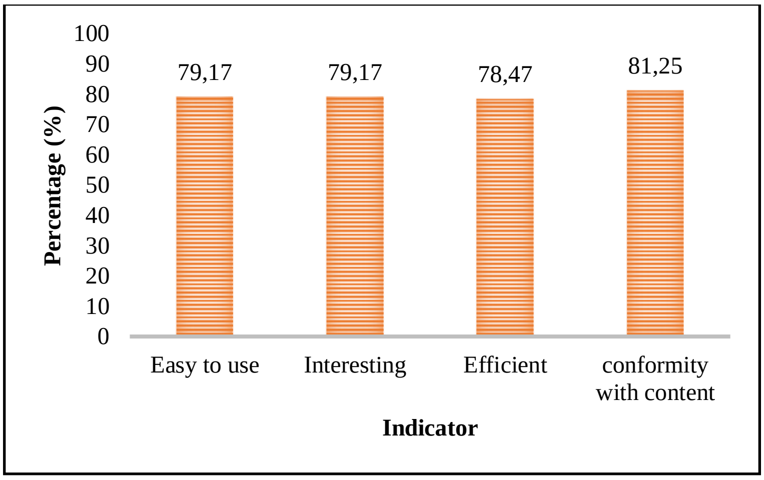

Figure 6. Student Questionnaire Analysis

Figure 6 shows the results of the practicality questionnaire analysis on the development of experimental tools. In the questionnaire, four aspects were given: easy to use, attractive, efficient, and suitability of the material. This aligns with Dwijayani's (2019) research that learning media can increase students' interest in learning. There are a total of 11 indicators in the questionnaire, namely, three indicators for ‘easy to use’, three indicators for ‘attractive’, three indicators for ‘efficient’, and two indicators for ‘suitability of the material’. The aspects of easy-to-use and attractive obtained the same percentage of 79.17 in the practical category. While the efficient aspect obtained the lowest percentage, namely 78.47%. But the difference is not too significant with other aspects. The highest aspect is obtained with a percentage value of 81.25% in the practical category. The analysis results of the average of the overall aspects are 79.51% in the practical category. Thus, the developed Pascal's law experimental tool can be used in physics learning.

Discussion

One of the learning media development models is the ADDIE model. The ADDIE model stands for analysis, design, development, and evaluation (Budoya et al., 2019; Almelhi, 2021). Several stages of developing learning media with the ADDIE model are the analysis, design, development, implementation, and evaluation (Spatioti et al, 2022).

The analysis stage is the first step in finding the problem to be solved. This analysis can be obtained from the results of interviews and observations at schools (Samudro et al., 2022). The analysis carried out relates to student learning outcomes, teacher learning media, learning models, and so on. Student learning outcomes can be obtained from daily, midterm, or final semester scores. Then, these values can be analyzed to determine whether there are misconceptions. Therefore, the analysis stage needs to be done to understand the urgent problems found in the field.

The second stage is the design stage of the tool to be developed. Tool development means similar tools already exist. However, its weaknesses are analyzed and used as innovation for further development. In the previous stage, an analysis was carried out, and the tools, materials, and the right design were determined. Learning media that are designed must follow the concepts of physics and are useful for facilitating teachers in delivering learning material (Caleon et al., 2023). The teacher plays a very important role in determining the right learning media to increase student learning outcomes (Nevrita et al., 2020; Puspitasari, 2019). The tools and materials used must consider the security and safety of students in learning. Thus, the design stage becomes the initial solution to the problems that have been found.

The next stage is the tool development stage. The designs that have been designed are then developed into tools that are ready to use (Rosmiati & Siregar, 2021). The tools developed were first tested internally. This aims to find out whether there are still deficiencies in the tool itself. In addition, trials are also carried out by taking initial data internally and calculating how many deviations occurred. From this stage, the tool development stage must be tried out so that students can get good experimental results.

After that, the stage of implementing the tool in schools (Sriwahyuni et al., 2021). The implementation stage is supported by pretest and post-test questions, worksheets, and tools developed. Pretest questions are given before conducting the experiment, while post-test questions are given after conducting the experiment. Meanwhile, worksheets are given to students to guide students in retrieving data (Kadir et al., 2020; Yau & Mok, 2016). The results of the N-gain analysis show that student learning outcomes increase after conducting experiments with Pascal's law experimental tool. However, the results do not improve significantly. This is because the tool developed is only one, so students cannot do experiments with repetition.

