



Challenges of the Science EduXplore Program and Alternative Solutions in Biology Learning through Outdoor Learning and Digital Transformation

Miftahul Jannah¹, Syafira Defni², Juju Juwita³, Bambang Supriatno^{4*}, Sariwulan Diana⁵

^{1,2,3,4,5}Master of Biology Education, Faculty of Mathematics and Natural Sciences Education, Universitas Pendidikan Indonesia, Bandung

Article Information

Received: 2025-09-04

Revised: 2026-03-19

Accepted: 2026-04-17

Published: 2026-04-30

Corresponding Author

Bambang Supriatno

(bambang@upi.edu)

Distributed under



CC BY-SA 4.0

Abstract

This study aims to analyze the implementation challenges of the Science EduXplore 2025 program and identify alternative solutions for its future development. The program represents an innovative biology learning model that integrates outdoor learning and digital transformation approaches. This research employed a descriptive quantitative method with a cross-sectional design. Data were collected through questionnaires completed by 30 junior high school participants and analyzed using descriptive statistics. The results indicate that participants generally responded positively to the program, particularly in terms of engagement, meaningfulness, and facilities. However, several challenges were identified, including limited exploration time, difficulties in using scientific tools, and the perceived relevance of the material. Based on these findings, alternative solutions were proposed, such as utilizing QR codes, mobile-based scientific sensor applications, and developing interactive e-modules. In addition, a differentiated approach based on educational levels (junior and senior high school) was implemented to align the complexity of the material. These findings suggest that integrating outdoor learning with digitalization holds significant potential to foster active, contextual, and reflective biology learning, and can serve as a foundation for sustainable educational program development.

Keywords: *Science EduXplore; outdoor learning; digital transformation; biology education; alternative solutions*

Abstract

Penelitian ini bertujuan untuk menganalisis tantangan pelaksanaan program Science EduXplore 2025 dan mengkaji alternatif solusi yang dapat diterapkan untuk pengembangan program selanjutnya. Kegiatan ini merupakan inovasi pembelajaran biologi berbasis pengalaman yang mengintegrasikan pendekatan outdoor learning dan transformasi digital. Penelitian menggunakan pendekatan kuantitatif deskriptif dengan desain cross-sectional. Data dikumpulkan melalui angket yang diisi oleh 30 siswa jenjang SMP dan dianalisis menggunakan statistik deskriptif. Hasil penelitian menunjukkan bahwa peserta secara umum memberikan respon positif terhadap kegiatan, terutama dalam aspek keterlibatan, kebermaknaan, dan fasilitas. Namun demikian, ditemukan beberapa tantangan seperti keterbatasan waktu eksplorasi, kesulitan penggunaan alat, dan relevansi materi. Berdasarkan hasil analisis, diidentifikasi beberapa solusi alternatif, seperti pemanfaatan QR code, aplikasi sensor ilmiah berbasis ponsel, serta pengembangan e-modul interaktif. Selain itu, dilakukan diferensiasi pendekatan berdasarkan jenjang peserta (SMP dan SMA) untuk menyesuaikan kompleksitas materi. Temuan ini mengindikasikan bahwa integrasi outdoor learning dan digitalisasi memiliki potensi signifikan dalam mengembangkan pembelajaran biologi yang aktif, kontekstual, dan reflektif, serta dapat dijadikan dasar untuk pengembangan program edukatif berkelanjutan.

Keywords: *Science EduXplore; outdoor learning; digital transformation; biology learning; alternative solutions*

1. INTRODUCTION

Learning Biology in schools is generally still theoretical using a lecture approach, resulting in low student involvement in learning (Souza & Santos, 2019). Conventional methods often fail to motivate students to understand concepts contextually, especially in relation to global issues such as sustainable development.

On the other hand, the challenges of learning biology today are not only related to understanding concepts, but also limitations in developing 21st century skills such as critical thinking, collaboration, and environmental data literacy (Rose et al., 2024). Many learning activities are still one-way and do not provide space for students to explore knowledge independently through direct observation. This contributes to students' lack of awareness of the importance of maintaining environmental sustainability and their low involvement in real science-based action (Juanda et al., 2021).

