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Mobile Experiential Learning for Environmental Pollution Science with Linking Authentic Field Data to Pro Environmental Behaviour in Secondary Schools

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Abstract

This research examines the magnitude of the integration of mobile experiential learning for secondary school environmental science learning with a focus on the integration of authentic field data and pro-environmental behavior. In recent times, mobile technology has proven to be a key tool that can facilitate better engagement from the students while also fostering experiential learning in the process. The research examines the effect of mobile learning on the students' level of understanding of environmental pollution by offering them opportunities for collecting real-world field data. This is authentic data with respect to pollution science, which was embedded in the curriculum to enhance the students' awareness and develop sustainable behaviour. A mixed-methods approach was used, which combined qualitative feedback and quantitative learning outcome analysis. The outcomes show that students who engaged in mobile experiential learning activities showed a deeper understanding of pollution science concepts than students who were taught using traditional classroom

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instruction. Furthermore, the research emphasizes the importance of using real field data and making a direct link between knowledge learned in the classroom and real-life environmental challenges. Students demonstrated greater motivation to engage in pro-environmental behaviors, e.g., waste reduction and pollution awareness. The results indicate that mobile experiential learning, when associated with field data collection, has the potential to greatly improve the learning of environmental sciences and to play a role in shaping environmentally responsible citizens. Future research could investigate the scalability of this approach and other topics in the environment.

Keywords:

Mobile experiential learning, environmental science, pollution science, authentic field data, pro-environmental behavior, secondary education, sustainable behaviors.

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Introduction

The importance of engaging in the promotion of environmental awareness and sustainable behaviors in young learners cannot be undervalued, especially in light of the ongoing expansion of global challenges relating to environmental pollution and climate change within a body of water (Sahabuddin & Makkasau, 2024; Douglas et al., 2024). As part of an overall educational strategy, mobile experiential learning is developing as one of the most powerful tools to improve students' engagement in environmental science education (Boncu et al., 2023). This approach combines mobile technology with hands-on and real learning experiences where students can link theoretical concepts with real environmental problems (Aguayo & Eames, 2023; Velliangiri, 2025).

Mobile experiential learning provides a dynamic platform for students to actively engage with the environment and is an opportunity for students to collect and analyze authentic field data (Llopiz-Guerra et al., 2024). This data collection is important in the process of understanding environmental pollution because, besides allowing the student to understand better about pollution science, it can also make the student face the impact of pollution on their environment around them (Liang et al., 2022). The use of mobile devices makes it easier to collect data in real time and provides a more in-depth interaction with the subject matter.

The basic aim of this paper is to discuss the effect of mobile experiential learning on secondary school students, especially the connection of authentic data from the field to the ability of the students to understand environmental pollution. By introducing hands-on learning activities, which encourage data collection and analysis, it is hoped that the study will be able to evaluate the impact of this strategy on students' pro-environmental behavior and attitudes towards pollution (Kalla et al., 2022).

This research will investigate the effectiveness of this pedagogical method to enhance the environmental literacy of students, raise their awareness of the science of pollution, and motivate them to act in more sustainable ways. It aims to prove the possibilities of mobile experiential learning in not just improving educational results, but also in creating a generation of environmentally conscious people.

Key Contributions

- The research shows that mobile experiential learning with the use of real field data collection can greatly increase students' engagement and understanding of environmental pollution science in secondary school.

- It shows the positive impact of mobile experiential learning on the students, which results in an increase in the awareness and adoption of pro-environmental behaviors such as waste reduction and pollution awareness.
- The research opens a door for teaching experiential learning through mobile technology in wider environmental science courses and will provide knowledge about how real-life data can bridge the knowledge gap between theory and real-life applications.

