[Research Article]

IMPLEMENTATION OF *VARK-FLEMING* LEARNING MODEL TO IMPROVE STUDENTS COGNITIVE LEARNING OUTCOMES ON MECHANICAL WAVE MATERIAL

Muhamad Lutfi Alfazri[1], Rahmat Rizal[1], dan Ernita Susanti[1]

[1]Department of Education, Universitas Siliwangi, Tasikmalaya, Indonesia
E-mail: rahmatrizal@unsil.ac.id

ABSTRACT

This study aims to address the low cognitive learning outcomes of students at one of the state high schools in Tasikmalaya, by implementing the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model to enhance students' cognitive learning outcomes in the topic of Mechanical Waves. This research is classified as quantitative, using a non-equivalent control group design. The population consists of the XI MIPA class at SMA Negeri 3 Tasikmalaya, with XI MIPA 4 as the experimental class and XI MIPA 5 as the control class. The assessment instrument comprises 10 essay questions covering 4 indicators of cognitive learning outcomes: C1, C2, C3, and C4. Data analysis techniques involve t-tests and N-gain values, with results indicating that $t_{calculated} > t_{table}$, specifically 6.44 > 2.35, and an N-gain value of 0.82, which is categorized as high. It can be concluded that implementing the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes on the topic of mechanical waves and also assist teachers in designing lessons that consider students' learning style preferences.

Keywords: VARK-*Fleming* learning model, student cognitive learning outcomes, mechanical waves

1. INTRODUCTION

Education is the initial foundation of development efforts, making it the main goal of every country. Education for developed countries is intended to improve the quality of life of its citizens. At the same time, education for developing countries is an effort to catch up in the international arena to be equal to developed countries (Yuliyanti et al., 2022). The progress of a country can be identified through the quality of education prepared by its government. One way for the government to improve the quality of education so that its goals are achieved is the need for a curriculum (Safrida et al., 2021). In accordance with the Indonesian Ministry of Education and Culture, which has made various efforts to improve the development and quality of education in Indonesia, one of which is developing a national education curriculum, namely the 2013 Curriculum which began to be implemented gradually in 2013 in several target schools (Ibrahim et al., 2020).

The 2013 curriculum is a government policy in the field of education that is expected to be able to answer the challenges and problems that will be faced by the Indonesian nation in the future (Mukni'ah, 2016). This curriculum allows students to explore their interests, develop their potential, and prepare them to become independent and empowered individuals in their lives. Curriculum 13 emphasizes students on cognitive, affective and psychomotor abilities that have their own indicators. The implementation of Curriculum 13 in schools is highly dependent on the readiness of teachers during the process of learning activities at school (Anjiana et al., 2025).

Learning is a dynamic and complex system that involves components such as goals, materials, methods, and evaluation (Rusman, 2011). The achievement of learning objectives is by realizing the efficiency and effectiveness of learning activities carried out by students. In the learning process, each student has their own characteristics in receiving, processing and remembering so that the information obtained also varies (Nurnaifah et al., 2022). Therefore, teacher readiness is needed in delivering the

material to be taught in order to achieve learning objectives. Moreover, physics learning has abstract characteristics and contains concepts so that teacher readiness is needed in developing physics learning strategies (Maryam et al., 2025).

Physics is a science that studies matter, energy and also how they interact. Physics subjects aim to deliver students in developing their experience in order to formulate and solve various problems in everyday life (Erpan et al., 2021). Physics can be categorized as a subject that is less attractive to students (Astalini et al., 2018). Because there is research that shows that physics is abstract material and uses a lot of formulas to make students' interest in learning low (Astalini, et al., 2018). This shows that students' attitudes towards physics learning can affect student learning outcomes.