Learning activities that utilize the environment and are designed to be problem-based can be alternative learning to connect theory and practice. Thus, it is necessary to implement a biology learning model that not only focuses on developing knowledge, but can also build scientific skills, leadership, and environmental responsibility values (Boncukçua & Gök, 2023). One of the relevant approaches is through field exploration activities which are packaged in the form of scientific missions. Based on research Fleischner et al. (2017) Field exploration activities in biology learning have been proven to be able to create an immersive learning experience and not only increase understanding of concepts, but also build environmental literacy and a sense of responsibility.

According to Ho et al. (2022) experiential learning such as *Game-based experiential learning* can significantly increase students' knowledge, attitudes, and involvement on complex issues such as the Sustainable Development Goals (SDGs), as well as overcome the problems of passive learning that are common in conventional classrooms. In addition, based on research Nurhasnah et al. (2019) Field exploration can increase students' awareness of biodiversity values and observation skills.

In addition, field exploration-based biology learning can be combined using technology. This has been proven by research Chapple et al. (2017) which shows that the use of QR codes and mobile devices during field exploration activities can enhance the learning experience and strengthen learners' engagement with scientific activities in the field. In line with research Yeung & Sun (2021) which proves that the integration of platform-based mobile technology and scientific sensors can improve concept understanding, learning motivation, and students' ability to connect knowledge with daily life more deeply. This refers to the combination of field exploration learning with technologies such as QR codes, the use of platforms, and scientific sensors on mobile phones can be an alternative solution to the biology learning process.

The Science EduXplore program is designed as an experiential biology learning innovation that integrates field trips or outdoor practicums with pre-real-time-post-activity design. Research shows that *Field trip* or outdoor learning has long increased students' interest, concept relevance, and observation skills, as long as it is prepared and followed up systematically (Behrendt & Franklin, 2014). However, existing practices often still leave drawbacks such as logistical constraints and cost or time, novelty effects that interfere with focus if not conditioned, stand-alone activities (not connected to the curriculum), assessments that are not aligned with goals, and inclusivity that is not optimal for all participants (Behrendt & Franklin, 2014; Whitmeyer et al., 2020). However, the results of the evaluation from the previous implementation show that there is a need to improve activities by incorporating new innovations such as the use of digital technology and sustainability strategies.

Based on the description that has been submitted, it is necessary to combine field exploration learning with the use of technology as one of the solutions to biology learning through the Science EduXplore program. One of the technologies that can be used is QR codes and scientific sensor applications on mobile phones. This innovation brings a novelty in biology learning that is collaborative and contextual.

The purpose of this research is to analyze the challenges faced by participants during the implementation of the Science EduXplore 2025 program, examine the responses of students and accompanying teachers to the implementation of the program, and formulate alternative solutions that can be applied in the development of the next Science EduXplore program.

2. METHOD

2.1. Research Design

Research It uses a descriptive quantitative approach with a design Cross-sectional, which aims to describe students' perceptions of the implementation of the program Science EduXplore 2025, as well as identifying challenges and alternative solutions in the implementation of outdoor learning-based biology learning and digital transformation (Cresswell & Creswell, 2017). This design allows researchers to obtain data images at a single time of implementation, without specific experimental treatments or groupings.

2.2. Population and Sample

The population in this study is all participants of the Science EduXplore 2025 program consisting of junior high school students. However, due to the limited participation of filling out the questionnaire, the analyzed sample amounted to 30 participants. Sampling was carried out using convenience sampling techniques, which is sample selection based on the availability and ease of access to respondents who fill out questionnaires voluntarily (Taherdoost, 2016). This technique is commonly used in educational research when access to the full population is limited, and it is considered practical and efficient to collect initial data in the context of field-based programs (Elfil & Negida, 2017).

