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Application of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on Students' Learning Achievement in the Topic of Sound Waves

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ABSTRACT
Physics is a science that is often considered difficult by students and causes low physics learning achievement. One of the causes of low learning achievement is internal factors that arise from within the students, so a strategy with a self-regulated approach is needed such as the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM (Analyse, Plan, Implement, Comprehend, Problem-Solve, Evaluate, Modify) so that students can carry out learning according to their needs and characteristics. This study aims to determine the application of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on students' learning achievement in sound wave material. This research was conducted at a high school in Bandung with a sample of 72 students. The research method used is a mixed method with an unbalanced mixed design (concurrent embedded design). Quantitative data were collected through nonequivalent (posttest only) control group design using the posttest instrument for learning achievement in sound waves. Then qualitative data as a support was collected through narrative qualitative using a SRSL APICPEM mixed questionnaire instrument. The results showed that the implementation of APICPEM SRSL in the experimental group went very good (average score is ≥80%), with the selection of various student learning strategies according to the characteristics and various other factors, both internal and external factors of students. As well as there is a significant influence from the implementation of SRSL APICPEM on learning achievement with the effectiveness of its influence is evident from the effect size test, which resulted in a value of 0.622, classified as very high. Therefore, this study was able to prove that the application of SRSL APICPEM was able to improve student learning achievement in the topic of sound waves.

Keywords: *self-regulated, self-regulated approach to strategic learning, learning achievement, sound waves*

INTRODUCTION

Science is a field of knowledge that has been introduced to students since they are in the elementary education level. One of the branches of science that is studied is physics, which is the study of natural phenomena or events that occur in everyday life. Therefore, physics is a science that is closely intertwined with human life. Unfortunately, physics is often perceived as a difficult subject to learn, so the average student lacks interest in studying physics, and many students have low learning achievements in physics (Charli, Ariani, & Asmara, 2019; Erviani, Sutarto, & Indrawati, 2016; Guido, 2013; Maulida, Prihandono, & Maryani, 2019).

Observations conducted at a high school in Bandung revealed that many students find learning physics difficult because they have to memorize a large number of concepts and equations in a relatively short period of time. This is reflected in the low academic performance of 11th-grade science students, as shown by their physics scores in the end-of-semester exams for the odd semester of the 2022/2023 academic year. Out of a total of 249 students, only one student scored above the minimum passing criteria (MPC), resulting in a pass rate of just 0.4%. The average physics score in the exams was only 46.38. The low academic achievement is attributed to technical errors during the web-based exam, students' lack of attention during physics lessons, and insufficient preparation for the exam. Sari and Satwika (2018) also investigated the causes of low academic performance, identifying poor study habits among students, such as not paying attention during lessons, skipping classes, neglecting assignments, and spending most of their time playing instead of studying.

In essence, learning achievement is defined as a measure of a students' success in learning (Syafi'i, Marfiyanto, & Rodiyah, 2018). Learning achievement is influenced by various factors, both internal factors stemming from the student themselves and external factors (Syah, 2008). One of the internal causes of low learning achievement in students is their habits (Sari & Satwika, 2018). This is because the habits they form will affect their learning activities, thus impacting their learning achievement (Herryanti, Tanzeh, & Masrokan, 2021). Therefore, Ningsih, Sulistyaningsih, and Hardjo (2014) state that students' habits, whether good or less favorable, should be promptly trained and observed by parents and teachers so that students can undergo positive changes and create a conducive and enjoyable learning environment that supports their learning activities.

Based on this issue, one way that teachers can use to improve learning achievement is by creating strategic learning and teaching, also shaping students' study habits (Filianti, 2022; Sagala, 2017). Considering the differences in study habits among students, this strategic learning can be carried out by students by applying learning strategies tailored to their own characteristics, also known as self-regulated learning. This is supported by Biber's statement (2022) that students need to determine learning strategies and enhance awareness of what they have learned in a subject so that they become more aware of how they learn new information or knowledge, what needs to be learned and understood, what they should do during the learning process, and at what level they position themselves in the learning process (Kristiyani, 2016; Latipah, 2015).