Learning outcomes are the results that students have obtained after receiving learning. Learning outcomes are also a curricular goal of educational programs in an educational institution in order to achieve the achievement of competencies or learning objectives that have been set (Hosnan, 2014). Factors that influence learning outcomes are internal and external factors. Internal factors include physiological and psychomotor while external factors include environmental and instrumental (Fauhah & Rosy, 2020). Learning outcomes are divided into three aspects, namely: cognitive aspects, affective aspects, and psychomotor aspects (Hosnan, 2014).

Krathwohl and psychologists revised Bloom's taxonomy on the aspect of cognitive abilities selected into two dimensions, the dimension of knowledge and the dimension of cognitive processes. The knowledge dimension in the learning process includes knowledge objects which are divided into four types, namely factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge (Rizal & Ramelan, 2024). The dimension of cognitive processes is a comprehensive classification of students' cognitive processes in the field of education (Mahmudi et al., 2022). According to Bloom revised Anderson in Krathwohl, (2002) that the

cognitive domain has six revised levels of thinking ability, namely C1 remembering, C2 understanding, C3 applying, C4 analyzing, C5 evaluating, and C6 creating.

Based on the results of observations obtained from the results of daily tests of students in class XI MIPA before remedial students have not been tutas or are still below the minimum criteria of the completeness value for physics learning is 75. Based on the results of the following preliminary study, the data on the results of students' daily tests are presented in Table 1.

Table1. Results of Students' Daily Exams

Class	Number of students	Average grade	≥ KKM		<KKM		KKM
			Total	%	Total	%	
XI MIPA 4	36	57,35	8	22%	28	78%	75
XI MIPA 5	36	54,58	9	25%	26	72%	75
XI MIPA 6	35	58,04	13	37%	22	63%	75
XI MIPA 7	35	49,11	7	20%	27	77%	75

The low daily test results of students occur due to several factors, namely the teacher still uses conventional methods during the learning process and also the lack of media used in the learning process. In addition, students rarely do practicum during the learning process. According to the teacher, the focus of students in paying attention to the material during the learning process only lasts 30 minutes because physics material contains abstract concepts resulting in decreased learning outcomes so that a model is needed that makes students more interactive and participates in the learning process.

The low results of students' daily tests require a model that provides opportunities for students according to their own learning preferences in receiving information, namely the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model. Learning using the VARK-Fleming model utilizes students' abilities that they already have by combining them in the learning process and also students can maximally find a concept through physical activities such as demonstrations, experiments, observations, and active discussion activities (Mulabbiyah et al., 2018). The application of this model proves that learning through modalities can meet the diverse learning needs of students and can also improve their learning abilities (Fatimatur, 2019).

The Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model is a learning style that was modified by Neil Fleming & Collen *Mills* from the VAK (Visual, Auditory, and Kinesthetic) learning style proposed by Barbe, Swassing, and Milone into a VARK (Visual, Auditory, Read/Write, Kinesthetic) learning style by incorporating the Read/Write modality (Fatimatur, 2019).

The Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model is a model that utilizes students' multi-sensory learning styles, namely vision, hearing, reading/writing, and movement combined during the learning process (Masnur, 2020). This *VARK-Fleming* learning model is supported by humanistic learning theory, which states that learning will be successful if students understand their environment and themselves (Mulabbiyah et al., 2018. This humanistic learning theory seeks to understand learning behavior from the point of view of the doer, not from the point of view of the observer (Maulida et al., 2024). Therefore, teachers have an important role in helping students recognize themselves to develop the potentials that exist in each of them. The VARK-Fleming learning model is a development of the quantum learning approach that is extended from the Neuro Linguistic Programming model (Fleming, 2011).

The VARK-Fleming learning model has 6 stages of the learning process as follows: 1) the preparation stage (preliminary activities) the teacher explains the learning guidelines, 2) the delivery stage (core activities on exploration) the teacher conveys material tailored to the VARK-Fleming learning style, 3) the training

stage (this activity is on elaboration) the teacher helps students to integrate and absorb new knowledge and skills, 4) the performance stage of the results (this activity is on confirmation) the teacher assists students in applying and expanding new knowledge and skills, the conclusion stage (closing activities) the teacher and students provide conclusions about the results of class learning (Ngalimun, 2012).

