Journal of Academic Biology and Biology Education
Vol. 3, No. 1, June 2026, pp. 24~32
ISSN: 3062-9705, DOI: 10.37251/jouabe.v3i1.3242

SETS Learning Model in Biology: Strengthening Students' Affective Competencies

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Article Info

Article history:

Received Mar 16, 2026
Revised Apr 20, 2026
Accepted May 30, 2026
Online First Jun 1, 2026

Keywords:

Affective Learning Outcomes
Biology Education
Fungi Concepts
Learning Interest
SETS Learning Model

ABSTRACT

Purpose of the study: This study aimed to analyze students' affective learning outcomes through the implementation of the Science, Environment, Technology, and Society (SETS) learning model on fungi concepts in biology learning. The research specifically focused on students' attitudes, learning interests, responsibility, discipline, cooperation, and environmental awareness during instructional activities.

Methodology: This study employed a descriptive research design involving 65 tenth-grade students at Pasawahan State Senior High School 1. Data were collected using questionnaires, observation sheets, practical worksheets, and laboratory reports. The SETS learning model integrated laboratory practices, group discussions, and fermentation projects. Instrument validation was conducted through expert judgment, while data analysis used descriptive percentage techniques.

Main Findings: The findings showed that the implementation of the SETS learning model improved students' affective learning outcomes with an overall average score of 81.5%, categorized as very good. Practicum process assessment achieved the highest score of 82.2%, followed by laboratory reports at 81.0% and practical worksheets at 80.8%. Students demonstrated positive attitudes, responsibility, discipline, cooperation, learning enthusiasm, and environmental awareness during biology learning activities.

Novelty/Originality of this study: The novelty of this study lies in its comprehensive analysis of affective learning outcomes through the SETS learning model on fungi concepts. Unlike previous studies emphasizing cognitive achievement, this research specifically examined discipline, responsibility, curiosity, cooperation, learning interest, and scientific attitudes through contextual laboratory activities, group discussions, worksheets, and fermentation projects integrated with environmental and societal applications.

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1. INTRODUCTION

Twenty-first century education demands learning approaches that integrate science, environment, technology, and society in a contextual manner. Biology learning does not only emphasize conceptual mastery but also the development of students' attitudes and interests [1]-[3]. The affective domain plays an important role

in shaping students' scientific character during the learning process [4]-[6]. However, the implementation of affective assessment in biology learning remains inadequate in many schools [7]-[9]. This condition requires learning models capable of developing affective aspects in an integrated way.

The rapid development of science and technology has significantly influenced human life and the environment. The misuse of technology without environmental awareness may create various social and ecological problems [10]-[12]. Therefore, education should equip students with critical thinking skills and environmental awareness [13], [14]. Biology learning becomes an essential medium for fostering responsibility toward the environment and society [15], [16]. The integration of science, environment, technology, and society is considered relevant to modern educational practices.

The Science, Environment, Technology, and Society (SETS) learning model was developed to connect scientific concepts with students' real-life experiences [17]. This model emphasizes the reciprocal relationship among science, technology, environment, and society. SETS learning provides opportunities for students to actively seek information and solve contextual problems [18], [19]. Besides improving conceptual understanding, this model can also foster scientific attitudes and social awareness among students [20], [21]. Therefore, the implementation of the SETS learning model is expected to create more meaningful and applicable biology learning.

Affective learning outcomes include students' attitudes, interests, values, and character during the learning process. The affective domain plays an important role in determining students' success in comprehensively understanding learning materials [22]-[24]. Students with positive attitudes and interests toward learning tend to achieve better academic outcomes [25]-[27]. Nevertheless, teachers still focus more on cognitive assessment than affective assessment [28]-[30]. Consequently, the development of students' character and scientific attitudes often receives limited attention in classroom practices.

Several previous studies have demonstrated that the SETS learning model contributes positively to biology learning outcomes. Research conducted by Putra [31] reported that the SETS learning model significantly improved students' motivation and biology learning outcomes on environmental change concepts. Another study revealed that SETS learning enhanced students' learning activities and overall biology achievement [32]. Furthermore, previous studies mainly emphasized cognitive achievement, motivation, and general learning outcomes rather than specifically investigating affective learning outcomes in biology instruction. Therefore, a research gap still exists regarding comprehensive analyses of students' affective domains, particularly attitudes and learning interests, through the SETS learning model on fungi concepts at the senior high school level.