Zimmerman and Martines-Pons (1990) stated that self-regulated learning is an internal factor that can influence students' learning achievement. This is because students with high learning achievement can internally manage their learning better than those with low performance. By practicing self-regulated learning, students become more active in utilizing their academic abilities, setting learning goals, selecting and planning their study strategies, and monitoring their learning progress (Zimmerman, 2008).

Irsyadella (2020) conducted research to explore the use of self-regulated learning strategies by successful learners in English language learning at Surabaya State University qualitatively, and concluded that high-achieving learners apply self-regulated learning strategies in four dimensions: cognitive, motivational, social, and affective. Similarly, research by Biber (2022) on the same topic found that students with high learning achievement use almost all of self-regulated learning strategies compared to students with low learning achievement in preparing for mathematics exams. Thus, it can be concluded that there is a positive influence on improving learning achievement through the application of these learning strategies (Anas & Alsa, 2016; Biber, 2022; Rosario, Nunez, Valle, et al., 2013; Toro, 2022; Woolfolk, 2018).

Among the various self-regulated learning strategy models that developed by experts, researchers focus on using the Self-Regulated Approach to Strategic Learning (SRSL) model, which consists of seven macro-metacognitive strategies called APICPEM: analyze, plan, implement, comprehend, problem-solve, evaluate, and modify. The advantage of this strategy model is that each macro-metacognitive strategy is explained in detail, enabling students to engage in recursive learning and adapt their learning strategies to their needs and characteristics (Philip, 2006).

Therefore, SRSL APICPEM provides flexibility for students to explore the use of their learning strategies in line with the concept of self-regulated learning.

Based on the previous discussions, researchers have identified a gap in students' learning achievement, particularly in the subject of physics. Hence, this study tests students from the 11th grade in a high school in Bandung to determine the influence and effectiveness of applying the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on physics learning achievement. In the testing process, the researchers selected the topic of Sound Waves because it is an everyday phenomenon that we continuously observe, and it is one of the mandatory topics in the physics curriculum for 11th-grade science students. However, many students find the topic of sound waves difficult to understand, as discovered by Heldawati, Septiana, and Yuliani (2022), that 57.7% of students struggling with this topic. This is often due to misconceptions and misunderstanding caused by the numerous formulas in this topic (Maulida, Prihandono, & Maryani, 2019). So that research on this material becomes interesting, and it is hoped that researchers can obtain good and ojective research results to solve these problems. In addition, to delve deeper into the discussion of the implementation of Self-Regulated Approach to Strategic Learning APICPEM by each student, this study utilizes a mixed-method concurrent embedded design.

Based on the problem background and empirical data obtained, this research aims to gain insight into the influence and effectiveness of applying the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on students' learning achievement in the topic of sound waves, as well as the implementation of SRSL APICPEM by each student as an effort to enhance their learning achievement.

METHODOLOGY

This research is a mixed-method study with a concurrent embedded design, which is a design that collects quantitative and qualitative data at the same time (concurrent), but both quantitative and qualitative methods have different portions (Creswell, 2009). The rationale for choosing this method and design is to complement the quantitative research regarding the influence and effectiveness of implementing the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on students' learning achievement in the topic of sound waves with qualitative data related to how each component of SRSL APICPEM is implemented by students in the experimental group and the learning strategies chosen by each student during the implementation of SRSL APICPEM as an effort to improve their learning achievement. Image 1 shows the research design used.

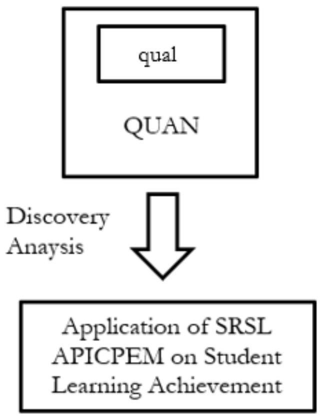

Image 1. Concurrent Embedded Design

The use of capital letters in the word "QUAN" signifies that this research uses quantitative methods as its primary method, while the use of lowercase letters in the word "qual" indicates that qualitative methods serve as a secondary method integrated into the primary method. The quantitative method used in this research is a quasi-experimental nonequivalent (posttest only) control group design, in which the researcher formed an experimental group receiving treatment, which is the application of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM using a scientific approach, and a control group receiving traditional scientific approach instruction. At the end of the instruction, both groups were given a posttest in the form of a learning achievement test on the topic of sound waves. The qualitative method employed is qualitative narrative, which is obtained from journal documentation in the form of a mixed questionnaire about the implementation of SRSL APICPEM that must be completed by students in the experimental group.