The material chosen in this study is mechanical wave material. This is based on interviews that have been conducted that mechanical wave material is complex material because it contains mathematical concepts and knowledge of wave properties, propagation through the medium, as well as the concepts of interference and diffraction so that it requires high focus for students. In accordance with research conducted by Wulandari, (2024) 73% of students find it difficult to understand mechanical wave material.

Based on this background, researchers are interested in applying VARK-Fleming) on mechanical wave material in class XI MIPA by conducting research entitled "Implementation of Visual, Auditory, Read/Write, Kinesthetic Learning Model (VARK-Fleming) to Improve Student Learning Outcomes on Mechanical Wave Material". The purpose of the researcher is to analyze the implementation of the Visual, Auditory, Read/Write, Kinesthetic(VARK-Fleming) learning model in improving student learning outcomes on mechanical wave material in class XI MIPA SMA Negeri 3 Tasikmalaya in the 2023/2024 school year.

2. METHODS

This research includes quantitative research using thequasi experiment method (Sugiyono, 2015). The design of this study using Nonequivalent Control Group Design can be seen in Table 2.

Table 2. Nonequivalent Control Desgn

Class	Pretest	Treatment	Posttest
Eksperiment	O_1	X	O_2
Control	O_3	-	O_4

(Sugiyono, 2015)

Description: O_1 is pretest in the control class; O_3 is pretest in the experimental class; O_2 is posttest on the control class; O_4 is posttests in experimental classes; and X treatment to students using the VARK-Fleming learning model.

The research to be carried out is by applying the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model in the experimental class and the Direct Instruction learning model in the control class. The population in this study were all XI MIPA classes consisting of 8 classes with a total of 279 students with sample determination using Purposive Sampling technique and selected XI MIPA 4 class as the experimental class and XI MIPA 5 class as the control class. In the study there are two variables, namely the independent variable and the dependent variable. The independent variable is the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model and the dependent variable is student cognitive learning outcomes.

With observation and test data collection techniques. Observation in the form of a model implementation sheet with a checklist sheet that will be filled in by 3 observers after the learning is complete. The test conducted is a test of student cognitive learning outcomes with a total of 10 essay-shaped questions, each of which covers 4 indicators of cognitive aspects, namely C1, C2, C3, C4 which have been validated and tested by researchers with the results that the instrument is valid and reliable. The test instrument will be used on the pretest and posttest. The final results of students' cognitive learning outcomes are presented in the form of a percentage. This percentage value will be interpreted into categories as shown in Table 3.

Table 3. Cognitive learning outcome categories

Category	Interpretation
81%-100%	Very high
61%-80%	High
41%-60%	Moderate
21%-40%	Low
0%-20%	Very low

(Arikunto S, 2013)

This study contains several data analysis techniques, namely the first analysis of

hypothesis testing with prerequisite tests which include normality test and homogeneity test, and then hypothesis testing. In this study, the hypothesis test used an *independent sample t-test* with a significant level of 0.01. Terms of significant *t-test* if $t_{count} > t_{table}$ then H_o rejected, H_a is accepted, otherwise if $t_{calculate} < t_{table}$ then H_o Accepted, H_a rejected.

There are two hypotheses in the study, namely (H_0) The application of the Visual, Auditory, Read/Write Kinesthetic (VARK-Fleming) learning model cannot improve students' cognitive learning outcomes in mechanical wave material in class XI MIPA and (H_a) The application of Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes on mechanical wave material in class XI MIPA.

The second analysis is to determine the improvement of students' cognitive learning outcomes using *N-Gain* analysis using equation (1).

$$N - Gain = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (1)$$
(Hake, 1998)

The N-gain category can be seen in Table 4.

