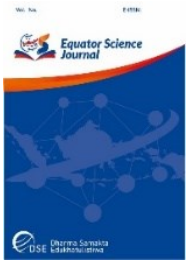
EQUATOR SCIENCE JOURNAL (ESJ) **e-ISSN: 2988-3881**
Volume 3, Issue 3 (2025) 137-145

EQUATOR SCIENCE JOURNAL (ESJ)
e-ISSN: 2988-3881
Journal homepage:
https://ejournal.edukhatulistiwa.com/index.php/ESJ



Integrating Flipped Learning Approach to Foster Students Self-Directed Learning in Science Learning

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Received: September 9, 2025. Revised: September 15, 2025. Accepted: September 21, 2025.
First Available Online: October 27, 2025. Publication Date: October 31, 2025.
DOI: 10.61142/esj.v3i3.255

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Keywords *:*
Flipped Learning, Student Autonomy, 21st-Century Competencies

ABSTRACT
This study aims to describe the integration of the Flipped Learning approach in fostering students' learning autonomy in Grade XI Biology at SMA Negeri 2 Palu, particularly on the topic of the Human Reproductive System. The research subjects consisted of 35 students. The study was conducted as Classroom Action Research (CAR) over two cycles, each comprising two meetings. Data were collected through teacher and student activity observations, formative tests, and student reflections, and analyzed using both quantitative descriptive and qualitative methods. The findings reveal that the percentage of teacher activity increased from 70% and 75% in cycle I to 85% and 95% in cycle II, while student activity increased from 50% in both meetings of cycle I to 72.5% and 85% in cycle II. Students' average formative test scores also improved from 58.1% and 62.7% in cycle I to 76.3% and 83.9% in cycle II. Student reflections indicated enhanced motivation, active participation, and readiness for independent learning. These findings suggest that science learning through the Flipped Learning approach can foster students' learning autonomy while simultaneously facilitating critical thinking skills and the effective use of technology required to meet the challenges of 21st-century education.

INTRODUCTION

Twenty-first century learning requires students to develop the ability to learn independently, think critically, and utilize information technology in their learning processes (Suhendar et al., 2025). However, classroom realities indicate that many students still struggle with self-directed learning and tend to depend heavily on their teachers (Syahputra, 2024). Based on observations during Biology lessons in Grade XI I at SMA Negeri 2 Palu, several critical issues were identified that reflect students' low learning autonomy. Most students relied on peers who were perceived as more capable, both in completing worksheets (SW) and during group discussions. Only a small portion of students actively contributed during presentations, while the majority remained silent and passive. In addition, the uncontrolled use of mobile devices frequently disrupted concentration. Attendance records and assignment submissions revealed that more than half of the students often submitted their independent tasks late, with some requiring repeated reminders. These problems were also reflected in the learning evaluation results, where many students demonstrated difficulty in understanding the material independently, thus relying on teacher explanations or peer assistance. This condition illustrates that students have not yet developed effective time management skills, lack strong initiative in preparing before class, and have not internalized the importance of independent learning as part of their responsibility as learners (Dirgeyasa, 2020).

These challenges are influenced by several factors, such as the use of instructional approaches that do not fully address students' needs and learning materials that are less contextual, making it difficult for students to construct meaning from the content being studied (Putra & Utami, 2022). Consequently, teachers are expected to implement more innovative instructional approaches that are relevant to students' learning contexts. One promising alternative is the Flipped Learning approach, where students engage with learning materials independently through online platforms prior to class, so that face-to-face sessions can be devoted to discussion, inquiry, and deeper conceptual exploration (Thalib et al., 2022). Previous studies, particularly in Biology education, have shown the effectiveness of this approach. For example, (Hasrida et al., 2023) reported that the application of Flipped Learning significantly improved students' learning outcomes. Their findings highlight that Flipped Learning addresses the shortcomings of traditional instruction by giving students the opportunity to prepare before classroom engagement.