Student Worksheets are used to support the application of Pascal's law experimental tools. In addition, worksheets help students collect data, process, and visualize experimental results. In other words, worksheets make it easier for teachers and students in the learning process (Basuki & Wijaya, 2018; Asrizal et al., 2019). The worksheets used previously have been adjusted to the basic competencies of learning. Furthermore, the worksheet is corrected according to the direction of the supervisor. The worksheet includes the title, student name, group name, experiment objectives, tools and materials, data tables, data analysis, further data analysis, and conclusions. Each student is given a worksheet for the smooth running of the experiment.

The last stage is the tool evaluation stage which involves students (Iswati, 2019). The results of student responses indicate that the designed experimental tool is easy for students to understand so that students can improve their understanding of the Pascal concept. This aligns with the opinion of Misbah et al. (2018) that a good worksheet can be used and understood by students well. Several questions are also asked in the worksheet to determine students' understanding of the concept. Worksheets can increase students' interest and creative skills (Hekmatulaini et al., 2020; Ubuz & Erdoğan, 2019; Chien & Chu, 2018). However, on the efficient aspect, not all students obtain accurate data in reading the spring balance scale. Worksheets and experimental tools have been designed according to Pascal's law material.

In general, students can distinguish between independent, dependent, and control variables. The independent, control, and dependent variables are mass, water, and spring balance, respectively. Most students also already know the factors that affect the pressure in a closed system, such as the mass and force exerted on the piston after conducting experiments. However, in describing the graph of the relationship between the force on the first cross-sectional area and the second cross-sectional area in the experiment with different cross-sectional areas, almost all students are wrong. When interviewed, students said that they were not used to making graphs and visualizing data in graphs. Incorrect graphic images result in errors in interpreting the data in the next question. Furthermore, student errors in reading the measurement results follow the questionnaire students filled out.

This research has several drawbacks. First, experimental tools are limited to a few masses of objects, so experimental tools are needed that are more flexible with large loads. Second, experimental tools are still being tested on a small sample scale, so larger trials are needed for one or two classes. Third, experimental tools can only be used manually on Pascal's law material and only one type of fluid. In further research, it is suggested that there be research related to comparing student achievement by learning with direct experimental tools, such as Pascal's law, with virtual experimental tools, such as PhET simulations.

CONCLUSION

Pascal's law experimental tool should be used by teachers in deepening students' physics concepts. Based on the research results, it is known that there are differences in student learning outcomes before and after using the tool. These results are indicated by obtaining an N-Gain of 0.24 in the moderate category. The results of student responses also show that the tools developed are easy to use, attractive, efficient and follow Pascal's law material. The average student response rate is 79.51% in the practical category. This shows that Pascal's law experimental tool that has been developed can make it easier for students to understand the concept of Pascal's law. In addition, students can also know the factors that directly affect the pressure on a closed system.

REFERENCES

Almelhi, A. M. (2021). Effectiveness of the ADDIE Model within an E-Learning Environment in Developing Creative Writing in EFL Students. *English Language Teaching, 14*(2), 20-36.

Anggreni, Y. D., & Yohandri, Y. (2022). Pengembangan E-book Berbasis Discovery Learning Terintegrasi Keterampilan 4C Untuk Pembelajaran Fisika SMA. *Jurnal Eksakta Pendidikan (JEP), 6*(2), 117-127.

Asrizal, A., Amran, A., Ananda, A., & Festiyed, F. (2019). Effects of Science Student Worksheet of Motion in Daily Life Theme in Adaptive Contextual Teaching Model on Academic Achievement of Students. Journal of Physics: Conference Series, 1185(2019) 012093, 1-9.

Astra, I. M., Nasbey, H., & Nugraha, A. (2015). Development of an Android Application in The

Form of a Simulation Lab As Learning Media For Senior High School Students. *Eurasia Journal of Mathematics, Science and Technology Education, 11*(5), 1081-1088.

Basuki, W. A., & Wijaya, A. (2018, September). The Development of Student Worksheet Based on Realistic Mathematics Education. In *Journal of Physics: Conference Series (Vol. 1097, No. 1, p. 012112).* IOP Publishing.

Budoya, C. M., Kissaka, M. M., & Mtebe, J. S. (2019). Instructional Design Enabled Agile Method Using ADDIE Model and Feature Driven Development Process. *International Journal of Education and Development Using Information and Communication Technology, 15*(1), n1.

Davis, A. L. (2013). Using Instructional Design Principles to Develop Effective Information Literacy Instruction: The ADDIE Model. *College & Research Libraries News, 74*(4), 205-207.

Dwijayani, N. M. (2019, October). Development of Circle Learning Media to Improve Student Learning Outcomes. In *Journal of Physics: Conference Series (Vol. 1321, No. 2, p. 022099).* IOP Publishing.