This paper has its structure as follows: Section I introduces the objectives of this study and the importance of promoting environmental awareness among secondary school students through mobile experiential learning. Section II is a literature review about experiential learning, about mobile learning in environmental education, and about the role of real field data for better students' understanding of pollution. Section III presents the methodology of this study, including the mobile experiential learning approach, data collection process, and study participants. Section IV presents the results, which show the improvement in engagement, understanding of environmental pollution, and adoption of pro-environmental behaviors by the students. Section V discusses implications for environmental science education based on the findings of this study, issues and limitations of the use of mobile experiential learning, and recommendations for future research. Finally, Section VI concludes the paper with a final summary of the findings made and future potential for mobile experiential learning in making environmentally-conscious individuals.

Literature Review

Experiential learning is a process of education or learning by doing in which students are actively involved in prearranged learning activities as opposed to passive reception of information (Fletcher et al., 2022). This type of learning enables students to apply the theoretical knowledge to practical situations, which helps them to better understand and retain the material learned (Tan & Nurul-Asna, 2023). For the purposes of environmental science education, the use of experiential learning is of special value in that it promotes the student's ability to link abstract concepts (e.g., pollution) with the context of real life (Cho & Park, 2023). This way, it becomes more relatable and engaging to the readers, and this helps them to develop a deeper understanding of the subject.

In recent years, mobile learning has become a feature in teaching environmental science (Teixeira et al., 2023). Mobile technology, like smartphones and tablets, has made learning more accessible, engaging, and interactive for students (Chen, 2022). Many studies have shown the positive effects of using mobile devices in environmental education, especially in field-based learning. Through the use of mobile apps and other mobile tools, students could obtain and analyze data in real time, which provides students with a valuable learning experience that can help them better understand environmental issues (Huang et al., 2025; Mejail & Nestares, 2025).

Mobile learning is also a way to encourage collaboration as students would be able to share data, discuss their findings, and receive immediate feedback from their teachers and peers (Lo, 2022). Additionally, mobile devices that include GPS and geographic information systems (GIS) technologies offer more dynamic, location-specific learning experiences, which may be especially useful in environmental education because context and location are important in understanding issues that concern the environment.

Authentic field data collection is necessary for a better understanding of environmental pollution by students (Tan & Nurul-Asna, 2023). When students collect data in the field, like measuring pollution levels in water or air, they get hands-on experience to reinforce the theoretical knowledge they have learned in the

classroom (Ria, 2022). This way of teaching students teaches them to see the effects of pollution for themselves and to learn to think critically and problem solve when analyzing and interpreting real-world data.

Field data collection also breeds responsibility and empowerment in the students, as they can contribute to the understanding and response of environmental problems directly (Wang et al., 2022). By studying environmental issues in the real world, students tend to demonstrate pro-environmental behaviors and become more environmentally conscious (Sanchez et al., 2024). Linking what is learned in the classroom to field data helps students understand the practical use of their studies, makes subject matter more engaging, and motivates them to take action for environmental sustainability (Majid et al., 2025).

The literature reviewed highlights the effectiveness of mobile experiential learning in improving environmental science education by bridging knowledge from theory and the real world (Baba-Nalikant et al., 2023). By using mobile technology in their learning, students are actively involved in collecting data in the field and gain a deeper understanding of environmental issues, such as pollution, by learning the impact they have on their surroundings (Hajj-Hassan et al., 2024). Mobile devices not only make it easy to collect data in real time but also encourage collaboration and instant feedback, which also adds to the learning experience. Moreover, the use of real field data helps to build up the sense of responsibility and empowerment among the students, which motivates them towards pro-environmental behaviors. This strategy shows the potential of using mobile experiential learning to conduct a more interactive and impactful environmental science curriculum that encourages students to relate the material they are learning in class with real-world applications.

Methodology

This study is a mobile-experiential learning approach to learning and uses smartphones and tablet devices to engage students in the real-world collection and analysis of environmental data. The approach is focused on getting students actively engaged in field-based activities pertaining to environmental pollution; measuring air quality, water pollution, and soil contamination. Using mobile applications designed to collect environmental data, students are given the ability to collect authentic and location-specific data during outdoor learning activities, which they can analyze later in the classroom. This approach encourages students to implement theoretical knowledge in a practical situation, which assists in inculcating learning through hands-on experiences.