The novelty of this study lies in its focus on analyzing students' affective learning outcomes through the SETS learning model on fungi concepts. This study not only evaluates students' attitudes but also examines their learning interests during instructional activities. In addition, the research integrates laboratory activities, group discussions, and field assignments within the SETS learning framework. These approaches provide more contextual and meaningful learning experiences for students. Therefore, this study offers a new perspective on the development of affective domains in SETS-based biology learning.

This research is important because the development of affective learning outcomes remains a challenge in biology education. Strengthening students' scientific attitudes and learning interests is necessary to build environmentally and socially responsible individuals. The SETS learning model is considered capable of addressing the need for contextual and real-life-oriented learning. The findings of this study are expected to serve as references for teachers in selecting effective learning models to improve students' affective learning outcomes. Therefore, the objective of this study is to analyze students' affective learning outcomes through the SETS learning model on fungi concepts.

2. RESEARCH METHOD

This study employed a descriptive research design to analyze students' affective learning outcomes through the Science, Environment, Technology, and Society (SETS) learning model on fungi concepts. The research was conducted at Pasawahan State Senior High School 1 during the first semester of the academic year. The subjects of this study consisted of 65 tenth-grade students, including 31 students from class X-1 and 34 students from class X-2. The participants were selected purposively because they had studied fungi concepts using the SETS learning model. The study focused on evaluating students' affective learning outcomes, particularly attitudes and learning interests during biology learning activities.

The implementation of the SETS learning model integrated science concepts with environmental, technological, and societal contexts related to fungi materials. Learning activities were conducted through laboratory practices, group discussions, and field assignments to encourage students' active participation and contextual understanding. The learning process emphasized students' scientific attitudes, environmental awareness, discipline, cooperation, and responsibility during classroom activities. The stages of SETS learning

included invitation, exploration, proposing explanations and solutions, and taking action. These stages were designed to provide meaningful learning experiences and improve students' affective competencies.

The research instruments consisted of questionnaires and observation sheets to measure students' affective learning outcomes. The questionnaire was used to assess students' learning interests, while the observation sheets evaluated students' attitudes during learning activities. The affective indicators assessed in this study included discipline, cooperation, responsibility, environmental care, activeness, scientific attitudes, and students' enthusiasm toward biology learning. Instrument validation was carried out through expert judgment to ensure content validity and suitability with the research objectives. The instruments were developed based on affective assessment guidelines issued by the Directorate of Senior High School Development.

Data collection was conducted during the implementation of biology learning activities on fungi concepts. Observations were carried out directly during laboratory practices, classroom discussions, and presentation sessions to identify students' affective behaviors. In addition, students completed questionnaires at the end of the learning activities to evaluate their interests and responses toward the SETS learning model. Supporting data were also obtained from students' worksheets and laboratory reports. All collected data were documented systematically to facilitate further analysis.

The collected data were analyzed descriptively using percentage analysis techniques. Students' affective scores obtained from observation sheets and questionnaires were categorized into several criteria, including very good, good, fair, and poor. The percentage results were then interpreted to describe students' affective learning outcomes during the implementation of the SETS learning model. Descriptive analysis was used to provide comprehensive information regarding students' attitudes and learning interests in biology learning. The findings were subsequently interpreted to explain the effectiveness of the SETS learning model in developing students' affective domains. The classification of percentage scores is presented in Table 1.

Table 1. Criteria for Affective Learning Outcome Assessment

Percentage Interval (%)	Category
81–100	Very Good
61–80	Good
41–60	Fair
21–40	Poor
0–20	Very Poor

3. RESULTS AND DISCUSSION

The implementation of the Science, Environment, Technology, and Society (SETS) learning model on fungi concepts was conducted for three weeks involving 65 tenth-grade students at Pasawahan State Senior High School 1, Kuningan, West Java, Indonesia. The learning activities included fungi observation practicums, group discussions, field assignments, and group presentations on tape and tempe fermentation projects. The affective learning outcomes were measured using observation sheets, practical worksheets (LKS), and students' laboratory reports. The analysis focused on students' attitudes and learning interests during biology learning activities. The findings demonstrated that the SETS learning model contributed positively to the development of students' affective learning outcomes.

