Proceedings of International Conference on Research in Education (ICRE) 2025, pp. 339-360
ISSN: 3124-4467
27-28 November 2025 - Yogyakarta, Indonesia
https://e-conf.usd.ac.id/index.php/icre
Fakultas Keguruan dan Ilmu Pendidikan, Universitas Sanata Dharma, Yogyakarta

THE EFFECT OF THE SOPLE LEARNING MODEL ON STUDENTS' LEARNING OUTCOMES IN THE TOPIC OF ENVIRONMENTAL CHANGE AND CONSERVATION

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Received: 18 November 2025; Accepted: 30 November 2025

Abstract
The purpose of this study is to investigate how students' learning results in the area of environmental change and conservation are impacted by the SOPLE (Self-Study, Opening, Practice, Listening, Evaluation) learning paradigm. The Flipped Classroom and the SAVI approach (Somatic, Auditory, Visualization, Intellectually) are combined in the SOPLE model to promote engaging and meaningful learning. There was a nonequivalent control group in a quasi-experimental design. Class XA was the regular group at St. Maria Iteng Private Senior High School, Manggarai, NTT, taught using traditional techniques, while Class XB was designated as the experimental group, taught using SOPLE. Multiple-choice pretest and posttest items made up the research instruments. The posttest difference between the experimental and regular groups was shown to be statistically significant by the Mann-Whitney U test ($U = 34.000$, $Z = -4.017$, $p < 0.001$). With a large effect size ($r = 0.68$), the experimental class's mean rank (25.00) was greater than the regular class (11.39). These results suggest that the SOPLE model works to enhance biology learning outcomes for students, especially when it comes to environmental subjects.

Keywords: environmental change and conservation, flipped Classroom, learning outcomes, quasi-experimental design, SAVI, SOPLE

Introduction
The learning model is the most important element in the learning process in the classroom. According to Ristanti et al. (2019), learning models can influence students' engagement and level of understanding of learning material in biology. In Novitayani's (2016) research, engaging and appropriate learning models can increase students' motivation and attention during class. One engaging and appropriate learning model for students is SAVI (Somatic, Auditory, Visual, Intelligence).

SAVI is a learning model that maximizes students' various senses so that students can learn more effectively and efficiently in a classroom setting. Ristanti et al. (2019) conducted research demonstrating that the SAVI-based learning model was highly effective, significantly improving the activeness and understanding of students in Class X MIA 1 SMAN 1 Papar concerning ecosystem material, with an effectiveness level reaching 81.9%. This percentage falls within the very positive criteria, indicating that the learning model is appropriate and engaging for increasing student engagement and understanding of the ecosystems material.

Another effective learning model is the flipped classroom. Scientific studies show that implementing a flipped classroom in a Chinese secondary school can improve student learning outcomes and motivation (Hung et al., 2019). This finding aligns with research conducted by Bhagat et al. (2016), which revealed that the use of flipped classrooms in Taiwan can improve student motivation and learning achievement.

Flipped Classroom is a learning model that encourages students to study material independently at home according to assignments given by the teacher. Thus, class time can be used for discussion, Q&A, and in-depth study of the material (Ministry of Education and Culture, 2020). According to Zainuddin et al. (2019), the use of the flipped classroom has several advantages, including: (1) increasing student learning motivation, (2) encouraging active student involvement in the learning process, (3) improving academic achievement, and (4) developing independent learning skills in students.

The SOPLE learning model is an innovative learning model that combines the SAVI and Flipped Classroom learning models. The SOPLE learning model was first developed by Widyaningsih (2024), a senior researcher in the Biology Education Study Program at Sanata Dharma University, Yogyakarta. The title of Widyaningsih's research is "Development of the SOPLE Learning Model on Human Mobility Material." The researcher is interested in implementing the SOPLE learning model created by Widyaningsih in grade X.

The combination of elements from the two models (SAVI and Flipped classroom) produces a new syntax that is reflected in the stages of learning activities in the teaching module. The syntax of the SOPLE learning model includes Self Study, Opening, Practice, Listening, and Evaluation. While undergoing teaching assistance at SMAS St. Maria Iteng, Manggarai, NTT from February - June 2025, the researcher was interested in specifically examining the learning outcomes of students in grade X with the application of the SOPLE learning model on the material of environmental change and conservation for grade X. This material was chosen because it is very contextual, can encourage students to make concrete contributions to the environment, mother earth and is the last material in the series of materials in this semester.

The novelty of this study lies in its critical transition from the model development stage to its practical, real-world implementation. Previous research by Widyaningsih (2024) completed the Research and Development (R&D) phase of the SOPLE learning model, yielding a highly validated model and learning tools (expert validation score: 0.88). However, the work was confined to development, and Widyaningsih (2024) did not proceed to the actual implementation or effectiveness testing in a classroom setting. This creates a critical research gap regarding the practical utility of the SOPLE model in diverse educational environments. This thesis directly addresses this gap by executing the first known field implementation of the validated SOPLE model to empirically test its efficacy.

This implementation provides novelty through a highly specific and rigorous framework. This research constitutes the first application of the SOPLE model within the context of the Merdeka Curriculum, applying it to the distinct subject matter of environmental change and conservation for Grade X students at a unique regional setting (St. Maria Iteng Private Senior High School, Manggarai, NTT). Furthermore, a rigorous methodological combination is employed for the effectiveness analysis, which includes the calculation of descriptive statistics, Normalized Gain (N-Gain), Normality and Homogeneity Tests, and the use of non-parametric statistical testing (e.g., Mann-Whitney U test) to determine statistical significance and effect size. Consequently, this work is not a mere contextual replication but a pioneering study that provides robust evidence of the SOPLE model's effectiveness in a contemporary Indonesian educational setting, utilizing a precise analytical lens previously unexplored by the model’s developers.