This research was conducted in May 2023, with the quantitative research subjects being 72 eleventh-grade high school students in one of the high schools in Bandung, consisting of 36 students in the experimental group and 36 students in the control group. This sample was selected using the convenience sampling or accidental sampling technique, which involves selecting samples based on convenience or availability from the population (Arikunto, 2015; Sugiyono, 2013). Meanwhile, the qualitative research subjects were all the students who received the SRSL APICPEM treatment, which is the students in the experimental group.

The research commenced with a preparation phase, which included conducting preliminary studies, identifying and formulating research questions, examining research variables, determining the research methodology to be employed, analyzing the fundamental and core competencies related to sound waves topics, designing instructional materials to facilitate the learning process, creating quantitative research instruments along with their validation and testing, and designing qualitative research instruments along with their validation. Subsequently, the implementation phase involved selecting samples through convenience sampling, then providing treatment to the experimental group, which entailed the application of SRSL APICPEM in scientific approach learning. At the beginning of the sessions, the researcher explained various learning strategies and the stages of SRSL APICPEM to the students. During three sessions, the students were directed to complete the SRSL APICPEM Questionnaire after classroom learning. Additionally, the control group received traditional scientific approach instruction for three sessions. Finally, a posttest was administered to both groups in the form of a multiple-choice learning achievement test on the topic of sound waves. The concluding phase of the research involved data analysis, drawing conclusions, and compiling and reporting the research findings.

The quantitative instrument used to measure students' learning achievement is a multiple-choice test consisting of 13 questions related to the topic of Sound Waves, which are organized according to competency achievement indicators and based on the cognitive aspect of Bloom's revised taxonomy, including C1 Knowlegde, C2 Comprehension, C3 Application, and C4 Analysis. Below is the matrix of the sound waves learning achievement test instrument.

Table 1. Matrix of the Sound Waves Learning Achievement Test Instrument

Question Number	Question Indicator	Cognitive Aspect
1	Explaining factors influencing the speed of sound wave propagation.	C2
2	Utilizing the equation for sound wave propagation in problems.	C3
3	Determining factors affecting the frequency of sound waves on a string.	C2
4	Determining the pitch produced by sound waves on a string.	C3
5	Selecting the correct statements regarding the characteristics of a sound source.	C1
6	Determining the pitch produced by sound waves in an organ pipe.	C3
7	Determining the length of a closed organ pipe	C3

Question Number	Question Indicator	Cognitive Aspect
8	Distinguishing the concepts of beats and sound resonance.	C4
9	Interpreting sound resonance diagrams.	C2
10	Determining sound resonance using equations.	C3
11	Applying sound intensity equations to solve problems.	C3
12	Comparing sound intensity levels in problems.	C4
13	Using the Doppler effect equation to solve problems.	C3

Before being administered as a posttest to both research groups, these questions were validated by three experts, consisting of two senior lecturers in the physics education program who have been teaching the Wave and Optics course for many years, and one senior physics teacher who teaches physics across three grade levels (10th, 11th, and 12th) and covers wave-related material, with over 20 years of teaching experience. Their experience and expertise are believed to be sufficient to accurately assess the questions that will be administered.

These questions also undergone testing. The expert validation results indicated that each question item was valid and suitable for testing. Subsequently, the testing results indicated that these thirteen questions had a validity rating ranging from quite high to very high, with an average score of 0.618 (high validity). Furthermore, the reliability of the questions achieved a score of 0.832, signifying a highly reliable assessment.

Meanwhile, the qualitative instrument used to monitor the implementation of SRSL APICPEM and the selection of learning strategies by students was a journal of activities presented in the form of a mixed questionnaire tailored to the micro-strategies aspect of the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM. This instrument was employed by students over the course of three sessions corresponding to the learning sessions for the topic of sound waves. Table 2 shows the matrix of the SRSL APICPEM questionnaire instrument.