Furthermore, (Jasman et al., 2024) reported that Flipped Learning has proven effective in strengthening 21st-century skills, promoting self-learning, and enhancing academic performance in Biology instruction. Similarly, a study conducted by (Ayunda et al., 2024) provided evidence that Flipped Learning can improve problem-solving skills as well as learning autonomy of senior high school students in the digestive system topic. This study also showed that the integration of digital media with Flipped Learning enabled students to become more organized and active in managing their own learning processes. These findings are supported by (Fisher et al., 2024) who revealed that Flipped Learning increases student engagement, active participation, and self-regulated learning by providing flexibility in accessing materials and reinforcing meaningful classroom interactions. In addition, (Etemi et al., 2024) confirmed that this approach positively influences perceptions of learning autonomy and technology acceptance among engineering students, thereby supporting its relevance for application in science learning at the secondary school level. However, there is still limited classroom action research that specifically integrates the Flipped Learning approach into the topic of the human reproductive system, Therefore study aims to contribute new insights to the development of Biology teaching practices in senior high schools.

Building on the issues and opportunities outlined above, this study aims to describe how the integration of the Flipped Learning approach can foster students' learning autonomy in Grade XI Biology at SMA Negeri 2 Palu, thereby contributing to the enrichment of instructional practices that support independent learning in science education.

METHOD

This study employed Classroom Action Research (CAR) conducted in Grade XI I of SMA Negeri 2 Palu during the even semester of the 2024/2025 academic year, with 35 students as the research subjects, consisting of 9 male and 26 female students. The research was carried out from April to May 2025 in Biology lessons on the topic of the Human Reproductive System. The research design referred to Kurt Lewin's model, which consists of four recurring stages: planning, action, observing, and reflecting. This model was chosen because it provides opportunities for researchers to plan improvements, implement actions, observe the outcomes, and reflect on the findings in order to continuously enhance the quality of learning (Eriska et al., 2023).

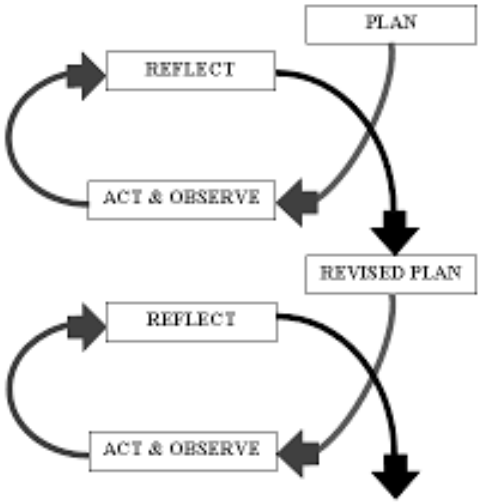

Fig 1. Classroom Action Research Model with Two Cycles
(Source: Eriska et al.,2023)

The research was conducted in two cycles, each consisting of two meetings that included planning, action implementation, observation, and reflection. In the planning stage, the researcher prepared learning tools such as lesson plans (LP), e-books, videos, and problem-based student worksheets (SW), as well as data collection instruments including observation sheets, formative tests, and reflection sheets. The implementation stage applied the Flipped Learning approach, in which students studied the material independently before face-to-face sessions by reading the e-book, taking notes, completing assignments provided in the e-book, and preparing questions for classroom discussion. In cycle I, the topics covered included the structure and function of the human reproductive organs and reproductive hormones, while in cycle II, the topics included the menstrual cycle, fertilization, gestation, childbirth, and disorders of the reproductive system. Classroom activities focused on group discussions, question-and-answer sessions, presentations, completion of problem-based worksheets, and formative assessments in the form of a quiz consisting of five essay questions administered at the end of the lesson. Observations were carried out to assess students' learning autonomy, which covered aspects such as learning readiness, involvement in discussions, ability to express opinions, and responsibility for independent tasks, as well as to evaluate teacher activities in planning, implementing, and managing instruction. Reflection was conducted in each meeting to review the results of observations and formative tests, identify strengths and challenges, and design improvements to be applied in subsequent meetings.