The topic of Environmental Change and Conservation is certainly significant in the biology curriculum because it provides students with an understanding of the interrelationship between humans and their environment. This material leads students to understand the impact of human activities on ecosystems and the urgency of maintaining environmental balance (Mardin et al., 2024).

In reality, in the 10th grade of St. Maria Iteng Private Senior High School, student learning outcomes on this topic are still relatively low. This is due to the lack of varied teaching methods and a lack of student engagement in the learning process. Students tend to be passive and unmotivated to understand the concepts presented. As a result, learning outcomes are suboptimal, and students’ understanding of the importance of environmental conservation remains low.

Seeing the importance of this material and the problems of student learning outcomes, innovation is needed in learning models that are more effective and appropriate to student needs. Interactive learning models and actively involving students in the learning process can increase student motivation and understanding. Therefore, the application of the SOPLE learning model, which is a combination of SAVI and flipped classroom, is expected to be able to answer this challenge and improve student learning outcomes in the material of Environmental Change and Conservation. ***The purpose*** of this study was to determine the effect of the application of the SOPLE learning model on student learning outcomes in the material of Environmental Change and Conservation in grade 10.

The SOPLE (Student-Oriented Project-based Learning in Environmental Education) model is structurally rooted in several established learning theories to maximize student engagement and effectiveness. Instead of applying a single paradigm, SOPLE integrates concepts from Social Constructivism, Multiple Intelligences, Accelerated Learning, and Holistic Education to create a comprehensive learning environment.

1. Social Constructivism

The SOPLE model aligns with Social Constructivism (Piaget & Vygotsky) by viewing learning as an active process where students construct their own knowledge through experience (Suryana et al., 2022; Nerita et al., 2023). Integration with SOPLE: This theory is primarily realized in the Self-Study (S) and Practice (P) stages, where students engage in dialogue, trial-and-error, and collaborative project work to form shared understanding and practical skills.

2. Theory of Multiple Intelligences

The model acknowledges Howard Gardner's premise that every individual possesses various types of intelligence (linguistic, logical-mathematical, naturalist, etc.) that develop differently (Berliana & Atikah, 2023; Jaya et al., 2023). Integration with SOPLE: The Practice (P) stage (project execution) and the Evaluation (E) stage (reporting/presentation) are deliberately designed to cater to diverse intelligences. Projects allow students to express learning through visual (spatial), verbal (linguistic), or experimental (naturalist/kinesthetic) means, ensuring broader engagement.

3. Accelerated Learning Theory

Drawing on the principles proposed by Dave Meier, SOPLE incorporates Accelerated Learning to optimize learning design and effectiveness by emphasizing that learning involves the whole mind and body, is creative, and benefits from cooperation (Zuhara & Busriadi, 2023; Rahmiati & Neviyarni, 2021). Integration with SOPLE: The Opening (O) stage focuses on creating a positive emotional state and a conducive learning environment (Meier's principle of positive emotion), while the Practice (P) stage emphasizes cooperative, hands-on activity, accelerating learning through active doing rather than passive reception.

4. Holistic Education Theory

SOPLE embraces the concept of Holistic Education, which seeks to harmoniously integrate the intellectual, emotional, social, and spiritual aspects of development (Pong, 2021). This approach, often rooted in social constructivism, focuses on educating the whole child (Miseliunaite et al., 2022). Integration with SOPLE: The Listening (L) stage and the Evaluation (E) stage specifically address the holistic dimension. The Listening (L) stage encourages introspection and reflection (intrapersonal/spiritual aspect), while the collaborative Practice (P) stage fosters the social dimension, ensuring development extends beyond mere intellectual potential.

SAVI learning model

Student learning outcomes are greatly influenced by the learning process at school, particularly emotional factors. Learning models are key to creating an active, enjoyable, and meaningful learning process, so they need to be identified, implemented, and developed optimally (Tibahary & Muliana, 2018; Mawikere, 2022). Rusman (2016) stated that one of the innovative learning models is SAVI. (Somatic, Auditory, Visualization, Intellectually), which involves all the senses and emotions in the learning process. This model consists of somatic, which is learning through movement and practice; auditory, through listening and speaking; visual, through observation and illustration; and intellectual, which focuses on problem-solving and explanation. This approach is expected to improve student understanding, resulting in better learning outcomes and the attainment of the required Minimum Mastery Criterion (MMC). The steps of the SAVI model learning activities, according to Purba and Sarmita (2022), can be described as follows.

Table 1. Steps in SAVI Model Learning Activities

Stages	Teacher Activities
Preparation	Students prepare themselves for the learning process guided by the following teacher-designed activities: - Apperception and listening to the learning objectives (Auditory) - Students enter their respective groups (Somatic) - Students build interest, motivation, and curiosity (Auditory)
Delivery	Students actively discover the learning material and construct their own knowledge, involving and facilitated by the teacher through the following steps: - Students receive the material along with concrete examples (Somatic and Auditory). - Students receive a detailed explanation of the material from the teacher based on the provided examples (Auditory).
Training	At this stage, students integrate and assimilate new knowledge and skills through various means, such as: - Students work on the worksheets by engaging in group discussions (Visual and Intellectual). - Students present the results of their work and practice listening to other students when providing responses and asking questions (Somatic, Auditory, Visual, Intellectual). - Students receive teacher assessment regarding the results of their work and make corrections if any errors are found (Auditory).
Appearance	This stage aims to assist students in applying and developing new knowledge and skills through the following activities: - Students complete an evaluation in the form of a question sheet, which is used to assess and enhance their understanding and skills after the learning process (Somatic and Intellectual). - Students review the material that has been previously taught together with the teacher; subsequently, students draw conclusions and receive assignments for the next session (Auditory).