Table 2. Overall Affective Learning Outcomes of Students

Assessment Component	Percentage (%)	Category
Practicum Process Assessment	82.2	Very Good
Practical Worksheet (LKS) Assessment	80.8	Very Good
Laboratory Report Assessment	81.0	Very Good
Average Score	81.5	Very Good

The results presented in Table 2 indicate that the overall affective learning outcomes of students reached an average percentage score of 81.5%, categorized as very good. The highest score was obtained from the practicum process assessment with a percentage of 82.2%. Meanwhile, the practical worksheet assessment obtained the lowest percentage score, although it remained within the very good category. These findings demonstrated that the SETS learning model effectively supported the development of students' affective competencies during biology learning activities. Students showed positive attitudes, discipline, responsibility, and active participation throughout the learning process.

These findings further confirm that the SETS learning model effectively improved students' affective learning outcomes on fungi concepts. The results are consistent with humanistic learning theory, which emphasizes emotional involvement, meaningful experiences, and active participation during learning activities. Humanistic theory explains that students develop better affective competencies when they are directly involved

in contextual and experiential learning processes. In this study, laboratory activities, discussions, and fermentation projects enabled students to connect biology concepts with real-life situations, thereby strengthening their discipline, responsibility, and learning enthusiasm. Similar findings were reported by Jumiah et al. [33], who found that the SETS learning model positively influenced students' biology learning activities and learning outcomes.

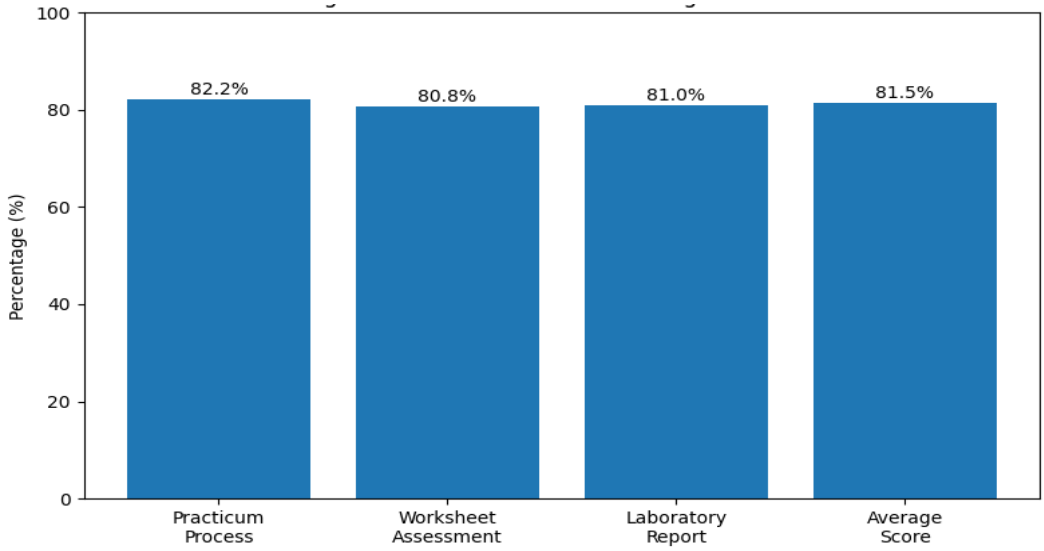

Figure 1. Overall Affective Learning Outcomes

Figure 1 shows that all assessment components achieved percentage scores above 80%, indicating consistent positive affective learning outcomes among students. The practicum process assessment obtained the highest percentage because students demonstrated strong discipline and responsibility during laboratory activities. In addition, the contextual learning experiences provided by the SETS model increased students' enthusiasm and participation during the learning process. The findings suggest that the integration of science concepts with environmental and societal contexts can improve students' affective engagement in biology learning.