Table 4. Gain categories

Category	Interpretation
$g \geq 0,7$	High
$0,3 - 0,7$	Medium
$g \leq 0,7$	Low

3. RESULTS AND DISCUSSION

3.1   Results

This study begins with conducting a pretest to determine the initial condition of students' cognitive learning outcomes before being treated in experimental and control classes. The posttest result data is shown in Table 5.

Table 5. Data analysis of cognitive learning outcomes on pretest results

Statistical Data	Class	
	Experiments	Control
N	36	36
Ideal value	100	100
Highest Scores	52	50
Lowest Scores	20	14
Average	31,3	30,5
Varians	85,04	94,85
Standard deviation	9,22	9,73

Based on Table 5, it is known that the average value of the pretest of the experimental class and the control class is not much different. This shows that no treatment has been given to the experimental and control classes. The control class variance value is slightly higher than the experimental class so that the control class has varied data. Then for the standard deviation value is used to determine the distribution of data from both classes. The standard deviation value of the control class is almost the same. This means that both classes have a distribution of data that is close to the average value.

The comparison of the percentage of indicators of students' cognitive learning outcomes in the experimental and control classes before being given the treatment is presented as follows in Table 6.

Table 6. Comparison of the percentage of cognitive learning outcomes in pretest

Cognitive Learning Outcomes	Experimental Classes		Control Classes	
	Presented	Category	Presented	Category
Remember	47%	Moderate	51%	Moderate
Understand	58%	Moderate	53%	Moderate
Apply	12%	Very low	6%	Very low
Analyze	2%	Very low	9%	Very low
Average	31%	Low	30%	Low

Table 6 shows the percentage of pretest results of cognitive learning outcomes of control class students and experimental classes. The average cognitive learning outcomes of the experimental class are slightly greater than the control class with both classes in the less category.

The provision of treatment in the form of learning models will be used after the *pretest* is carried out. The experimental class used the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model, while the control class used the Direct Instruction model.

The experimental class was taught using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model on mechanical

wave material and the control class used the Direct Instruction model that is often used by teachers. The posttest results are shown in Table 7.

Table 7. Data analysis of cognitive learning outcomes on posttest

Statistical Data	Class	
	Experiments	Control
N	36	36
Ideal value	100	100
Highest Scores	97	93
Lowest Scores	76	62
Average	88,3	77,7
Varians	37,6	65,19
Standard deviation	6,13	8,07

Table 8. Comparison of the percentage of cognitive learning outcomes in posttest

Cognitive Learning Outcomes	Experimental Class		Control Class	
	Presented	Category	Presented	Category
Remember	76%	High	90%	Very high
Understand	78%	High	92%	Very high
Apply	83%	Very high	88%	Very high
Analyze	78%	High	90%	Very high
Average	79%	High	90%	Very high

After treatment was administered to both classes, a posttest was conducted to determine students' cognitive learning outcomes. Data on students' cognitive learning outcomes are presented in Table 8. Table 8 shows the percentage of cognitive learning outcomes of control class students and experimental classes after being given the treatment of learning models. The average cognitive learning outcomes of experimental class students were greater than the control class after treatment. From these data it is known that after being given treatment using a learning model, the

level of cognitive learning outcomes of experimental class students is 11% higher than the control class with the experimental class category being very good and the control class in the good category.

After carrying out the pretest and posttest, the experimental class and control class data will be analyzed for hypothesis testing. Before the hypothesis test is carried out first the normality test and homogeneity test. The results of the normality test using Chi-Square calculation using N-Gain data on students' cognitive learning outcomes are shown in Table 9.

Table 9. Results of the calculation of the Chi-Square Normality Test

Class	$\chi^2_{calculated}$	χ^2_{table}	Conclusion	Conclusion of the analysis
Experiment	10,27		H_0 accepted	Samples have been taken from a normally distributed population
Control	8,01	12,8	H_a accepted	

Table 9 is the result of the normality test from the calculation using Chi-Square. After calculating using Chi-Square. Based on the calculated data, it is known that the value of χ^2_{table} which is 12.8 and the value of $\chi^2_{calculated}$ for the N-Gain data of the experimental class and control class, namely 10.27 and 8.01. Therefore, from both classes the value of $\chi^2_{calculated}$ is smaller than χ^2_{table}, then H_0 is accepted and H_a is rejected. So it can be concluded that the data of both classes are normally distributed.