Table 2. Matrix of the SRSL APICPEM Questionnaire Instrument

Number	SRSL Component	Description	Indicator	Question Number
1	Analyse	Students identify the learning objectives, understand the important aspects of the task/learning that align with their characteristics, and explore potential learning techniques individually. They contemplate analytical questions in the scientific context before commencing independent learning. These questions may encompass what, why, and how related to the physics learning they are undertaking in school.	1. Reviewing the learning objectives. 2. Understanding the essential aspects of the task/learning.	1, 2, 3,4 (AP Section)
2	Plan	Students create a plan concerning the overall picture of the task or learning, then specify the strategies they will use to support independent learning.	1. Creating a independent learning plan 2. Determining the learning strategies to be used in their independent learning	5, 6 (AP Section)
3	Implement	Students implement the independent learning strategies they have planned.	Implementing the independent learning plan	1, 2 (ICPEM Section)
4	Comprehend	Students monitor their learning comprehension (such as double-checking).	Monitoring learning comprehension	3, 4, 5 (ICPEM Section)

Number	SRSL Component	Description	Indicator	Question Number
5	Problem solve	Students seek and understand solutions they can use to solve problems in the task/learning.	Identifying solutions that can be used to solve problems in the task/learning	6, 7 (ICPEM Section)
6	Evaluate	Students reflect on the planning and execution of their independent learning, then evaluate how successful the learning plan and execution were in achieving the learning objectives. Additionally, students consider how effective the strategies they employed in independent learning were.	1. Reflecting on the effectiveness of the plan and execution of independent learning with respect to the predeterminded learning objectives. 2. Assessing how well the strategies employed in learning were.	8, 9, 10 (ICPEM Section)
7	Modify	Students have the ability to modify the independent learning strategies they use.	Considering the learning strategies to be used in the next independent learning session.	11, 12 (ICPEM Section)

Before being administered to the sample for research, the instrument underwent content validity and construct validity testing by three experts: two physics education lecturers who are masters in education, ensuring that the content of the instrument remains relevant from an educational and physics perspective, and one guidance counselor who has a psychology background and extensive experience as a school counselor in secondary education, ensuring the content remains relevant from a psychological or metacognitive perspective of self-regulation. Their experience and expertise are believed to be sufficient to evaluate the instrument effectively.

Content validity testing was conducted using the Content Validity Index (CVI) and Content Validity Ratio (CVR) (Yusoff, 2019). In the CVI validity test, an S-CVI value of 0.98 was obtained, indicating that the SRSL instrument has very high validity and is suitable for use. Furthermore, the CVR validity test also yielded results indicating that each item in the questionnaire demonstrated sufficient and high validity, signifying that all items in the SRSL instrument are valid.

The quantitative data analysis conducted in this study involved hypothesis testing for two independent samples and effect size to determine the influence and effectiveness of implementing SRSL APICPEM on students' learning achievement. However, before conducting inferential statistical tests, prerequisite tests were performed, including tests for normality and homogeneity. To facilitate data analysis, IBM SPSS Statistics 25 software was used. Because the prerequisite tests indicated that the data were not normally distributed and not homogenous, non-parametric inferential statistical tests were employed, leading to the use of the Mann-Whitney U test. The first step conducted was similar to an independent samples t-test, which involved formulating the null and alternative hypotheses.

$$H_0: \mu_1 = \mu_2$$
$$H_1: \mu_1 \neq \mu_2$$

$H_o =$ "There is no significant difference in the learning achievement of students who apply the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM in scientific learning compared to the learning achievement of those taught only using scientific learning."

$H_1 =$ "There is a significant difference in the learning achievement of students who apply the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM in scientific learning compared to the learning achievement of those taught only using scientific learning."

The initial hypothesis (H_o) states that learning with the application of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM does not significantly impact students' learning achievement in the topic of sound waves. Conversely, the alternative hypothesis (H_1) states the opposite, indicating that learning with the application of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM significantly affects students' learning achievement in the topic of sound waves.

To assess the effectiveness of this influence, an effect size was used for Mann-Whitney U with the following equation:

$$r = \frac{z}{\sqrt{n}} \quad (1)$$

The criteria for interpreting the effect size values are shown in Table 3 below (Fritz, Morris, & Richler, 2011).