The research instruments consisted of observation sheets, learning outcome tests, and reflection sheets. The observation sheets were used to assess teacher and student activities based on indicators adapted from Yasmun (2023), using a 1–4 Likert rating scale. The teacher activity indicators included: delivering learning objectives, utilizing digital media, facilitating discussion and collaboration, providing feedback, and managing instructional time. Meanwhile, the student activity indicators included: learning readiness, participation in discussions, ability to express opinions, group

collaboration, and completion of independent tasks. The learning outcome test consisted of 15 essay questions developed according to the competency indicators of the Human Reproductive System material, with cognitive levels ranging from C2 to C4 based on the revised Bloom's Taxonomy. The reflection sheet on learning autonomy was developed based on indicators from (Rusmini et al., 2024), covering students' initiative, responsibility, and self-regulation in independent learning.

Data from the observation sheets on teacher and student activities as well as learning outcome tests were analyzed quantitatively using percentage calculations of the mean score to examine the progression of student engagement and learning achievements across cycles. The formula for calculation and the criteria for assessment are as follows:

$$\text{Score} = \frac{\text{Obtained Score}}{\text{Maximum Score}} \text{ x } 100\%$$

The calculation of scores was carried out using the following formula (Darwin et al., 2023)**.** The scale and assessment criteria for the percentage scores of observation and formative test results referred to (Zahrotunnayyiroh, 2024) as presented in Table 1.

Table 1. Assessment Criteria for Observation and Formative Test Results

No	Score Range	Description/Category
1.	76 % – 100%	Excellent
2	51% – 75 %	Good
3	26 % – 50 %	Fair
4	0% – 25%	Poor

Meanwhile, data from the student reflection sheets were analyzed qualitatively by examining students' descriptive responses to identify perceptions, initiative, responsibility, and self-regulation in independent learning. Improvement in learning autonomy was considered to occur when the percentage scores of student activity observations and the average formative test results indicated a shift to a higher category from cycle to cycle, for example from fair to good or from good to excellent. In addition, the results of reflection analysis were used as supporting evidence to capture behavioral changes in students' learning practices, such as increased preparedness, active engagement, and responsibility in carrying out independent learning (Yasmun, 2023).

RESULTS AND DISCUSSIONS

RESULTS

This study was carried out in two learning cycles, each consisting of two meetings. Data collected from teacher and student activity observations, as well as students' formative test results, are summarized in the following diagrams to illustrate the patterns of improvement in engagement and learning outcomes from cycle I to cycle II, as can be seen in Figure 2 below.

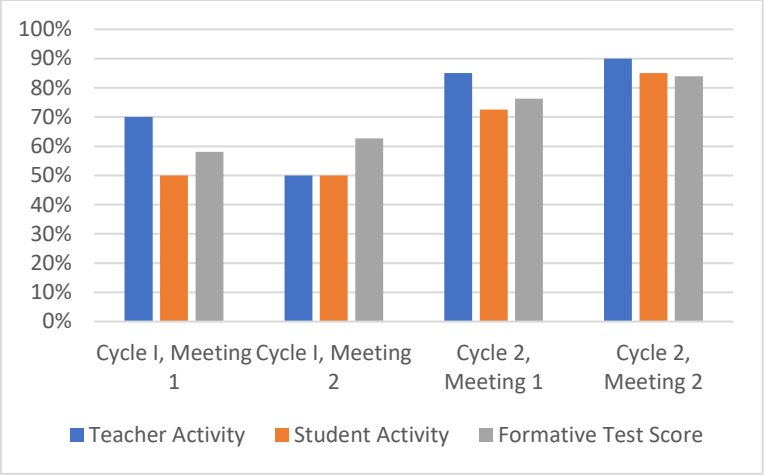

Fig 2. Comparison of Average Percentage Scores of Teacher Activity, Student Activity, and Formative Tests in Cycles I and II

In addition to being presented in the form of per-meeting diagrams, the data from teacher activities, student activities, and formative tests were also summarized as cycle averages. These averages were calculated from the two meetings in each cycle to provide a general overview of the overall improvement. Table 2 presents a comparison of the mean scores and percentages between Cycle I and Cycle II.