Homogeneity test is conducted to determine whether the two groups are homogeneous or not. The calculation uses Fisher's test with N-Gain data of experimental and control classes. The results of the homogeneity test analysis are shown in Table 10.

Tabel 10. Homogeneity Test Calculation Results

Class	N	Varians (S^2)	$F_{calculated}$	F_{table}	α	Conclusion
Experiment	36	0,007	1,42	1,77	0,05	H_0 accepted
Control	36	0,010				

Table 10 shows that the *N-Gain* data of the experimental class and control class have $F_{calculated} < F_{table}$ which is 1.42 < 1.77 with hypothesis H_0 is accepted and H_a is rejected. So it can be concluded that the two classes have the same variance or homogeneous..

After the experimental class and control class data are normally distributed and have variance and homogeneity. Furthermore, hypothesis testing was carried out using independent sample t-test. The results of the hypothesis test analysis in this study are shown in Table 11.

Tabel 11. Hypothesis test results

Data	N-gain experiment and control
$t_{calculated}$	6,44
α	0,05
t_{table}	2,35
Conclusion	H_a accepted

Based on Table 11, it shows that the results of the calculation of the hypothesis test using a statistical test, namely the t-test with a significance level (α=0,05) were obtained, namely $t_{calculated}$ > t_{table} (6.44 > 2.35), so H_0 was rejected and H_a was accepted. This means that at a 95% confidence level, it can be concluded that the application of the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes on mechanical wave material in class XI MIPA SMA Negeri 3 Tasikmalaya in the 2023/2024 school year.

The results of the N-Gain of students' cognitive learning outcomes per indicator of the experimental class and the control class can be seen in Table 12.

Tabel 12. Data from the analysis of *students* ' cognitive learning outcomes

Cognitive Learning Outcomes	Experimental Class		Control Class	
	N-Gain	Category	N-Gain	Category
Remember	0,81	High	0,51	Medium
Understand	0,81	High	0,53	Medium
Apply	0,86	High	0,82	High
Analyze	0,90	High	0,76	High
Average	**0,82**	**High**	**0,68**	**Medium**

In Table 12, it is known that the improvement of students' cognitive learning outcomes per indicator. For the results of the N-gain indicator, considering that the experimental class is larger compared to the control class. In the comprehension indicator, the N-Gain value of the experimental class was greater than that of the control class. Furthermore, the indicator of applying the experimental class was larger than the control class of the two in the high category. Finally, the indicator of analyzing the experimental class was larger compared to the control class, both of which were of high category. Of the four indicators of cognitive learning outcomes, it was shown that the average N-Gain of the experimental class was greater than that of the control class. This shows that using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes compared to Direct Instruction learning.

3.2   Discussion

This study aims to analyze the improvement of students' cognitive learning outcomes after being treated using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model on mechanical wave materials. As a result of the analysis of this study, there was a difference in the average posttest score of students' cognitive learning outcomes between the control class and the experimental class. The cognitive learning outcomes of students in the experimental class using the VARK-Fleming learning model were better than those in the control class using direct instruction learning.

The learning process in the experimental classroom was carried out in 2 meetings using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model. The cognitive learning outcomes of the experimental class students were better compared to the control class. A detailed explanation of the syntax of the

VARK-Fleming learning model on students' cognitive learning outcomes is as follows:

The preparation stage (preliminary activities) aims to facilitate the indicator of remembering. At this stage, the teacher gives questions before starting learning related to the material being discussed, namely mechanical waves. The question is to encourage students to remember the material that has been studied before.