Table 3. Interpreting The Effect Size Values

Effect Size	Criteria
$r \geq 0{,}5$	High
$0{,}3 \leq r > 0{,}5$	Medium
$0{,}1 \leq r > 0{,}3$	Small

Qualitative data analysis, on the other hand, employed Miles and Huberman's analysis approach, which consists of data reduction, data presentation, and drawing conclusions or verification (Sugiyono, 2013). In the data reduction phase, data obtained from the mixed questionnaire were summarized, key and essential points were selected, and themes and data patterns were identified to provide a clear overview of the research. This process was aided by coding each student's responses in the SRSL APICPEM questionnaire. The next stage is data presentation, where data is presented in the form of brief descriptions, tables, graphs, and percentages to organize the data into patterns and relationships. The aim is to make it easy for the researcher to understand the data obtained in the study. Data description using calculating percentage. The number of parts is the number of codes assigned to each student's response, while the total number is the total number of student responses. The categories of SRSL APICPEM implementation are shown in Table 4 (Kurniasari, Pribowo, & Putra, 2020).

Table 4. Categories of SRSL APICPEM Implementation

Percentage	Category
$\geq 80\%$	Very good
60% - 79%	Good
40% - 59%	Fair
21% - 39%	Low
0% - 20%	Very low

The final stage is drawing conclusions or verification, where the analyzed data results in a research conclusion regarding the description of the implementation of each component of SRSL APICPEM applied by students in the experimental group and the learning strategies chosen by students while implementing SRSL APICPEM.

RESULT AND DISCUSSION

Implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM

The implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM is observed through the execution of each component by students in the experimental group. This qualitative data was obtained through the SRSL APICPEM mixed questionnaire administered three times during sessions, and it was analyzed using Miles and Huberman's analysis approach. Firstly, the acquired data was reduced by assigning codes to each student's responses, and then the data was presented in the form of tables and percentages to facilitate drawing conclusions. The following table indicates the implementation of each SRSL APICPEM component.

Table 5. Implementation of Each SRSL APICPEM Component

Number	Component of SRSL	Percentage (%)	Category
1	Analyse	91,5	Very good
2	Plan	94	Very good
3	Implement	79,5	Very good
4	Comprehend	97	Very good
5	Problem Solve	90,5	Very good
6	Evaluate	99	Very good
7	Modify	97,5	Very good

Based on Table 5, it is evident that each SRSL component has been executed very good. All students fulfill the SRSL indicators as outlined in Table 2 concerning the SRSL APICPEM questionnaire instrument matrix. However, students' responses to each question at each APICPEM stage were fluctuating and diverse, consistent with the approach used in this strategy, which is self-regulated. This aligns with the theory proposed by the creator of the Self-Regulated Approach to Strategic Learning model, Philip (2006), which emphasizes that the SRSL model takes into account the fact that students may have learned specific learning strategies but may require some modifications in their application to better adapt to themselves. The SRSL APICPEM strategy guides students to become more aware of how to use learning strategies by focusing on themselves as the primary decision-maker and responsible for each learning activity. Therefore, SRSL provides room for students to explore the use of strategies while building their understanding of the given tasks or learning materials.

Selection of Learning Strategies by Students During Applying SRSL APICPEM

The learning strategies applied by students in this research are flexible and adapted to the Self-Regulated approach, allowing students to choose one or more of the provided learning strategies for their independent learning. The selection of learning strategies takes place during the planning component. Below is the presentation of data regarding the learning strategies chosen by students in the experimental group during three SRSL APICPEM sessions.

Table 6. Selection of Learning Strategies by Students during Applying SRSL APICPEM

Number	Learning Strategy	Amount			Average
		Session 1	Session 2	Session 3	
1	Dual coding	3	4	5	4
2	Keyword mnemonic	3	3	4	3
3	Summarize	20	22	17	20
4	Highlighting	15	18	18	17
5	Read Aloud	8	8	6	7
6	Self-Explanation	13	6	7	9
7	Practice Testing	17	8	8	11
8	Concrete Examples	5	5	5	5

Based on the data, it can be concluded that the most frequently chosen learning strategy by students while implementing SRSL APICPEM is summarizing, selected an average of 20 times. This is followed by highlighting, practice testing, self-explanation, read-aloud, dual coding, concrete examples, and the least selected is keyword mnemonic.