In Hartati (2023), the SAVI learning model (Somatic, Auditory, Visual, Intellectually) has several advantages, one of which is its ability to develop students' intelligence comprehensively. This is due to the integration of various learning aspects, such as physical movement combined with activities that stimulate intelligence. The SAVI learning model has several weaknesses, one of which is the need for adequate facilities and infrastructure for optimal learning. This necessitates a substantial investment in educational costs to provide facilities appropriate to the model's needs (Sutarna, 2018). The SAVI learning model can pose a challenge to developing independence and critical thinking skills in students (Natasha et al., 2024).

Flipped Classroom Learning Model

According to Rakhmawati and Choiriyah (2023), Flipped Classroom is a learning method that reverses the traditional learning process. In this model, students first study the material at home, then complete assignments and discuss them in class. This contrasts with the traditional method, where learning takes place in class and assignments are completed at home. This allows for more effective use of class time for discussion and Q&A. Furthermore, this model is more flexible because it can adapt to the diverse abilities, backgrounds, and characteristics of students (Patandean & Indrajit, 2020). The flipped classroom learning model can be used effectively as a learning strategy that utilizes online resources (Wells & Holland, 2016). Rafiqah and Dani (2021) outline the steps for the Flipped Classroom model's learning activities:

Table 2. Steps in the Learning Model Activity of Flipped Classroom

Stages	Teacher Activities
Preparation (Pre-class)	
Activities in Class	- At this stage, students receive guidance from the teacher throughout the learning process. - Students are divided into several groups, with each group consisting of 4–5 members. - The material previously viewed by the students is discussed through group discussions and a question-and-answer session. - Students interact (through questions and answers) with the teacher to reinforce the concepts of the material being studied. - Students receive guidance and assistance in problem-solving through Student Worksheets (SWS). - Students collaborate within their groups to solve the given problems. - The teacher facilitates the students to express their ideas and concepts related to the given problems. - One student group presents the results of the discussion while the other groups provide responses.
Follow-up	- Students receive a teacher assessment to evaluate their understanding of the learning material. - Students receive assignments and material for the next session.

Flipped classroom has several advantages. This model allows students to learn at their own pace, giving them the opportunity to review material they don't yet understand. Homework can be completed in class, allowing students to directly ask the teacher if there are any unclear parts (Kurniawati et al., 2019). The Flipped Classroom model allows students to access learning materials more effectively, while class time can be used more productively for discussion and interaction. Research also shows that teachers who implement this model tend to achieve better outcomes than those using conventional learning methods.

However, according to Talbert, there are several shortcomings in the implementation. One of these is creating instructional videos, which takes a lot of time and effort for teachers. Furthermore, if teachers cannot actively interact with students during online learning, this can reduce students' motivation to learn. This model can also be a challenge for students accustomed to traditional learning, who may struggle to adapt to the new approach. Some students may also struggle to understand material presented through videos created by the teacher themselves (Kurniawati et al., 2019). Students who don't have a cell phone, laptop, or computer will have difficulty accessing materials or videos provided by the teacher. Difficult internet access can also limit students' ability to understand the material or video content being delivered (Rafiqah & Dani, 2021).

SOPLE Learning Model

The SOPLE learning model is a combination of two learning models, namely SAVI (Somatic, Auditory, Visualization, Intellectually) and flipped classroom. The combination of these two models creates a new syntax consisting of five main steps:

Self Study, Opening, Practice, Listening, and Evaluation. This model emphasizes student-centered learning, with the teacher acting as a facilitator supporting the learning process. The uniqueness of this model lies in its ability to accommodate five of the eight types of human intelligence: linguistic, logical-mathematical, kinesthetic, interpersonal, and naturalist. This model is applied to topics related to environmental change and preservation (Widyaningsih, 2024).

The SAVI learning model emphasizes the full use of students' senses through various activities: physical activities (Somatic), speaking and listening (Auditory), observation and description (Visual), and problem-solving and critical thinking (Intellectual). By fully utilizing the senses, it is hoped that this will stimulate students' enthusiasm and interest in participating in the learning process, so that learning can proceed optimally. Meanwhile, the learning model SOPLE integrates in-class learning with out-of-class learning. The goal is to maximize learning activities. Students can study the material from the teacher at home, and it is hoped that they will be better prepared to learn in class.

The SOPLE learning model aims to motivate students to participate in the learning process while also enabling teachers to effectively deliver material with a broad scope and complex content (Widyaningsih, 2024). The following are the steps in SOPLE.

Table 3. Steps of the SOPLE learning model

Stages	Teacher Activities
Self-Study	- Students receive the learning material via a WhatsApp group or a learning platform. - Students create a summary of the shared material.
Opening	- Students receive apperception that stimulates interest, motivation, and curiosity (Auditory). - Students listen to the learning objectives (Auditory). Students are divided into several groups (Somatic).
Practice	- Under the teacher's guidance, students complete the student worksheets by engaging in group discussions (Visual and Intellectual). - Students present the results of their work with their group members, and other students respond to the work and assess the results. Other students also have the opportunity to ask questions (Somatic, Auditory, Visual, Intellectual). - Students attend to the teacher's assessment of their work results and correct the answers if any errors are found (Auditory).
Listening	- Students listen to the teacher when clarification is provided regarding any errors in the students' work results (Auditory). - Students attend to the teacher's affirmation of the material that has been studied, detailing it based on real-world examples (Auditory and Visual).
Evaluation	- Students complete a learning evaluation in the form of questions to determine their level of understanding and skills (Intellectual). - Students draw conclusions and receive assignments for the next session (Auditory and Intellectual).