The delivery stage (core activity on exploration) aims to facilitate indicators of learning outcomes of remembering and understanding. In the memory and comprehension indicators, there was a very significant difference between the experimental class and the control class, the memorization indicator was 90% and the comprehension indicator was 92% with both being in the same category, namely very good, while the control class of the remembering indicator was 76% and the comprehension indicator was 78% with both being in the same category, namely good. At the delivery stage, the teacher directs students to find new subject matter independently, fun, and relevant, either from what the teacher conveys, the internet, or from books, involving the five senses that are in accordance with the learning style of the VARK-Fleming model. At the delivery stage, students experience four learning styles according to the VARK-Fleming model. This difference occurs because the experimental class experiences all four learning styles, so that it does not cause boredom during the learning process. In accordance with research conducted by Othman et al. (2010) that the effectiveness of students in receiving learning materials depends on the student's learning style. In contrast to the control class, students only listen to the material delivered by the teacher.

The Training Phase (this activity is an elaboration) facilitates the indicators of applying and analyzing. The indicators applied

to the control class and the experimental class were not much different from the experimental class, the indicators applied 88% and the control class 83% were both categorized as very good. At this stage, students apply the material that has been understood by carrying out simple experiments according to the steps in worksheet. The ability of students to apply the concepts that have been learned by carrying out practicum students can see the relationship between theory and practice, experience firsthand the process, and the problems/challenges that students learn. This helps students with students' analytical skills in facing concrete problems. In line with the research conducted by Hamidy et al. (2023) that learning that applies the practicum method in the learning process has better analytical skills. The indicators applying the control class and the value experiment are not much different. This happened because in the control class and the experimental class where students carried out experiments with the same WORKSHEET so that both classes were categorized as very good.

The stage of the appearance of the results (this activity is on confirmation) facilitates the indicators of understanding. The comprehension indicator achieved a score of 92% in the experimental class in the very good category and 78% in the control class in the good category. At this stage, teachers help students in applying and expanding the new knowledge and skills they get in learning activities so that learning outcomes improve. The comprehension indicator in the experimental class was greater than in the control class. This happened because in the experimental class, students were given the opportunity to use four learning styles during the process of delivering the material. Meanwhile, in the control class, students only listen to the material that the teacher conveys in front of the class. Thus, the indicators of understanding the experimental class were greater than that of the control class, even though in both classes, students carried out presentations in front of the class.

The closing stage facilitates the indicator remembering. The recall indicator reached a figure of 90% in the experimental class in the very good category and 76% in the control class in the good category. At this stage, the teacher asks student representatives to provide conclusions about the learning results that have been obtained in class. With students giving conclusions about the material that has been understood, it encourages students' memory of the material. After that, the teacher gives conclusions related to strengthening the material that has been studied. The indicator of remembering the experimental class was greater compared to the control class. This happens because in the education class, students are given the opportunity to conclude the material after learning ends. Meanwhile, in the control class, only the teacher concludes after the learning ends.

Based on the discussion above, research using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model is appropriate for use in mechanical wave materials in class XI Mathematics and Science SMA Negeri 3 Tasikmalaya. These results are evidenced by the average score of the posttest that the cognitive learning outcomes of the experimental class students are higher than that of the control class. So it can be said that using the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes compared to using the Direct Instruction model. In accordance with research conducted by Ayu et al. (2014) stated that learners using the VARK model can improve student learning outcomes.

There are obstacles when implementing the Visual, Auditory, Read/Write, Kinesthetic

(VARK-Fleming) learning model in time management. In the implementation of the experiment, it took quite a long time. So before carrying out the learning process, researchers must prepare first before learning takes place.

4. CONCLUSION

Based on the results of the research and the discussion of the results of data processing, it was concluded that the application of the Visual, Auditory, Read/Write, Kinesthetic (VARK-Fleming) learning model can improve students' cognitive learning outcomes in mechanical wave material in class XI MIPA SMA Negeri 3 Tasikmalaya for the 2023/2024 school year. These findings strengthen the conceptual foundation that the use of activity-oriented learning models and student engagement contributes to optimizing cognitive, affective, and psychomotor processes. This supports various previous studies that confirm that appropriate learning design plays a crucial role in improving the quality of learning outcomes.