As previously explained, learning strategies with a self-regulated approach prioritize the regulation or self-management of students in their learning. Therefore, students are given the freedom to modify their learning and study plans based on their reflection (Toro, 2022; Sari & Satwika, 2018). Hence, each student is given the freedom to choose one, two, or even more than two learning strategies for independent learning. If we look at Table 7 again, there is a difference in the number of selections of learning strategies at each SRSL session. This difference occurs because the selection of learning strategies is discussed in the final stage of SRSL APICPEM, which is "modify". In this stage, students are directed to take action after using the learning strategy previously chosen in the planning stage and implemented in their independent learning. Students are given the opportunity to decide whether to use the same learning strategy in their next independent learning session, use a different learning strategy, or even modify their learning strategy. From the three SRSL APICPEM sessions, the dominant response is "depends." This means that students' decision to modify their learning strategy depends on various factors. The reasons can vary from the material being studied, the available study time, the situations and conditions they face, the perceived effectiveness of the strategy, to the students' feelings while learning.

Hence, it can be inferred that various other factors also influence students' decisions in determining their independent learning strategies, including internal factors like physical and emotional states, feelings, as well as external factors such as time, materials, and their learning environment. This is in line with the findings of Rina Dunn, a pioneer in the field of learning styles (as cited in Mufidah, 2017), who discovered that many variables affect an individual's learning style, including physical, emotional, sociological, and environmental factors.

The Influence of SRSL APICPEM on Students' Learning Achievement

Based on the normality and homogeneity tests conducted, both the experimental and control groups had non-normal and non-homogeneous data distributions. This was due to the results of the normality test of learning achievement at a significance level of 0.05 in both the experimental and control groups, which were 0.000 < 0.05, as well as the results of the homogeneity test of learning achievement at a significance level of 0.05 in both the experimental and control groups, which were 0.002 < 0.05. This occurred because the posttest data on learning achievement in both groups contained outliers or data with extreme scores. Therefore, the posttest data were analyzed using a non-parametric analysis, specifically the Mann-Whitney U test, which aimed to test the hypothesis for two independent samples to determine whether there was an effect of treatment on the experimental and control groups' learning achievement in the subject of sound waves. The following are the results of the Mann-Whitney U hypothesis test.

Table 7. Mann-Whitney U Hypotesis Test Result

Test Statistics[a]	
	Posttest (Learning Achievement)
Mann-Whitney U	197.500
Wilcoxon W	863.500
Z	-5.278
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Group

Based on Table 7, the significance value (2-tailed) was 0.000 < 0.05. This means that the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. Therefore, it can be concluded that there is a significant difference in the learning achievement of students who apply the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM in scientific learning compared to learning achievement in scientific learning alone.

This conclusion is also supported by the data found during the study. The positive influence of SRSL APICPEM on learning achievement can be seen in Table 7, which shows the learning achievement results of the experimental and control groups. The average learning achievement in the experimental group was 88.2, while the average learning achievement in the control group was 73.5, with a difference of 14.7 between them. Based on this data, it can be concluded that the average learning achievement in the experimental group is 1.2 times higher than that in the control group.

Table 8. Learning Achievement Test Results on Experimental and Control Group

Result	Experimental Group			Control Group		
	Max	Min	Average	Max	Min	Average
Posttest	92,3	61,5	88,2	92,3	38,5	73,5

Therefore, the hypothesis testing results, supported by the facts found during the study, can answer that learning with the implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM has a significant influence on students' learning achievement in the subject of sound waves.

Efectiveness of SRSL APICPEM on Students' Learning Achievement

After conducting the Mann-Whitney U test, a non-parametric Effect Size test was performed to determine the magnitude of the influence of the implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM on students' learning achievement in the subject of sound waves. Since this research data is non-parametric, the effect size test used is also for non-parametric data. Based on the calculation, the effect size value obtained is 0.622, which interprets that the influence of the implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM has a high effectiveness on students' learning achievement in the subject of sound waves. Thus, this result can prove that learning with the implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM is effective for students' learning achievement in the subject of sound waves.