The SOPLE model has several advantages, including combining various types of student intelligence, introducing more engaging and interactive learning methods, and increasing student motivation. Teachers can be more effective in teaching complex material because this method provides opportunities for students to learn outside of class and discuss the material in class (Widyaningsih, 2024). Widyaningsih further stated that while this model is effective, its implementation requires adequate facilities, such as access to technology that supports independent learning outside of the classroom. Furthermore, students accustomed to traditional learning may face challenges adjusting to this model.

Method

This research was conducted using a quasi-experimental approach. This approach was chosen because it was not possible to randomly assign subjects to the experimental and regular classes (control). The research design used was a Nonequivalent Control Group Design. This research design involved two non-randomly selected groups, where one group was given treatment (the SOPLE learning model) and the other group was not (conventional learning).

The study was conducted from February 9, 2025, to June 10, 2025. The study was conducted at St. Maria Iteng Private High School, Satarmese District, Manggarai Regency, NTT Province. The population in this study was all students in grades XA and XB at St. Maria Iteng Private Senior High School. Class XA consisted of 29 students and Class XB consisted of 28 students.

All 29 students in Class XA and 28 students in Class XB at St. Maria Iteng Private Senior High School made up the initial group for this study. However, there were three main methodological reasons why the final studied sample was smaller. First, a number of students were eliminated because they did not finish the pretest and posttest (missing data). Second, the decrease was also influenced by student absences during the testing times. Due to these exclusions, the learning outcome population was decreased to a final sample size of 35 students for the primary analysis, with 17 students in Class XB and 18 students in Class XA.

Tests were used as the data collection techniques. In this study, data on the learning outcomes of tenth-grade students were collected through pretests and posttests. These tests aimed to measure students' understanding of environmental change and conservation, as outlined in the Independent Curriculum (*Kurikulum Merdeka*) teaching module. Daily tests (posttests) were also used to monitor students' learning progress as a summative assessment. Furthermore, the implementation of Student Worksheets (LKPD) served as a formative assessment, facilitating the application of students' knowledge and skills, and providing data on their competency achievement.

The quality testing of the posttest instrument, which consisted of 36 items, was conducted to ensure the instrument possessed adequate psychometric quality, focusing equally on validity, reliability, discrimination index, and difficulty level. The item analysis began with validity, categorized as low (0.200 - 0.399), adequate (0,400 - 0,599), high (0,600 - 0,800), and very high (0,800 - 1,00). The results indicated that 18 items were valid and 18 items were not. The valid items predominantly fell into the high criterion (12 items) and the adequate criterion (6 items). Subsequently, the overall instrument reliability, measured using Cronbach's Alpha, was determined. The quality criteria for reliability range from very low (0,000 - 0,200) to very high (0,801 - 1,00). The obtained value was 0.732, which classifies the instrument's reliability as high (0,601 - 0,800), suggesting good internal consistency across the items.

Furthermore, analysis of item characteristics involved the discrimination index and the difficulty level. The discrimination index was grouped into poor (< 0.19), adequate (0.20 - 0.29), good (0.30 - 0.39), and very good (> 0.40). The item distribution showed 23 items rated as very good, 8 items as adequate, and 5 items as poor. Simultaneously, the item difficulty was evaluated based on the criteria of difficult (0.00 - 0.30), moderate (0.31 - 0.70), and easy (0.71 - 1.00), revealing that 22 items were classified as moderate and 14 items as easy.

Based on the synthesis of all four critical quality factors, the items deemed acceptable and selected for the final score calculation were those that met the validity criterion, possessed a moderate difficulty level (0.31 - 0.70), and exhibited an adequate discrimination index or higher (score > 0.20). Following a rigorous selection process, a total of 18 best items were finalized from the initial 36 items for inclusion in the final score calculation, ensuring the instrument used is aligned with the learning objectives and possesses optimal psychometric quality across all crucial measurement aspects.

Student Learning Outcome Data Analysis is analyzed using the following steps.

1. Descriptive Analysis.

Student learning outcomes are seen from the average value, minimum value, maximum value, standard deviation, and percentage of learning completion. Individual completion is measured by the Minimum Standard for Completion 70, and the student's learning outcome score is calculated using the following formula (Astuti, 2023).

$$Student\ Learning\ Outcomes\ Score = \frac{Correct\ Answers\ score}{Total\ score} \times 100\%$$

Students are categorized as having completed a course if they receive a score above 70; scores below 70 are considered incomplete. The following is the formula for class completion percentage (Astuti, 2023).

$$Class\ completion\ rate\ = \frac{Number\ of\ completed\ students}{Total\ student\ participants} \times 100\%$$

Categorizing student learning outcomes typically refers to assessment categories on a scale of 0–100. Descriptive analysis also describes student learning outcomes by examining the mean, median, minimum, maximum, and standard deviation. Before conducting statistical tests, it is crucial to examine the underlying pattern.

2. Normalized Gain (N-Gain) Student Learning Outcomes

The N-Gain formula is used to find out how much learning outcomes have improved from pretest to posttest. The high N-Gain value in the experimental class compared to the regular class (control) provides information that the treatment is effective in improving learning outcomes.

3. Normality Test of Student Learning Outcomes

The normality test of learning outcomes is useful for determining whether the learning outcome data is normally distributed. The normality test is needed to determine whether the data follows a normal distribution because the learning outcomes are in the form of scores (interval/ratio scale). In addition to using the Shapiro-Wilk, this study also used Kolmogorov Smirnov.

4. Homogeneity Test of Student Learning Outcomes

Homogeneity test of student learning outcomes is carried out to determine whether the variance in the experimental class and the regular class (control) is homogeneous or not, and also to ensure whether the variance between the experimental and regular class (control) is homogeneous. Levene's test is usually used to test homogeneity.