Table 2. Mean Scores and Percentages of Teacher Activities, Student Activities, and Formative Tests

Variabel	Cycle I	Percentages	Cycle II	Percentages	Category
Teacher Activities	29,0	72,5%	36,0	90,0%	Improved
Student Activities	20,0	50,0%	31,5	78,8%	Improved
Formative Test	15,1	60,5%	20,1	80,2%	Improved

Furthermore, the improvement of students' learning autonomy was corroborated by the qualitative analysis of the reflection sheets completed at each meeting. This analysis provided a more comprehensive understanding of changes in students' learning behaviors, particularly in terms of three main indicators: initiative, responsibility, and self-control. The findings revealed that students gradually became more proactive in preparing for lessons, more consistent in completing their assignments on time, and better able to regulate their focus and participation during class discussions. The detailed results of this analysis are presented in Table 3.

Table 3. Analysis of Student Reflection Sheets on Learning Autonomy

Indicator	Cycle I	Cycle II	Observed Change
Initiative	Most students only skimmed the e-book, and some had not prepared questions before class.	The majority of students read the e-book more thoroughly, prepared notes, and brought questions for discussion.	Increased initiative in preparing for learning
Responsibility	Some students delayed completing worksheets (SW) and independent tasks.	Almost all students completed worksheets on time and were more serious in accomplishing tasks	Improved sense of responsibility for assignments.

Indicator	Cycle I	Cycle II	Observed Change
Initiative	Most students only skimmed the e-book, and some had not prepared questions before class.	The majority of students read the e-book more thoroughly, prepared notes, and brought questions for discussion.	Increased initiative in preparing for learning
Self-Regulation	Some students were still distracted and less focused during discussions.	Students were better able to regulate themselves, stay focused during discussions, and respect their peers' opinions.	Positive changes in learning behavior.

DISCUSSION

Based on the data presented in the bar charts of teacher activities, student activities, and formative test scores, supported by the mean scores in Table 2 and the qualitative findings in Table 3 regarding students' learning autonomy reflections, a consistent improvement was observed across all aspects from Cycle I to Cycle II. In Cycle I, Meeting 1, teacher activity was recorded at 70% (good), student activity at 50% (fair), and the average formative test score at 58.1% (fair). This condition indicates that at the initial stage of implementing e-book–based Flipped Learning, students still tended to be passive, were not yet accustomed to reading the e-book prior to class, and were less optimal in utilizing discussion time. The teacher was also still in the adjustment stage of facilitating digital-based learning. In Cycle I, Meeting 2, teacher activity increased to 75% (good) and the formative test score to 62.7% (fair), while student activity remained at 50% (fair). The mean scores in Table 2 also confirm that overall in Cycle I, teacher activity fell into the "good" category, whereas student activity and formative test results were still in the "fair" category, indicating that although the teacher's management of learning began to improve, student engagement remained low due to a lack of readiness for independent learning.

After reflection and improvement, the results in Cycle II showed a significant increase. In Meeting 1, teacher activity reached 85% (excellent), student activity 72.5% (good), and the average formative test score 76.3% (good). The revised strategies, including reinforcing the obligation to read the e-book before class, providing clearer guidance, and facilitating more intensive discussions, proved effective in encouraging students to become more active. The improvement became even more evident in Cycle II, Meeting 2, with teacher activity reaching 95% (excellent), student activity 85% (excellent), and the average formative test score 83.9% (excellent). The mean scores in Table 2 further corroborate these findings, showing that teacher activity increased from 72.5% in Cycle I to 90.0% in Cycle II, student activity from 50.0% to 78.8%, and formative test results from 60.5% to 80.2%, all of which indicate an overall improvement in category. Their initiative increased, shifting from merely skimming the e-book to preparing notes and questions before lessons. Their sense of responsibility also grew, as they became more consistent in completing worksheets (SW) on time instead of delaying tasks. Likewise, self-regulation improved, as students who were previously easily distracted became more focused during discussions and more respectful of their peers' opinions. Thus, the results in cycle II demonstrate that the majority of students had developed learning autonomy, actively participated in discussions, and completed tasks more effectively compared to the previous cycle.