2.3. Research Procedure

This research is carried out through several structured stages. The first stage is preparation, which includes the preparation of research instruments in the form of a four-level Likert scale closed questionnaire, coordination with the Science EduXplore 2025 program committee, and determination of the sampling techniques to be used.

The second stage is program implementation and data collection. The Science EduXplore program will be held on April 22, 2025 at the Botanical Garden of the Indonesian Education University, Bandung.

The third stage is data processing and analysis. The collected questionnaire data was tabulated and analyzed using quantitative descriptive statistics. The results of the calculation are then presented in the form of graphs and interpreted descriptively to describe the participants' perception of the program.

The fourth stage is reflection and preparation of alternative solutions. Based on the results of the analysis of questionnaire data and field observation records during the activity, a literature review was conducted to identify and formulate alternative solutions that can be applied to the development of the Science EduXplore program in the future. The flow of this research procedure is summarized in Figure 1 below.



Figure 1. Research Flow

2.4. Instrument Research

The instrument used in this study is in the form of a closed questionnaire with a four-level Likert scale which was prepared to measure participants' perception of the implementation of *the Science EduXplore 2025* program. This questionnaire was developed to evaluate five aspects, namely: (1) participant satisfaction with the program, (2) the significance of the activity in improving scientific understanding, (3) the participant's involvement and interest in science after participating in the activity, (4) the relevance of the activity to the needs of the participants, and (5) the quality of the facilities and the interactivity of the activity. The questionnaire consists of 6 statement items, with the answer options "Strongly Agree," "Agree," "Disagree," and "Disagree."

2.5. Data Analysis

The data obtained from the questionnaire was analyzed using quantitative descriptive statistics, namely by calculating the percentage of frequency for each category of answers in each question item (Cresswell & Creswell, 2017). The percentage calculation is done using the following formula (Sudijono, 2010):

$$P = \frac{f}{N} \times 100\%$$

Description:

P : Frequency percentage

f : Frequency of answers in a given category

N : Number of all respondents

3. RESULT AND DISCUSSION

3.1 Realization and Challenges in the Implementation of the Science EduXplore 2025 Program

The Science EduXplore program was held on Tuesday, April 22, 2025 at the Botanical Garden of the University of Education Indonesia. This activity took place in two sessions, namely morning and afternoon. Each includes a series of scientific missions at each post designed to develop students' observation, critical thinking, and collaboration skills. This program is successfully realized according to the plan that has been prepared by the committee both in terms of technical, participation, and learning outcomes.

This activity was attended by 11 groups of students, where each group amounted to 5 people. Each group participated in the rotation of five scientific activity posts, namely the Weather Detective Post, Plant Identification Post, Cemani Chicken Post, Exploring Other Worlds Post, and MaggotQuest Post.

Based on the results of the observation of activities and the internal evaluation of the committee, a number of technical and pedagogical challenges were found that affected the effectiveness of the program implementation. The main challenge arises from the time constraints at certain posts such as the Plant Identification Post shown in Figure 2, namely that the exploration and filling of the LKPD cannot be completed optimally because the duration is too short, which is 25 minutes.



Figure 2. Plant Identification Post

Another challenge is found in the Weather Detective Post shown in Figure 3, namely that participants experience difficulties in using weather measuring devices such as anemometers and digital thermometers, which shows the need for initial training in the use of tools. Participants are also still unfamiliar with the electric microscope used at the Exploring Other Worlds Post.



Figure 3. Weather Detective Post

In addition, some posts such as the Cemani Chicken Post faced obstacles from the aspect of the object of observation, namely the chickens used were the result of crosses and did not match the original morphological description, thus confusing the participants.