5. Hypothesis Testing of Student Learning Outcomes

The hypothesis test aims to determine whether there is a significant difference in learning outcomes—specifically at the posttest stage—between the experimental class using the SOPLE model and the regular class (control) utilizing the conventional method. The independent sample t-test is used if the data is normally distributed and homogeneous, and the non-parametric Mann-Whitney U test is used if the data is not normally distributed. The hypothesis of student learning outcomes, namely: a) H_0 (Null hypothesis): There is no significant difference in posttest learning outcomes between students taught with SOPLE and those taught conventionally on the material Environmental Change and Conservation in class X St. Maria Iteng Private Senior High School, Manggarai, NTT. b) H_a (Alternative hypothesis): There is a significant difference in posttest learning outcomes on the material of Environmental Change and Conservation in class X St. Maria Iteng Private Senior High School, Manggarai, NTT.

Findings and Discussion

Descriptive Analysis of Student Learning Outcomes

Descriptive analysis shows a general overview of the distribution of student learning outcomes in the experimental and regular class (control) before and after treatment (pretest) and after treatment (posttest). The descriptive analysis shows the number of students (N), average value (mean), median, mode, standard deviation, variance, range, minimum value, and maximum value. The data are presented in Table 4 below.

Table 4. Descriptive Data on Student Learning Outcomes

	N	Minimum	Maximum	Sum	Mean	Std. Error	Std. Deviation	Varian
Experiment Pretest	17	14	93	1024	60,24	4,87	20,08	403,19
Experiment Posttest	17	56	100	1577	92,76	3,07	12,66	160,31
Regular Pretest	18	43	82	1247	69,28	2,60	11,03	121,85
Regular Posttest	18	63	83	1350	75,00	1,54	6,57	43,17

Based on Table 4, we can see an increase in learning outcomes in both classes from the pretest to the posttest. In the experimental class, the average score increased from 60.24 to 92.76 after the implementation of the SOPLE learning model. The median score also increased from 68.00 to 100.00, and the mode from 71 to 100. These increases indicate that most students achieved high scores on the posttest. The maximum score increased to 100, while the minimum score also increased from 14 to 56. Although the standard deviation decreased slightly from 20.08 to 12.66, this still shows a more even distribution of scores towards high scores after the treatment (implementation of the SOPLE learning model).

In the regular class (control), the average score also increased from 69.28 to 75.00, but not as much as in the experimental class. The median increased from 73.00 to 78.00, and the mode remained stable at 78. The minimum score increased from 43 to 61, and the maximum score increased gradually from 82 to 83. The standard deviation decreased significantly from 11.04 to 6.57, indicating that the distribution of scores became more even after conventional learning. Overall, when compared to the conventional class, the experimental class achieved better and more widespread learning to high scores. The data in Tables 5 and 6 below are the categorization of student learning outcomes in the regular class (control) and experimental class.

Table 5. Categorization of Learning Outcomes (Posttest) of Regular Class (Control) (XA) Students

Value Interval	Category	Total Students	Percentage (%)
85 - 100	Very good	0	0.00
75 - 84	Good	10	55.56
65 - 74	Enough	7	38.89
50 - 64	Not Enough	1	5.56
< = 49	Very less	0	0.00

Table 6. Categorization of Learning Outcomes (Posttest) of Experimental Class (XB) Students

Value Interval	Category	Total Students	Percentage (%)
85 - 100	Very good	14	82.35
75 - 84	Good	1	5.88
65 - 74	Enough	1	5.88
50 - 64	Not Enough	1	5.88
< = 49	Very less	0	0.00

Table 5 shows that out of a total of 18 students, 10 (55.56%) received a score in the 75-84 range, categorized as good. Meanwhile, 7 (38.89%) received a score in the 65-74 range, categorized as adequate. One (5.56%) received a score in the 50-64 range. Students did not achieve a score of 85-100, or very good, and no students received a score <49.

Table 6 shows that the score interval of 85-100, which is categorized as very good, was obtained by 14 students with a percentage of 82.35%. Meanwhile, the score interval of 75-84, which is categorized as good, was obtained by one student (5.88%). This percentage of 5.88% is the same as the score interval of 65-74, which is categorized as sufficient, and 50-64, which is categorized as poor, with each obtained by one student. No students had a score interval <49 (0%). Score categories in the posttest (daily test) class XA (regular class) and XB (experimental class of the SOPLE model) show that the value of class XB is much higher than that of class XA.

The descriptive analysis results show that the SOPLE learning model improves student learning outcomes. The significant increase in the average posttest score from 60.24 to 92.76 in the experimental class demonstrates this. Furthermore, the maximum pretest score for the experimental class was 93 and increased to 100 in the posttest. These results indicate that most students achieved high scores after the treatment.

The categorization of values in Tables 5 and 6 shows that in the regular class (control), the posttest scores of a total of 18 students, who obtained a score interval of 75-84 with the Good category, were 10 people or 55.56%. Meanwhile posttest of experimental class students (XB) showed that the score interval of 85-100 with the Very Good category was obtained by 14 students with a percentage of 82.35%. Meanwhile, the score interval of 75-84 in the Good category was obtained by one student (5.88%). In the experimental class (XB), students achieved the Very Good category, by 14 students while in the regular class (control), no students achieved the Very Good category. Regular class (control) students in the posttest only received scores below the experimental class, namely the Good category, by 11 students. This means that the posttest improvement of the experimental class after the SOPLE learning model treatment was very great.

This improvement occurred after students in the experimental class were taught using the SOPLE learning model, which systematically combines independent learning (self-study) with somatic, auditory, visual, and intellectual activities. Students gained a better understanding of environmental change and conservation through an active and structured learning process. This resulted in high exam scores.

In contrast to the experimental class, the regular class (control), although producing improved learning outcomes, did not achieve as significant a change as the experimental class. Conventional learning, which is more teacher-centered, likely results in limited student engagement in understanding the material. After the learning process, the distribution of grades became more uniform. The decrease in standard deviation and variance in both classes demonstrates this. Therefore, it can be concluded that the SOPLE learning model not only improves average learning outcomes but also evenly distributes grades.