5. REFERENCES

Anjiana, R., Surahman, E., & Rizal, R. (2025). Urgensi Scientific Reasoning Skills dan Creative Thinking Skills dalam Pendidikan: Analisis Awal Hasil Peserta Didik di Sekolah. *DIFFRACTION: Journal for Physics Education and Applied Physics*, *7*(2). http://jurnal.unsil.ac.id/index.php/Diffraction

Astalini, A., Kurniawan, D. A., & Sumaryanti, S. (2018). Sikap Siswa Terhadap Pelajaran Fisika di SMAN Kabupaten Batanghari. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *3*(2). https://doi.org/10.26737/jipf.v3i2.694

Astalini, Kurniawan, D. A., & Putri, A. D. (2018). Identifikasi Sikap Implikasi Sosial dari IPA, Ketertarikan Menambah Waktu Belajar IPA, dan Ketertarikan Berkarir Dibidang IPA Siswa SMP Se-Kabupaten Muaro Jambi. *Jurnal Tarbiyah : Jurnal*

Ilmiah Kependidikan, *7*(2). https://doi.org/10.18592/tarbiyah.v7i2.2142

Ayu, G., Riesa, A., Wahyuni, D. S., Gede, I., & Darmawiguna, M. (2014). Pengaruh Penerapan Model Pembelajaran Vark (Visual, Aural, Read/Write & Kinesthetic) Berbantuan LKS untuk Meningkatkan Hasil Belajar TIK Kelas XI di Sma Negeri 3 Singaraja Tahun Ajaran 2013/2014. *KARMAPATI (Kumpulan Artikel Mahasiswa Pendidikan Teknik Informatika)*, *3*(3).

Erpan, A., Nanda, F. F., Augustini, M. C., & Desnita, D. (2021). Meta Analisis Pengaruh Model Pembelajaran Kooperatif Pada Mata Pelajaran Fisika Terhadap Hasil Belajar Siswa. *Jurnal Kumparan Fisika*, *4*(2). https://doi.org/10.33369/jkf.4.2.120-128

Fatimatur, E. R. (2019). Teknologi Pembelajaran Implementasi Pembelajaran Era 4.0. In (1st ed., Vol. 1, Issue 1). UIN SUNAN AMPEL PRESS.

Fauhah, H., & Rosy, B. (2020). Analisis Model Pembelajaran Make A Match Terhadap Hasil Belajar Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(2). https://doi.org/10.26740/jpap.v9n2.p321-334

Fleming, N. D. (2011). *Teaching and Learning Styles: VARK Strategies*. https://books.google.co.id/books?id=K04uyQEACAAJ

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). https://doi.org/10.1119/1.18809

Hosnan, M. (2014). Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21.: Kunci Sukses Implementasi Kurikulum 2013. *Prosiding TEP & PDs Transformasi Pendidikan Abad 21*.

Ibrahim, I., Ridwan, R., & Arifin, A. (2020). Implementasi Kurikulum 2013 Untuk Meningkatkan Kualitas Pendidikan Di Indonesia (Kajian Proses Pembelajaran K-13 Di Kota Tarakan Dan Kabupaten

Bulungan Kalimantan Utara). *Borneo Journal of Biology Education (BJBE)*, *1*(2). https://doi.org/10.35334/bjbe.v1i2.1727

Ihwan Mahmudi, Muh. Zidni Athoillah, Eko Bowo Wicaksono, & Amir Reza Kusuma. (2022). Taksonomi Hasil Belajar Menurut Benyamin S. Bloom. *Jurnal Multidisiplin Madani*, *2*(9). https://doi.org/10.55927/mudima.v2i9.1132