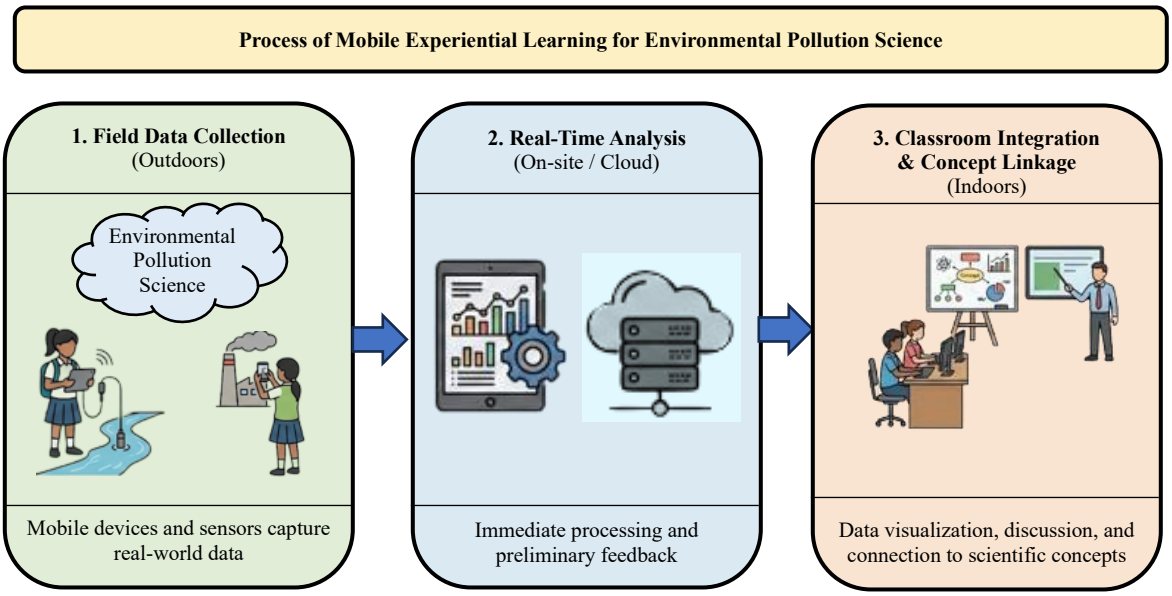

Figure 1. Mobile experiential learning approach

Figure 1 shows the cyclical process of mobile learning experience in environmental pollution science. It starts with Field Data Collection, where students use mobile devices to collect real-world data on environmental issues. This is followed by Real-Time Analysis of the data, which enables the students to visualize the collected data. The next step, Classroom Integration, is the integration of the field data with pollution science concepts, which allows students to make connections between their experiences and the science theory. Finally, Reflection & Discussion allows an opportunity for students to share the findings of their learning, discuss the implications, and reflect on the learning process. Each step is connected to the others, so the learning is comprehensive.

In this research, real data were gathered in structured field trips to some of the local environmental sites with environmental pollution. Students used mobile devices with sensors, GPS, and environmental monitoring apps for recording information such as air and water quality readings, levels of soil contamination, and indices of biodiversity. The information gathered in the field was directly related to important pollution science concepts such as the source, type, and impact of pollution on the environment. This data was then analyzed in the classroom, and students were able to link their observations to theoretical models and scientific principles relating to environmental pollution, which helped improve their level of understanding of the subject.