These high learning outcomes indicate that students who received the SOPLE learning model treatment were able to understand what they read, saw, experienced, or felt based on their learning process in learning, including observations and research conducted. Experimental class students have higher process skills, especially in developing their basic mental, physical, and social abilities (Susanto, 2018).

N-Gain Student Learning Outcomes

To determine the extent of the increase in student learning outcomes from pretest to posttest that can be attributed to the treatment (the SOPLE learning model in the experimental class), an N-Gain calculation was performed for each class. This was calculated for each class and expressed as a score (value) and percentage. Then, to assess learning effectiveness, this value was interpreted according to the categories of high, medium, and low. The data are presented in Table 7 below.

Table 7. N-Gain Average of Student Learning Outcomes

Class	Pretest	Posttest	N-Gain Score	N-Gain (%)	N-Gain Interpretation
Experiment	60.24	92.76	0.8	80.0065	High/ Effective
Regular	69.28	75	0.089	8.9933	Low/Ineffective

Table 7 shows a clear difference between the two classes. The experimental class had an average N-Gain score of 0.800 (80.01%), which is categorized as **high/effective**, indicating that learning outcomes improved significantly after the implementation of the SOPLE model. On the other hand, the regular class (control) had an average N-Gain score of 0.089 (8.99%), which is categorized as low, indicating that there was almost **minimal** improvement from pretest to posttest.

While both groups showed an increase in mean scores from pretest to posttest (Experimental: 60.24 to 92.76; Regular: 69.28 to 75.00), the magnitude of the increase differed substantially. The relatively high N-Gain (0.80) in the experimental class indicates that there was a significant and highly effective increase in scores after the SOPLE learning model treatment, whereas the regular class experienced only a slight increase (0.089), which falls into the low improvement category.

The results of the N-Gain calculation show a striking difference between the experimental class and the regular class (control). The experimental class obtained an N-Gain score of 0.80 (80.01%) with a high category, which indicates that learning with the SOPLE model is able to improve student learning outcomes effectively. In contrast, the regular class (control) obtained an N-Gain score of only 0.089 (8.99%) with a **low category**, suggesting that the increase in learning outcomes in this class was **minimal** compared to the maximum possible gain.

In the experimental class, significant improvements indicated that students truly gained a better understanding after using the SOPLE model. This model provides students with the opportunity to learn actively through the stages of Self-Study, Opening, Practice, Listening, and Evaluation. During these stages, students not only passively receive information but also directly engage in the learning process. This is supported by external factors such as diverse learning resources, such as scanned textbooks and then shared with students, YouTube videos of learning materials, and PPTs. Furthermore, the school environment is conducive, safe, and provides a positive learning atmosphere. Classrooms are clean, tidy, and comfortable for learning. The school culture at St. Maria Iteng Private Senior High School upholds academic values, honesty, and encourages active student participation (Yandi et al., 2023).

In the regular class (control), the learning process remained conventional, resulting in lower student engagement, a lower increase in their understanding of concepts, and lower overall learning outcomes compared to the experimental class. A low N-Gain score indicates minimal student improvement and is classified as low effectiveness. Therefore, these findings indicate that, compared to conventional learning, the use of the SOPLE learning model significantly improves student learning outcomes.

Results of the Normality Test of Student Learning Outcomes

A normality test was conducted to determine whether the distribution of learning outcome data in the regular and experimental classes was normal. This test is crucial for determining the type of statistical test to be used in the following stages, whether parametric or non-parametric. This study used two normality test methods: Kolmogorov–Smirnov and Shapiro–Wilk, with a significance level of 0.05. Data are considered normal if the significance value is greater than 0.05, and abnormal if the significance value is less than or equal to 0.05. The data are presented in Table 8 below.

Table 8. Results of the Normality Test of Student Learning Outcome Data

		Kolmogorov-Smirnov		Shapiro Wilk	
	Class	Sig.	Information	Sig.	Information
Results	Experiment Pretest	0.146	Normal	0.081	Normal
	Experiment Posttest	<0.001	Abnormal	<0,001	Abnormal
	Regular Pretest	0.061	Normal	0.064	Normal
	Regular Posttest	0.012	Abnormal	0.065	Normal

The results of the normality tests indicated that several data sets did not consistently meet the assumption of normality. Table 8 above shows that in the experimental class (pretest), the Kolmogorov– Smirnov significance value was 0.146 and the Shapiro–Wilk significance value was 0.081, each greater than 0.05, indicating that the data were normally distributed; in the experimental class (posttest), the significance value was less than 0.001, indicating that the data were not normally distributed.

In the pretest, the regular class (control) had a mark significance of 0.061 for Kolmogorov–Smirnov and 0.064 for Shapiro–Wilk, indicating a normal distribution. In the posttest, the regular class (control) had a significance value of 0.012 for Kolmogorov–Smirnov (not normal) and 0.065 for Shapiro–Wilk (normal). The data were considered not completely normal under these conditions because one of the tests (KS) showed non-normal results.

To ensure statistical prudence and the validity of the results, this study adopted a conservative decision rule: If either of the two normality tests (Kolmogorov–Smirnov or Shapiro–Wilk) indicated a non-normal distribution, or if the data from one of the two groups (experimental or regular) clearly violated the normality assumption, a non-parametric statistical test would be employed. Based on this rule, the normality assumption was determined not to be conclusively met. Specifically, the posttest data for the experimental class were proven to be non-normal by both tests, and the Kolmogorov–Smirnov test for the regular class also indicated a significant deviation from normality (Sig = 0.012), contradicting the Shapiro–Wilk result. Consequently, the non-parametric Mann–Whitney U Test was selected to compare the learning outcomes between the two groups. This decision ensures that the conclusions drawn regarding the difference in learning outcomes are not biased by potential violations of the data normality assumption.