Hamdi, S., Triatna, C., & Nurdin, N. (2022). Kurikulum Merdeka dalam Perspektif Pedagogik. *SAP (Susunan Artikel Pendidikan), 7*(1), 10-17.

Hasibuan, A. R. H., Aufa, A., Khairunnisa, L., Siregar, W. A., & Adha, H. (2022). Implementasi Kurikulum Merdeka di Sekolah Penggerak SDN 104231 Sugiharjo Kecamatan Batang Kuis. *Jurnal Pendidikan dan Konseling (JPDK), 4*(6), 7411-7419.

He, P., Zheng, C., & Li, T. (2021). Development and Validation of an Instrument for Measuring Chinese Chemistry Teachers' Perceptions of Pedagogical Content Knowledge for Teaching Chemistry Core Competencies. *Chemistry Education Research and Practice, 22*(2), 513-531.

Hekmatulaini, E., Djuwita, P., & Dadi, S. (2020). Pengembangan LKPD Pada Pembelajaran Tematik Menggunakan Model Role Playing di Kelas V Sekolah Dasar. *JURIDIKDAS: Jurnal Riset Pendidikan Dasar, 3*(3), 315-325.

Iswati, L. (2019). Developing ADDIE Model-Based ESP Coursebook. *Indonesian EFL Journal, 5*(2), 103-112.

Japar, M., Irawaty, I., Syarifa, S., & Fadhillah, D. N. (2020). Pelatihan Pembuatan Media Pembelajaran Berbasis ICT Untuk Meningkatkan Kompetensi Guru PPKn SMP. *Jurnal Karya Abdi Masyarakat, 4*(2), 264-269.

Japar, M., Irawaty, I., Syarifa, S., & Fadhillah, D. N. (2020). Pelatihan Pembuatan Media Pembelajaran Berbasis ICT Untuk Meningkatkan Kompetensi Guru PPKn SMP. *Jurnal Karya Abdi Masyarakat, 4*(2), 264-269.

Maliasih, M., & Hindarto, N. (2015). Pengembangan Alat Peraga KIT Hidrostatis untuk Meningkatkan Pemahaman Konsep Tekanan Zat Cair Pada Siswa SMP. *UPEJ Unnes Physics Education Journal, 4*(3).

Misbah, M., Dewantara, D., Hasan, S. M., & Annur, S. (2018). The Development of Student Worksheet by Using Guided Inquiry Learning Model to Train Student's Scientific Attitude. *Unnes Science Education Journal, 7*(1).

Molenda, M. (2003). In Search of the Elusive ADDIE Model. *Performance improvement, 42*(5), 34-37.

Nathasia, H., & Abadi, M. (2022). Analisis Strategi Guru Bahasa Indonesia dalam Implementasi Kurikulum Merdeka di SMKN 11 Malang. *Basastra, 11*(3), 227-245.

Nelisma, Y. (2022). Implementasi Kurikulum Merdeka Belajar Perpektif Manajemen Pendidikan Islam. *Al-Fahim: Jurnal Manajemen Pendidikan Islam, 4*(2), 158-172.

Nevrita, N., Asikin, N., & Amelia, T. (2020). Analisis Kompetensi TPACK pada Media Pembelajaran Guru Biologi SMA. *Jurnal Pendidikan Sains Indonesia, 8*(2), 203-217.

Pangke, R., Rende, J. C., & Komansilan, A. (2021). Pengembangan Alat Peraga Sebagai Media Pembelajaran Penerapan Konsep Hukum Pascal Untuk Peserta Didik Kelas Viii Di Smp Negeri 1 Sitimsel. Charm Sains: *Jurnal Pendidikan Fisika, 2*(2), 75-82.

Puspitasari, A. D. (2019). Penerapan Media Pembelajaran Fisika Menggunakan Modul Cetak dan Modul Elektronik Pada Siswa SMA. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar, 7*(1), 17-25.

Reski, A., Rahayu, M., & Lestari, R. D. (2022). Alat Peraga Hukum Pascal Untuk Pembelajaran Fisika SMA. *Musamus Journal of Science Education, 4*(2), 016-022.

Rofiqah, S. A., & Effendi, E. (2022). Pengembangan Media Pembelajaran Berupa Alat Peraga Press Hidrolik Sebagai Penerapan Konsep Hukum Pascal Untuk Peserta Didik Kelas VIII SMP. *U-Teach: Journal Education of Young Physics Teacher, 3*(1), 13-19.