The improvement observed in this study aligns with the findings of (Hasrida et al., 2023) who emphasized that Flipped Learning can foster active student engagement because learners study the material prior to face-to-face sessions. This is consistent with the present data, in which student activity scores increased significantly from the fair category in cycle I to the excellent category in cycle II. With better learning preparation through e-books and videos, students became more actively involved in discussions, asking questions, and expressing opinions. This is further supported (Fisher et al., 2024) who found that Flipped Learning enhances engagement, active participation, and students' self-regulated learning by offering flexibility in accessing materials and strengthening meaningful classroom interactions. In addition, (Hidayat et al., 2024) and (Syukur et al., 2025) demonstrated that beyond improving mastery of science concepts, the integration of digital technology in Flipped Learning expands learning interactions and facilitates more intensive communication between teachers and students. This was also reflected in the present study, where the use of e-books, Google Drive, and

WhatsApp enabled the teacher to provide continuous guidance, even outside face-to-face sessions. The impact was evident in the improvement of teacher activity scores from the good to the excellent category, as the teacher became more effective in managing instructional time, providing feedback, and facilitating digitally supported discussions.

Furthermore, (Yasmun, 2023) emphasized that student reflections can strengthen non-cognitive aspects such as autonomy, responsibility, and learning initiative. This is consistent with the findings of the present study, which revealed an improvement in students' learning behaviors, as they became more disciplined in accessing materials, more consistent in completing tasks on time, and more proactive during discussions. Thus, the implementation of e-book–based Flipped Learning in this study not only enhanced cognitive outcomes (formative test scores) but also fostered stronger attitudes of independence and collaboration. These results are further supported by (Yassin, 2022) who reported that Flipped Learning significantly reinforces student interaction, both among peers and between students and the learning materials, particularly in large classroom settings. This corresponds with the current findings, which showed that students were more actively engaged in face-to-face discussions after independently studying the e-book and video materials.

In addition, a systematic study by (Ridha et al., 2024) identified strategies such as gamification, immediate feedback, guided group work, and independent reflective thinking as key factors in enhancing student engagement in the Flipped Learning approach. These strategies are consistent with the practices applied in this study, where students were trained to engage in self-reflection and collaborate in groups. The impact was evident in the increased proactivity of students during cycle II. Furthermore, (Velázquez & Lara, 2022) demonstrated that Flipped Learning is effective in fostering students' autonomy and critical thinking. This supports the findings of the present study, as students were required to engage in independent study prior to class and apply critical thinking during face-to-face discussions. In other words, e-book–based Flipped Learning not only strengthened cognitive learning outcomes but also equipped students with critical thinking skills and autonomy that are highly relevant to the demands of 21st-century learning.

CONCLUSION AND SUGGESTION

The integration of the Flipped Learning approach in Grade XI I of SMA Negeri 2 Palu proved effective in enhancing students' learning autonomy and Biology learning outcomes. Teacher activity increased from 70% in cycle I to 95% in cycle II, student activity from 50% to 85%, and formative test scores from 58.1% to 83.9%. Student reflections also indicated improvements in learning behavior, including greater initiative, responsibility, and self-regulation across cycles. However, this study is limited by the relatively small sample size and the implementation within only two cycles, which may not fully capture the long-term effectiveness of the approach. Therefore, future research is recommended to involve a larger number of participants, broaden the scope of subject matter, and further explore the use of other digital media innovations in the implementation of Flipped Learning.

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