Results of the Homogeneity Test of Student Learning Outcomes

The homogeneity test was conducted to determine whether the data variance between the regular and experimental classes was homogeneous or equal. This examination process is crucial for determining the appropriate type of hypothesis test. In this study, Levene's homogeneity test was used with a significance level of 0.05. If the Sig. value is greater than 0.05, the data are homogeneous (equal variance), and if the Sig. value is less than 0.05, the data are not homogeneous (different variance). The data are presented in Table 9 below.

Table 9. Results of the Homogeneity Test of Variance of Student Learning Outcomes

		Levene Statistic	Sig.	Detail
Students' learning outcomes (Homogeneity)	Based on Mean	3,737	62	Homogeneous
	Based on Median	394	535	Homogeneous
	Based on Median and with adjusted df	394	537	Homogeneous
	Based in trimmed mean	2,237	144	Homogeneous

All Levene's test methods show significance values greater than 0.05, as shown in Table 9 above. For example, the significance value based on the median is 0.062, the medians are 0.535 and 0.537, and the median (trimmed mean) is 0.144. All these values indicate that there is no significant variation between the experimental class and the regular class (control).

The results of the homogeneity test show that the variance of both data groups is the same, which means that the distribution of learning outcome data between the regular and experimental classes is almost the same. Although the data met the homogeneity requirements, the results of the previous normality test showed that some data had a non-normal distribution, especially in the posttest. Because the assumption of normality was not fully met, despite being homogeneous, hypothesis testing was still carried out using the Mann–Whitney U test, which is non-parametric. Therefore, the Mann–Whitney U test was the appropriate choice for this study because the data variance was homogeneous; some data did not have a normal distribution; and the non-parametric test was more suitable since the number of samples for each group was not large.

Hypothesis Test Results (Mann-Whitney U) on Student Learning Outcomes

Hypothesis testing was conducted to determine whether there were significant differences in learning outcomes between the experimental class using the SOPLE learning model and the regular class (control) using conventional learning. The non-parametric Mann–Whitney U test was used to test the hypothesis. This was done because the results of the normality test indicated that the posttest data did not have a normal distribution. When the normality assumption is not met, this test is suitable for comparing two independent groups. The data are presented in Tables 10 and 11.

Table 10. Results of the Mann-Whitney U Test on Student Learning Outcomes

Test Statistic[a]	Real Difference Results of Experimental Class Posttest and Regular Class Posttest
Man-Whitney U	34
Wilcoxon W	205
Z	-4.017
Asymp. Sig. (2-tailed)	< 0.001
Exact Sig. [2*(1-tailed Sig.)]	< 0.001

Table 11 Mean Rank Value of Student Learning Outcomes

	Class	N	Mean Rank	Sum of Ranks
Real difference results (there is an increase in results learn significantly)	Posttest of Experiment Class	17	25,00	425,00
	Posttest of Regular Class	18	11,39	205,00
	Total	35		

As evidence that student learning outcomes in the experimental class tend to be better than those in the regular class (control), Table 11 shows that the mean rank of the experimental class is 25.00, much higher than that of the regular class (control) 11,39. This difference is shown as statistically significant in Table 10, as indicated by the Mann– Whitney U value of 34.000 and the asymptotic sig. (2-tailed) value of <0.001 (smaller than the 0.05 significance level). This indicates that the difference is statistically significant between the experimental and regular classes.

In the final test (posttest) of the experimental class and regular class (control), the Mann–Whitney U value = 34,000, Z = -4.017, and the asymptotic significance (2-tailed) is <0.001, far below the 0.05 significance level. The results of the Mann–Whitney U test indicate a significant difference in learning outcomes between the experimental class and the regular class (control). These results indicate that students tend to have significantly higher learning scores in the experimental class than in the regular class (control). In addition to assessing significance, this study also calculated the effect size (r) to determine the extent of the treatment's influence. To determine the effect size, the following formula was used.

$$r = [Z : \sqrt{N}$$

With $Z = -4.017; N = 35$

$$r = 4.01735 : \sqrt{35} = 4.017 : 5.916 = 0.68$$

The SOPLE learning model significantly influences student learning outcomes, as indicated by the r value = 0.68, which is in the large category (Cohen, 1988). Based on the results of this test, the decision regarding the hypothesis is

- H_0 (null hypothesis) rejected: There is no significant difference in learning outcomes between the experimental class and regular class (control) on the material of Environmental Change and Conservation in class X St. Maria Iteng Private Senior High School, Manggarai, NTT.
- H_1 (alternative hypothesis) is accepted: There is a significant difference in posttest learning outcomes between the experimental class and regular class (control) on the material of Environmental Change and Conservation in class X St. Maria Iteng Private Senior High School, Manggarai, NTT.

The results of the hypothesis test showed that there was a statistically significant difference between the two groups (posttest of the experimental class and posttest of the regular class (control). This decision was made because the p-value was <0.05. These results confirm that the SOPLE learning model is effective in improving students' biology skills, especially regarding the environment (material on environmental change and conservation). Students are motivated to actively participate in the learning process through the SOPLE stages: Self-Study, Opening, Practice, Listening, and Evaluation. Students not only receive information passively but also learn to collaborate and understand concepts independently, which improves their conceptual understanding.

Teacher-centered learning tends to decrease student participation and engagement. This is indicated by lower posttest scores in the regular class (control) and lower average rankings. Therefore, the results of the Mann–Whitney U test and the effect size (r) calculation demonstrate statistically and practically that the implementation of the SOPLE model has a significant and substantial impact on improving student learning outcomes.