3.2 Participants' Responses to the Science EduXplore Program

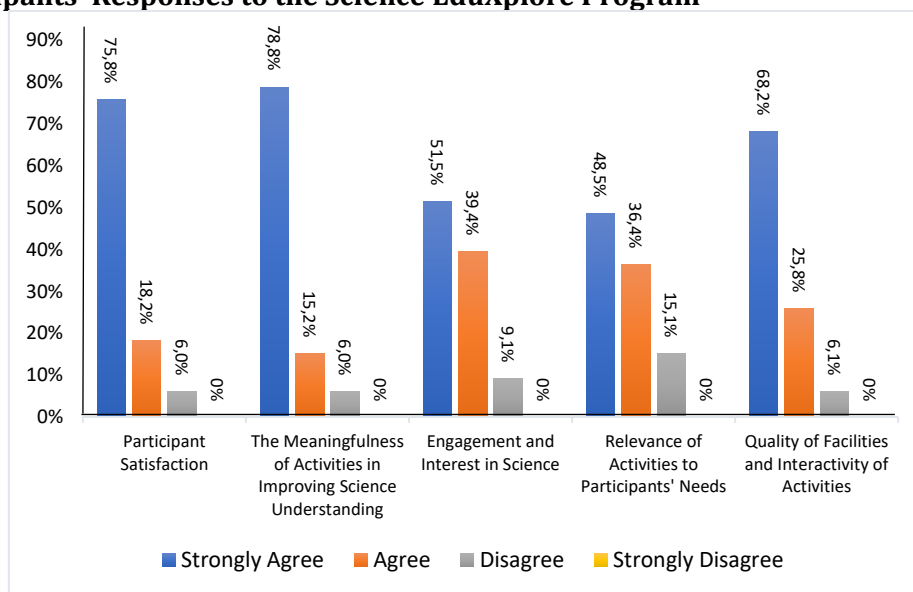


Figure 4. Results of Participant Response Analysis After Participating in Science EduXplore Program

The results of the questionnaire filled out by 30 participants showed that in general, the participants' response to Science EduXplore activities was very positive. As many as 75.8% of participants stated that they really enjoyed the activity, and 78.8% admitted to gaining new knowledge. In fact, 51.5% of participants admitted that they were more interested in science after participating in this activity. This shows that the outdoor learning approach is able to arouse interest and active involvement of participants.

Participants' responses also showed that 68.2% felt that the facilities and services were adequate. However, on the item about the relevance of the activity, 15.1% of participants said they disagreed, indicating that there was a small percentage of participants who felt that the activity was not fully in accordance with their needs or learning context.

The following data from the analysis of participants' responses while participating in Science EduXplore activities is presented in Figure 4.

3.3 Alternative Solutions for Further Program Development

Based on the results of the evaluation of activities and analysis of participants' responses, it was found that although the Science EduXplore 2025 program received a generally positive response, there were still several challenges in technical and pedagogical implementation. Therefore, a literature review and reflection activities were carried out to identify various alternative solutions that can strengthen the implementation of the program in the future.

One of the approaches that is considered effective is the combination of field-based exploratory learning with digital technology. According to Chapple et al., (2017); Yeung & Sun (2021), the use of technology such as QR codes can significantly improve the quality of biology learning, both in terms of cognitive, motivational, and student involvement. The first solution that can be implemented is the use of QR codes for the identification of plant specimens at plant identification posts. This innovation allows participants to access scientific information in the form of morphological descriptions, Latin names, and ecological functions of specimens independently through digital devices. This can reduce dependence on instructors and strengthen students' digital literacy.

The second solution is the use of mobile phone sensor applications such as Phyphox at weather detective posts. The app allows participants to measure air pressure and temperature changes in a systematic manner *real time* through the phone's built-in sensors that connect directly to the data analysis system within the app. According to Staacks et al. (2018) Phyphox is designed to support science experiments by utilizing sensors such as barometers and accelerometers to accurately obtain atmospheric and altitude data, along with remote access features to display results in real time. Thus, the use of Phyphox in weather observation not only improves the accuracy and efficiency of measurements, but also strengthens the application of digital technology in scientific inquiry-based learning.

Meanwhile, Google Weather can also be used to measure temperature, air pressure, and humidity in real time, accurately, and practically without having to use manual measuring tools that are often unfamiliar. This strategy not only facilitates observation, but also introduces participants to technology-based science, while also increasing the effectiveness of practice time. This is in accordance with research Cabrera et al. (2021) that the use of scientific sensor-based mobile phone apps can reduce tool misuse and improve data accuracy.