The practicum process assessment results indicated that students achieved a very good category with an average percentage score of 82.2%. The highest scores were found in punctuality and procedural compliance indicators. Students demonstrated strong discipline and were able to follow laboratory procedures properly during fungi observation activities. Students also showed good performance in the completeness of tools and materials, neatness, and worksheet completion. However, the curiosity indicator obtained the lowest percentage score, although it still belonged to the good category.

Table 3. Practicum Process Assessment Results

Indicator	Percentage (%)	Category
Punctuality	88.3	Very Good
Procedural Compliance	88.0	Very Good
Completeness of Tools and Materials	84.0	Very Good
Neatness	81.2	Very Good
Worksheet Completion	79.5	Good
Curiosity	76.3	Good
Average Score	82.2	Very Good

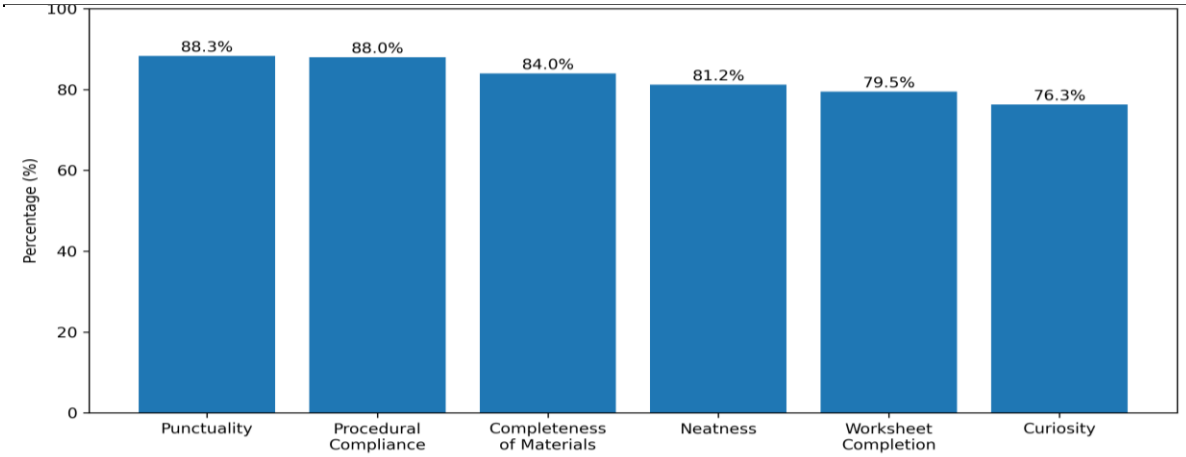

Figure 2. Practicum Process Assessment Results

The lower score found in the curiosity indicator suggested that some students still experienced difficulties expressing questions and opinions during learning activities. This finding may be related to students' self-confidence and limited opportunities for interaction during classroom discussions. According to Bloom's affective domain taxonomy, curiosity belongs to the receiving and responding levels, which require continuous stimulation through interactive and student-centered learning environments. Nevertheless, students became more enthusiastic when the learning activities were associated with real-life experiences, particularly during fungi observation and fermentation practices. These findings are supported by Barata and Agilliana [34], who found that contextual biology learning models significantly improved students' self-confidence and willingness to participate actively in classroom discussions. Contextual experiences within the SETS model therefore contributed positively to students' emotional engagement and learning motivation during biology instruction.

The high percentage score obtained in the practicum process assessment indicated that contextual laboratory activities effectively strengthened students' affective engagement during biology learning. Students showed excellent punctuality, procedural compliance, and responsibility because the SETS learning model emphasized direct scientific experiences and active participation in observation activities. These findings support constructivist learning theory proposed by Vygotsky, which states that knowledge and attitudes are constructed through active interaction with the environment and collaborative experiences. Through fungi observation activities and fermentation projects, students were encouraged to learn collaboratively while applying scientific concepts to authentic situations. Similar results were reported by Putra [31], who revealed that the SETS learning model significantly increased students' motivation and biology learning outcomes through contextual learning experiences. The findings also align with research published in Biosfer: Jurnal Pendidikan Biologi, which showed that collaborative learning activities positively affected students' engagement and scientific attitudes in biology learning [35].