Factors supporting significant improvements in learning outcomes include the SOPLE learning model, which is able to increase student learning motivation, encourage teachers to improve their competencies through good teaching preparation, create dialogic-assertive communication between teachers and students, build learning discipline and classroom management, and improve students' self-management skills. These factors support significant improvements in grades after the SOPLE learning model is implemented (Yandi et al., 2023).

The uniqueness of the SOPLE learning model is that it can accommodate five of the eight types of intellectual intelligence possessed by humans according to Gardner: linguistic, logical-mathematical, kinesthetic, interpersonal, and naturalist (Jaya et al., 2023). This model is applied to the material of environmental change and conservation and has been proven to significantly improve student learning outcomes. Howard Gardner advanced the theory of Multiple Intelligences. Through this theory, Gardner emphasizes the importance of respecting the uniqueness of each individual with different learning styles. Gardner also encourages the development of more diverse assessment models to measure a person's intelligence more fairly (Musfiroh, 2017).

Handoyo and Asy'ari (2019) researched the use of the surrounding environment as a science learning laboratory in the development of multiple intelligences of Elementary School Teacher Education (PGSD) students at Sanata Dharma University. The results showed an increase in students' understanding of science concepts, as well as an increase in aspects of biological intelligence, especially logical, interpersonal, intrapersonal, naturalist, linguistic, musical, and kinesthetic intelligence in students. This study proves that the SOPLE learning model, which contains 5 elements of intellectual intelligence, improves students' understanding of science and various aspects of biological intelligence.

The SOPLE learning model, which has been proven to significantly improve student learning outcomes, confirms that the SAVI element in it has accommodated the full use of students' senses with various activities such as physical activity (somatic), speaking and listening (auditory), observing and describing (visualization), and solving problems and thinking critically (intellectually). By utilizing these senses fully, students are inspired by their enthusiasm and interest in participating in the learning process so that the learning can run optimally. (Rusman, 2016). This is in line with research evidence from Setiyaningsih et al. (2022); the SAVI learning model has a significant influence on increasing HOTS and student self-regulation, with a significance value of 0.000 ($p < 0.05$).

The SOPLE learning model also accommodates the flipped classroom learning model, which involves in-class learning with out-of-class learning. The goal is to maximize learning activities. Students learn the material from the teacher at home, and in this study, students appeared more prepared to learn in class. They actively asked questions, especially during other groups' presentations, and sought confirmation from the researcher as the teacher (Rakhmawati & Choiriyah, 2023). Research by Susilawati (2020) showed that the practice of the flipped classroom learning model improved students' understanding of the whole-mount material (pollen and spore acetolysis), with an N-Gain percentage of 43.76% for the regular class (control) and 64.87% for the experimental class. Consistent with previous research, Herrani (2020) demonstrated that the application of flipped learning on microbiology material integrated with a learning management system improved students' understanding, with a score of 3.4 for class A and 3.5 for class B. The implementation of flipped learning on Microbiology material integrated with an LMS, based on learning evaluation results, was categorized as very good. Research by Fitriani et al (2023) shows that the Flipped classroom learning model increases student activity and learning outcomes in biodiversity material for class X-3 of SMA Negeri 1 Gowa in 2023, with the percentage (learning outcomes) of the cognitive domain, the average test score for cycle I reaching 55.56%, and cycle II reaching 76.47%.

The SOPLE learning model is also supported by the theory of social constructivism. The concept of constructivism is based on the psychological and philosophical idea that people actively construct their own understanding and knowledge. The main principle of constructivism is that knowledge is not something given by teachers to students, but rather the result of a construction process carried out by individuals themselves. The curriculum used in the SOPLE learning model is the Independent Curriculum, making it highly compatible with strengthening the profile of Pancasila students, which provides ample space for student experience and active involvement both in and outside the classroom (Nerita et al., 2023).

Conclusion

The study discovered that using the SOPLE (Student-Oriented Learning in Environmental Education) learning model successfully enhanced biology students' learning results, especially when it came to environmental subjects. This difference was significant, suggesting a big effect size in favor of the SOPLE model-using experimental group. According to this research, SOPLE is a very successful teaching strategy for raising student performance and cognitive engagement in environmental biology classes. Compared to traditional training, the model's focus on student-centered projects and environmental context effectively promoted deeper understanding and improved subject-matter mastery.

The findings have important relevance for biology education methodology and curriculum development. The SOPLE model, which can foster higher-order thinking abilities necessary for environmental literacy in addition to factual memory, provides a strong and practical substitute for conventional teaching techniques. In order to educate students for practical problem-solving, we advise its adoption, especially in courses that concentrate on intricate, real-world concerns like environmental science.

There are a number of limitations to this study that should be taken into consideration for future research.

1. Time Restrictions

The SOPLE model involves a significant amount of time for project implementation, which occasionally surpasses the allotted class time. Strategies to more effectively incorporate the model into regular academic timetables should be explored in future implementations.

2. Sample Size and Attrition

Only students with complete attendance and assessment data (pretest and posttests) were included in the final data analysis. The studied sample size was reduced due to student absences and incomplete pretest and posttest. Ten students (five per class) were designated for instrument validation and subsequently excluded from the primary data analysis to maintain independence.

3. Assessment Scope

Only the cognitive component of learning outcomes was included in the current evaluation. In order to provide a more thorough picture of SOPLE's overall impact on student development, future research should include tools to assess the affective and psychomotor domains.

4. Operational Constraints

Due to issues with student data constraints and school internet connectivity, the researcher had to manually distribute surveys and provide an internet hotspot during class. Although these problems were resolved, they highlight possible challenges in expanding the SOPLE model in environments with insufficient technology infrastructure.

Future studies could concentrate on the model's efficacy across various biological disciplines and educational levels, the long-term retention of learning outcomes, and the influence of SOPLE on non-cognitive skills (affective domain and psychomotor domain).

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