Furthermore, to ensure the inclusivity of the activity, a differentiation of approaches was carried out based on the level of participants (junior high and high school). Each post is tailored in terms of depth of material, skill level, and facilitation methods. For example, junior high school participants are simply directed to observe the basic morphological structure of plants, while high school participants are given the additional challenge of connecting observation data with the concept of plant ecology or physiology. This kind of differentiation approach is supported by research showing that when teachers structure a variety of assignments that are appropriate to students' abilities and levels, student engagement and learning achievement increase (Graaf et al., 2019). By integrating technology in a meaningful way even though differentiation is carried out at each level, not only to accelerate the delivery of material, but to encourage deeper conceptual

understanding, increase scientific literacy, and grow ecological awareness in a digital context (Zhong et al., 2022).

In addition to differentiation based on educational level, the success of the activity also depends on the context of the material that is close to the lives of students. Research Erna et al. (2025) shows that the development of booklets based on local potential has proven to be practical, attractive, and easy for high school students to use. This proves that the utilization of local potential not only enriches the content of biology learning, but also increases the relevance of learning experiences and students' engagement with their surrounding environment.

From some of the alternative solutions above, it can be assumed that the integration of outdoor learning with digitalization has great potential in overcoming conventional learning challenges and encouraging the development of 21st century skills. The results of the analysis show that the integration of the two is not only able to increase students' interest and engagement, but also opens up space for more active, contextual, and reflective learning.

4. CONCLUSION

The Science EduXplore 2025 program was successfully implemented and received a positive response from students, especially in terms of satisfaction, meaningfulness, and involvement during activities. This shows the effectiveness of the learning approach based on field exploration and technology. The main challenges in the implementation of activities include limited exploration time at several posts, difficulties in using weather measuring instruments and electric microscopes, and incompatibility of observation objects with the material designed. In addition, some participants felt that the activities were not fully relevant to their learning needs. Alternative solutions that can be applied for program development include the use of *QR codes* for field specimen identification and the use of mobile-based scientific sensor applications such as Phyphox and Google Weather, as well as differentiation of learning approaches based on junior high and high school levels. The integration between outdoor learning and digital transformation has been proven to increase the effectiveness of contextual biology learning and support the strengthening of scientific literacy, 21st century skills, and ecological awareness of students.

5. ACKNOWLEDGMENT

The author would like to express his deepest gratitude to all teachers, as well as junior high school students in the cities of Bandung and Cimahi who have actively participated in the Science EduXplore 2025 program. The involvement of teachers as companions during the activity is very meaningful in supporting the smooth implementation of the program and providing motivation to students.

6. REFERENCES

- Behrendt, M., & Franklin, T. (2014). A Review of Research on School Field Trips and Their Value in Education. *International Journal of Environmental and Science Education*, 9(3), 235–245. <https://doi.org/10.12973/ijese.2014.213a>
- Boncukçua, G., & Gök, G. (2023). A problem-based learning activity to learn about sustainable development. *Science Activities*, 60(4), 185–200. <https://doi.org/10.1080/00368121.2023.2258353>
- Cabrera, A. N., Droste, A., Heusinkveld, B. G., & Steeneveld, G. J. (2021). The Potential of a Smartphone as an Urban Weather Station—An Exploratory Analysis. *Frontiers in Environmental Science*, 9(August), 1–16. <https://doi.org/10.3389/fenvs.2021.673937>
- Chapple, D., Weir, B., & Martin, R. S. (2017). Can the incorporation of quick response codes and smartphones improve field-based science education? *International Journal of Innovation in Science and Mathematics Education*, 25(2), 49–71.