Krathwohl, D. R. (2002). A revision of bloom's taxonomy: An overview. In *Theory into Practice* (Vol. 41, Issue 4). https://doi.org/10.1207/s15430421tip4104_2

Masnur, M. (2020). Peningkatan Kreativitas Matematika Melalui Model Vark-Fleming Pada Siswa Kelas V Sdn 8 Tampaan. *Mahaguru: Jurnal Pendidikan Guru Sekolah Dasar*, *1*(1). https://doi.org/10.33487/mgr.v1i1.321

Maryam, S., Rizal, R., & Suhendi, H. (2025). Development of Electronic Student Worksheets Based on the Science, Environment, Technology, and Society Learning Model on Sound and Light Waves Topic. *JURNAL EKSAKTA PENDIDIKAN (JEP)*, *9*(2), 167–181. https://doi.org/10.24036/jep/vol9-iss2/971

Maulida, M., Berlianna Putri, S., Irawan, H., Maulidah, R., & Rizal, R. (2024). Analisis Keberhasilan Penggunaan E-Learning pada Pembelajaran Fisika Kelas X MIPA di SMAN 4 Tasikmalaya. *DIFFRACTION: Journal for Physics Education and Applied Physics*, *6*(2), 75–82. https://doi.org/10.37058/diffraction.v6i2.10220

Rusman, M. (2011). Model-model pembelajaran: Mengembangkan profesionalisme guru. In *Jakarta: Raja Farindo Persada* (Vol. 1).

Mukni'ah. (2016). Perencanaan Pembelajaran Sesuai Kurikulum Tingkat Satuan Pendidikan (KTSP) dan Kurikulum (K-13). In A. Muhith Pustaka Pelajar (Anggota IKAPI).

Mulabbiyah, I. & Ahmad, S. (2018). Penerapan Model Pembelajaran Fleming-VAK (Visual, Auditory, Kinesthetic) untuk Meningkatkan Hasil Belajar Siswa Kelas IV MI Thohir Yasin pada Muatan Pelajaran IPA. *El-Midad Jurnal Jurusan PGMI*, *10*(1).

Ngalimun. (2012). Strategi Dan Model Pembelajaran. In *Aswaja Pressindo*.

Nurnaifah, I. I., Akhfar, M., & Nursyam. (2022). Pengaruh Gaya Belajar terhadap Hasil Belajar Fisika Siswa. *Al-Irsyad Journal of Physics Education*, *1*(2). https://doi.org/10.58917/ijpe.v1i2.19

Rizal, R., & Ramelan, M. M. (2024). Optimalisasi pemanfaatan google form dalam penilaian hasil belajar peserta didik di SDN 4 Argasari. *KARISMAS: Jurnal Pengabdian Karya Inovasi Masyarakat*, *1*(1), 6–13.

Safrida, N., & Muhammad, M. (2021). Implementasi Kebijakan Pemerintah dalam Meningkatkan Kualitas Pendidikan di Aceh Barat. *Publikauma : Jurnal Administrasi Publik Universitas Medan Area*, *9*(2). https://doi.org/10.31289/publika.v9i2.6027

Sugiyono. (2015). *Metode Penelitian Kuantitatif Kualitatif Dan R&D*. ALFABETA cv.

Wulandari, K. M. (2024). Penerapan LKS Berbasis Contextual Teaching And Learning Terhadap Hasil Belajar Siswa Pada Materi Gelombang Mekanik Di SMAN 4 Palangka Raya. *Relativitas: Jurnal Riset Inovasi Pembelajaran Fisika*, *6*(2). https://doi.org/10.29103/relativitas.v6i2.13435

Yuliyanti, Y., Damayanti, E., & Nulhakim, L. (2022). Perkembangan Kurikulum Sekolah Dasar Di Indonesia Dan Perbedaan Dengan Kurikulum Di Beberapa Negara. *Lingua Rima: Jurnal Pendidikan Bahasa Dan Sastra Indonesia*, *11*(3). https://doi.org/10.31000/lgrm.v11i3.7271