Rohmadi, S. H. R. H. (2022). Mapping dan Orientasi Kurikulum Merdeka Berbasis Kearifan Lokal di Pendidikan Dasar. *Pendidikan Guru Madrasah Ibtidaiyah, 1*(1), 291-302.

Rosmiati, U., & Siregar, N. (2021, July). Promoting Prezi-PowerPoint Presentation in Mathematics Learning: The Development Of Interactive Multimedia by Using ADDIE Model. In *Journal of Physics: Conference Series (Vol. 1957, No. 1, p. 012007).* IOP Publishing.

Sabates, R., Carter, E., & Stern, J. M. (2021). Using Educational Transitions to Estimate Learning Loss Due to COVID-19 School Closures: The Case of Complementary Basic Education in Ghana. *International Journal of Educational Development, 82*, 102377.

Sadiah, H. (2021). Pemahaman Siswa Terhadap Hasil Belajar Fisika Pada Materi Suhu dan Kalor di SMA Negeri 2 Kota Jambi. *Jor. Eva. Edu, 2*(2), 59-62.

Samudro, G. D., Shodikin, A., & Aini, K. N. (2022). Pengembangan Media Pembelajaran Berbasis Android Menggunakan Ispring Suite 10 Pada Materi Turunan Fungsi Aljabar. *Jurnal Eksakta Pendidikan (JEP), 6*(2), 161-169.

Schüler-Meyer, A., Prediger, S., Kuzu, T., Wessel, L., & Redder, A. (2019). Is Formal Language Proficiency in the Home Language Required to Profit from A Bilingual Teaching Intervention in Mathematics? A Mixed Methods Study on Fostering Multilingual Students' Conceptual Understanding. *International Journal of Science and Mathematics Education, 17*, 317-339.

Schuurman, T. M., Henrichs, L. F., Schuurman, N. K., Polderdijk, S., & Hornstra, L. (2021). Learning Loss in Vulnerable Student Populations after the First COVID-19 School Closure in the Netherlands. *Scandinavian Journal of Educational Research*, 1-18.

Septiani, A. (2022). Implementasi Kurikulum Merdeka Ditinjau dari Pembelajaran Matematika dan Pelaksanaan P5 (Studi di SMAN 12 Kabupaten Tangerang). *AKSIOMA: Jurnal Matematika dan Pendidikan Matematika, 13*(3), 421-435.

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE

Instructional Design Model in Distance Education. *Information, 13*(9), 402.

Sriwahyuni, T., & Saehana, S. (2021, November). Developing Android-Based Teaching Material on Temperature and Heat Using ADDIE Model. In *Journal of Physics: Conference Series (Vol. 2126, No. 1, p. 012021).* IOP Publishing.

Vidieyanti, N. (2022). Manajemen Peningkatan Mutu Pendidikan Pasca Covid-19 dengan Pengimplementasian Kurikulum Merdeka. *Satya Sastraharing: Jurnal Manajemen, 6*(2), 100-108.

Widyastuti, E. (2019, March). Using the ADDIE Model to Develop Learning Material for Actuarial Mathematics. In *Journal of Physics: Conference Series (Vol. 1188, No. 1, p. 012052).* IOP Publishing.

Yulyanti, E., & Pratiwi, U. (2022). Implementasi Metode Pra-Experimental Designs untuk Meningkatkan Sikap Ilmiah dan Literasi Sains Pada Praktikum Fisika Materi GLB Siswa Ma Al-Iman Bulus Purworejo. *Lontar Physics Today, 1*(1), 18-25.

Chien, Y. H., & Chu, P. Y. (2018). The Different Learning Outcomes of High School and College Students on A 3D-Printing STEAM Engineering Design Curriculum. *International Journal of Science and Mathematics Education, 16*, 1047-1064.

Ubuz, B., & Erdoğan, B. (2019). Effects of Physical Manipulative Instructions with or without Explicit Metacognitive Questions on Geometrical Knowledge Acquisition. *International Journal of Science and Mathematics Education, 17*(1), 129-151.

Kadir, M. S., Yeung, A. S., Ryan, R. M., Forbes, A., & Diallo, T. M. (2020). Effects of a Dual-Approach Instruction on Students' Science Achievement and Motivation. *Educational Psychology Review, 32*, 571-602.

Yau, K. W., & Mok, I. A. C. (2016). Insights from Students' Private Work in Their Notebooks: How Do Students Learn from The Teacher's Examples? *Educational Studies in Mathematics, 93,* 275-292.

Caleon, I. S., Tan, Y. S. M., & Cho, Y. H. (2018). Does Teaching Experience Matter? The Beliefs and Practices of Beginning and Experienced Physics Teachers. *Research in Science Education, 48*, 117-149.