- Cresswell, J. W., & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.
- Elfil, M., & Negida, A. (2017). Sampling methods in Clinical Research ; an Educational Review. *Emergency*, 5(1), 3–5.
- Erna, Mahrudin, & Irianti, R. (2025). The Practicality of Local Potential-Based Booklets as a Material for Enriching the Concept of Biodiversity in High School. *Bio-Edu: Journal of Biology Education*, 10(2), 95–105. <https://doi.org/https://doi.org/10.32938/jbe.v10i2.7781>
- Fleischner, T. L., Espinoza, R. E., Gerrish, G. A., Greene, H. W., Kimmerer, R. W., Lacey, E. A., Pace, S., Parrish, J. K., Swain, H. M., Trombulak, S. C., Weisberg, S., Winkler, D. W., & Zander, L. (2017). Teaching Biology in the Field: Importance, Challenges, and Solutions. *BioScience*, 67(6), 558–567. <https://doi.org/10.1093/biosci/bix036>
- Graaf, A. de, Westbroek, H., & Janssen, F. (2019). A Practical Approach to Differentiated Instruction: How Biology Teachers Redesigned Their Genetics and Ecology Lessons. *Journal of Science Teacher Education*, 30(1), 6–23. <https://doi.org/10.1080/1046560X.2018.1523646>
- Ho, S. J., Hsu, Y. S., Lai, C. H., Chen, F. H., & Yang, M. H. (2022). Applying Game-Based Experiential Learning to Comprehensive Sustainable Development-Based Education. *Sustainability (Switzerland)*, 14(3), 1–20. <https://doi.org/10.3390/su14031172>
- Juanda, A., Maulida, A. N., Gloria, R. Y., & Nasrudin, D. (2021). Learning Observation: The Demands of 21st Century Biology Learning in Senior High School. *Indonesian Journal of Science Education*, 9(3), 445–458. <https://doi.org/10.24815/jpsi.v9i3.20162>
- Nurhasnah, N., Miarsyah, M., & Rusdi, R. (2019). The Effectiveness of Field Trip in Biology Learning towards Students' Increased Concern for Biodiversity Values. *Indonesian Journal of Science and Education*, 3(1), 43. <https://doi.org/10.31002/ijose.v3i1.860>
- Rose, A. E., Nancy, A., Sudira, E., Haria, Y., & Suryanda, A. (2024). Exploration of Innovative Strategies for Biology Learning in the 21st Century. *TAUGHT: Journal of Education and Learning*, 3(1), 102–107. <https://doi.org/10.54259/diajar.v3i1.2270>
- Souza, C. M. de, & Santos, C. B. dos. (2019). Practical Lessons in Biology Education: Challenges and Possibilities. *ID on Line Journal of Psychology*, 13(45), 426–433. <https://doi.org/10.14295/idonline.v13i45.1839>
- Staacks, S., Hütz, S., Heinke, H., & Stampfer, C. (2018). Advanced Tools for Smartphone-Based Experiments : Phyphox. *Physics Education*, 53, 1–6.
- Sudijono, A. (2010). *Introduction to Education Statistics*. Raja Grafindo Persada.
- Taherdoost, H. (2016). Sampling Methods in Research Methodology ; How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management (IJARM)*, 5(2), 18–27.
- Whitmeyer, S. J., Atchison, C., & Collins, T. D. (2020). Using Mobile Technologies to Enhance Accessibility and Inclusion in Field-Based Learning. *GSA Today*, 30(9), 4–10. <https://doi.org/10.1130/GSATG462A.1>
- Yeung, W. K., & Sun, D. (2021). An exploration of inquiry-based authentic learning enabled by mobile technology for primary science. *International Journal of Mobile Learning and Organisation*, 15(1), 1–28. <https://doi.org/10.1504/IJML0.2021.111594>
- Zhong, T. C., Mat Saad, M. I., & Che Ahmad, C. N. (2022). Integrating Technology-Mediated Learning in Biology Education (Histology): A Systematic Literature Review. *EDUCATUM Journal of Science, Mathematics and Technology*, 9(1), 48–57. <https://doi.org/10.37134/ejsmt.vol9.1.5.2022>