These research results are supported by the study conducted by Stephanie Toro (2022) in "Self-Regulated Learning Strategies for the Introductory Physics Course with Minimal Instructional Time Required," which found that the implementation of self-regulated learning strategies improved student learning achievement in the basic physics course. Furthermore, the study by Sari and Satwika (2018) also found a significant relationship between self-regulated learning and students' learning achievement at SMK Muhammadiyah 1 Taman Sidoarjo. Additionally, the research by Anas and Alsa (2016) discovered a significant positive relationship between self-regulated learning and mathematics learning achievement in junior high school students, meaning that the higher the SRL, the higher the mathematics learning achievement. This aligns with the research conducted by Biber (2022) and Irsyadella (2020), which found that students who have good learning achievements are able to apply self-regulated learning strategies. Of course, this research is based on the findings of self-regulated learning experts, such as Zimmerman (1989), who found a positive relationship between self-regulated learning strategies and learning achievement.

The advantage of this research is its novelty in the topic of SRL strategies on learning achievement, as there have been no studies on the implementation of the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM model developed by Philip (2006) regarding physics learning, especially in the topic of sound waves. Therefore, this research can serve as a new reference for future research, such as applying SRSL APICPEM strategies to learning achievements in other physics topics or even in other subjects. The implications of this research for enhancing physics education are significant. The findings can be utilized to design interventions aimed at improving students' study habits, such as more engaging teaching methods and additional support to help students enhance their performance. Additionally, the research provides a valuable reference for further evaluation within the context of physics education, as the developed instrument can aid in assessing students' understanding and identifying areas that need improvement. Also, the study highlights the importance of incorporating psychological approaches into the learning process, particularly concerning self-regulation. This approach can be implemented to boost students' motivation and learning strategies, which, in turn, can lead to improved academic achievement.

However, the limitation of this research is the qualitative data, which only serves as supporting data to observe the application of SRSL APICPEM used by students through activity journals presented in the form of questionnaires. Qualitative data can be just as strong as quantitative data when obtained through various other instruments and data triangulation, leading to better research results. Also, as for recommendations regarding the sustainability of this research, it is suggested that future studies could further explore the relationship and dynamics between students' choice of learning strategies and their learning styles. Additionally, subsequent research can focus on measuring students' Self-Regulated Learning (SRL) before and after the implementation of SRSL APICPEM strategies to establish a connection between SRSL APICPEM, SRL, and students' learning achievements.

Future research directions include conducting longitudinal studies to observe how students' study habits and performance in physics evolve over time. This approach can provide deeper insights into the effectiveness of implemented interventions and long-term changes in students' study habits. Additionally, integrated interventions can be developed and tested, combining educational and psychological aspects, such as training programs that focus not only on physics content but also on developing self-regulation skills and time management. Experimental research can be carried out to test the effectiveness of new teaching methods or learning strategies designed based on the findings of this study. This could involve evaluating various teaching approaches and motivational techniques to identify the most effective methods for improving students' physics performance. Comparative studies between schools with different teaching strategies could also be conducted to determine the factors most contributing to success or failure in physics education, aiding in the design of more effective educational policies. Furthermore, this research can extend beyond the field of physics, and collaboration with researchers from other disciplines, such as psychology, could enhance the quality of the research.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that each component of the Self-Regulated Approach to Strategic Learning (SRSL) APICPEM was applied very good by students in the experimental group. The students' choice of learning strategies was not fixed in each meeting and varied significantly due to various factors, including internal factors such as physical, emotional, and psychological factors, as well as external factors such as time, materials, and learning environment. Furthermore, it was found that there was a significant influence of the implementation of SRSL APICPEM on students' learning achievement in the subject of sound waves, as evidenced by the results of the Mann-Whitney U test that supported the alternative hypothesis. The effect size test also showed that the impact was relatively high (effect size value is 0,622). This indicates that the implementation of Self-Regulated Approach to Strategic Learning (SRSL) APICPEM significantly contributes to improving students' learning achievement in the topic of sound waves. The SRSL APICPEM strategies provide students with the opportunity to explore the use of learning strategies tailored to their individual characteristics, enabling students to self-regulate and take responsibility for their learning activities. This research can serve as a reference for future studies aimed at addressing low student learning achievement through the application of SRSL APICPEM strategies, both in physics and other subjects.

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