The practical worksheet assessment results showed an average percentage score of 80.8%, categorized as very good. The highest score was obtained in the neatness indicator, followed by the conclusion indicator. These findings indicated that students were able to organize and communicate their observations systematically during biology learning activities. Students also demonstrated good analytical skills when interpreting fungi observation results and answering conceptual questions. The SETS learning model encouraged students to connect biological concepts with environmental and societal contexts, thereby improving their learning interests and engagement.

Table 4. Practical Worksheet Assessment Results

Indicator	Percentage (%)	Category
Neatness	86.2	Very Good
Conclusion	84.0	Very Good
Discussion	81.5	Very Good
Data Analysis	76.8	Good
Observation Results	75.7	Good
Average Score	80.8	Very Good

The lowest score in the worksheet assessment was found in the observation results indicator. Some students still experienced difficulties in drawing fungi structures accurately and identifying the characteristics of observed fungi specimens. This finding indicated that students' observational and scientific communication skills still required improvement. However, students were able to compensate for these weaknesses through

group discussions and references obtained from books and internet sources. These activities reflected that the SETS learning model promoted collaborative learning and independent information-seeking behavior among students.

These findings indicate that the SETS learning model facilitated the development of students' analytical thinking and scientific communication skills through contextual scientific tasks. According to Vygotsky's social constructivist theory, meaningful learning occurs through social interaction, collaboration, and communication among learners during problem-solving activities [36], [37]. In this study, group discussions and worksheet activities enabled students to exchange ideas, interpret fungi observations, and construct scientific understanding collaboratively. The contextual learning experiences also encouraged students to become more independent in seeking scientific information from various learning resources. Similar findings were reported by Hanifah and Purbosari [38], who stated that collaborative and inquiry-based biology learning improved students' affective engagement and scientific process skills.

The assessment of students' laboratory reports also showed positive results with an average percentage score of 81.0%, categorized as very good. The highest score was obtained in the punctuality of report submission. This finding demonstrated that most students showed strong discipline and responsibility in completing their assignments according to the agreed schedule. Students were also able to prepare laboratory reports neatly and follow the required experimental procedures appropriately. The implementation of field-based fermentation projects through the SETS approach provided students with meaningful scientific experiences connected to everyday life.

Table 5. Laboratory Report Assessment Results

Indicator	Percentage (%)	Category
Submission Punctuality	84.0	Very Good
Report Neatness	82.7	Very Good
Experimental Procedure	81.0	Very Good
Data Presentation	79.0	Good
Report Completeness	78.5	Good
Average Score	81.0	Very Good

However, the completeness and systematic structure of laboratory reports received the lowest percentage score. Some students still had difficulties organizing report components systematically and using proper scientific language in report writing. These findings indicated that scientific writing skills among students still need further development through continuous guidance and practice. Despite these limitations, most students demonstrated positive scientific attitudes, including responsibility, discipline, cooperation, and neatness during biology learning activities. The SETS learning model successfully facilitated students in applying scientific concepts within real-life contexts while strengthening their affective competencies.

The laboratory report assessment results also reflected positive affective development, particularly in discipline, responsibility, and scientific attitudes. Students demonstrated punctuality in report submission and followed experimental procedures properly during the fermentation projects conducted through the SETS approach. These findings support Kolb's experiential learning theory, which emphasizes that meaningful learning occurs through concrete experiences, reflective observation, and active experimentation [39]-[41]. The integration of field-based fermentation projects enabled students to understand the relevance of fungi concepts in food technology and environmental applications. Despite the positive outcomes, some students still faced difficulties organizing report structures systematically and using scientific language appropriately. Similar findings were reported by Dewayani et al. [42], who found that biology learning models integrating collaborative and practical activities improved affective learning outcomes, although scientific writing skills still required further development through continuous practice

Overall, the findings of this study demonstrated that the SETS learning model effectively improved students' affective learning outcomes on fungi concepts. Students showed high levels of discipline, responsibility, cooperation, enthusiasm, and environmental awareness during biology learning activities. The integration of science, environment, technology, and society within the learning process enabled students to connect biology concepts with real-life experiences. These contextual experiences increased students' learning interests and promoted active participation during laboratory and discussion activities. The findings support previous studies stating that contextual learning models positively influence students' affective engagement and scientific attitudes.

The results of this study also indicated that practical activities and collaborative learning significantly contributed to the development of students' affective domains. Laboratory observations, group discussions, and fermentation projects encouraged students to communicate, cooperate, and solve problems collaboratively. Furthermore, the SETS learning model fostered students' environmental awareness by relating fungi concepts to everyday environmental and technological issues. Although some indicators still showed lower scores, such as

curiosity and scientific writing skills, the overall affective learning outcomes remained in the very good category. Therefore, the SETS learning model can be considered an effective alternative learning approach for improving students' affective competencies in biology education.

The novelty of this study lies in the comprehensive analysis of students' affective learning outcomes through the implementation of the SETS learning model on fungi concepts in biology learning. Previous studies generally focused on cognitive achievement and general learning outcomes, whereas this study specifically examined affective indicators, including discipline, responsibility, curiosity, cooperation, learning interest, and scientific attitudes through practicum activities, worksheets, and laboratory reports. In addition, the integration of fungi observation and fermentation projects provided authentic contextual experiences that connected science concepts with environmental, technological, and societal applications. This approach offered a more comprehensive understanding of how the SETS learning model contributes to students' affective development during biology learning activities. Furthermore, the study contributes to biology education research by highlighting the importance of contextual and experiential learning in strengthening students' affective competencies in secondary education.

The findings of this study have important implications for biology learning practices in secondary schools. The positive affective outcomes demonstrated that the SETS learning model can be used as an alternative instructional approach to improve students' discipline, responsibility, cooperation, learning motivation, and environmental awareness simultaneously. The integration of contextual laboratory activities and real-life projects also supports the development of meaningful and student-centered learning environments. In addition, the study suggests that biology teachers should incorporate collaborative and experiential learning activities more consistently to strengthen students' affective and scientific competencies. The findings may also serve as a reference for curriculum developers and educators in designing contextual biology learning models that integrate science, environment, technology, and society effectively.

This study was limited to one school and involved a relatively small number of participants, which may restrict the generalizability of the findings to broader educational contexts. In addition, the study focused only on affective learning outcomes in fungi concepts, so further research involving different biology topics and broader assessment aspects is needed to obtain more comprehensive results.

4. CONCLUSION

The findings of this study demonstrated that the implementation of the Science, Environment, Technology, and Society (SETS) learning model effectively improved students' affective learning outcomes on fungi concepts. The overall affective learning outcomes achieved an average percentage score of 81.5%, categorized as very good, indicating positive development in students' discipline, responsibility, cooperation, enthusiasm, and environmental awareness during biology learning activities. The contextual learning experiences provided through fungi observation practicums, group discussions, worksheets, laboratory reports, and fermentation projects successfully increased students' active participation and learning interest. The integration of science concepts with environmental, technological, and societal contexts also enabled students to connect biological knowledge with real-life situations meaningfully. Therefore, the SETS learning model can be considered an effective alternative learning approach for strengthening students' affective competencies in biology education. Future studies are recommended to involve larger participant groups, different biology topics, and broader assessment variables to obtain more comprehensive findings regarding the effectiveness of the SETS learning model in science education.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Pasawahan State Senior High School 1, Kuningan, West Java, Indonesia, for providing support and permission to conduct this research. The authors also thank all students who participated actively in the learning activities and contributed to the successful completion of this study.

AUTHOR CONTRIBUTIONS

Conceptualization, MNS and TS; Methodology, MNS; Software, MNS; Validation, MNS and TS; Formal Analysis, MNS; Investigation, MNS; Resources, TS; Data Curation, MNS; Writing – Original Draft Preparation, MNS; Writing – Review & Editing, TS; Visualization, MNS; Supervision, TS; Project Administration, MNS; Funding Acquisition, TS.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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