Table 1. Data collection tasks and variables

Task	Environmental Variables Measured	Mobile App Used	Data Collection Method
Air Quality Measurement	Particulate Matter (PM2.5, PM10), CO2	Air Quality Monitor App	Real-time measurements using sensors
Water Quality Analysis	pH, Dissolved Oxygen, Nitrate Levels	Water Quality Sensor App	On-site sampling and data logging
Soil Contamination Assessment	Heavy Metals (Lead, Arsenic), pH	Soil Tester App	Soil sampling and in-app analysis
Biodiversity Index	Species Richness, Population Density	Biodiversity App	GPS-based location tracking and observation

Table 1 summarizes the tasks, the different environmental variables measured, the mobile apps used, and the methods used for the data collection during the field activities. The tasks varied from measuring air quality to analyzing soil contamination, and each activity had a specific mobile app designed for environmental monitoring. These mobile applications enabled real-time data logging, which meant that students could capture relevant data in the field immediately and later analyze and discuss it in the classroom.

Study Participants and Data Collection Procedure

The research sample comprised 150 students from secondary schools belonging to different educational institutions and was grouped into teams for data collection in the field. Each team was assigned a specific environmental monitoring task, which could be monitoring particulate matter in the air, checking the water quality, or checking the soil contamination. Students were led by their teachers and field experts through the data collection process using a series of outdoor sessions. The mobile apps used in the study enabled the students to record their findings in real-time, and then the data was aggregated for further analysis. A mix of qualitative feedback and quantitative data was gathered in order to assess the impact of the mobile experiential learning approach on the students' understanding of environmental pollution and their pro-environmental behaviors.

Environmental Pollution Index (EPI) Calculation

To determine the level of pollution in different field sites, the Environmental Pollution Index or EPI was calculated using the formula:

$$EPI = \frac{(PM2.5 + CO2 + Nitrate) \times 100}{MaximumPollutantThreshold} \qquad (1)$$

Where:

- PM2.5 is the particulate matter concentration in micrograms per cubic meter,
- CO2 - is the carbon dioxide concentration in parts per million,
- Nitrate is the amount of nitrates contained in water,
- Maximum Pollutant Threshold: Maximum Pollutant Threshold is the threshold value for each of the pollutants as per the national environmental standards.

This equation (1) made it possible to have a uniform measure of the level of pollution at various places, which was useful in comparing the severity of pollution in different locations. The use of this index offered a quantitative framework for analyzing and interpreting the environmental data collected by the students.

Results

Findings

The results of the mobile experiential learning activities show that students showed significant improvements in how engaged they were and also how much they understood the concepts of environmental pollution. The students who were involved in the field data collection activities experienced a significant rise in motivation and interest in environmental science. Their ability to relate real-world observations with theoretical knowledge in the classroom was also found to be significantly improved. The hands-on experience of collecting real data in the field helped students to visualize the effect of pollution in their local environment and make the learning process more meaningful and relevant.

Additionally, the students showed a greater sense of responsibility and empowerment when it comes to environmental issues. Many had a greater awareness of the pollution issues in their community, especially after seeing first-hand the levels of pollution in water, air, and soil. This improved perception was coupled with an increased level of understanding of the sources and effects of pollution, which was reflected in their written accounts and class discussions.

The summary of the degree of student engagement and motivation within the context of the mobile experiential learning activities can be found in Table 2. The responses are on the basis of a post-activity survey given to the students.

Table 2. Student engagement and motivation in mobile experiential learning

Criteria	Mobile Learning Group (%)	Traditional Learning Group (%)
Increased Interest in Environmental Science	85%	55%
Motivation to Participate in Discussions	80%	60%
Awareness of Local Pollution Issues	90%	50%
Willingness to Adopt Sustainable Practices	88%	45%

Impact of Authentic Field Data on Students' Understanding of Environmental Pollution

The use of real field data had a great positive effect on the comprehension of environmental pollution by the students. Students who participated in data collection demonstrated an enhanced ability to analyze and interpret the science concepts in pollution, as compared to students who received the traditional form of classroom-based instruction alone. By using the data directly, students were able to see the real-world implications of environmental pollution, and this led to a better retention of key concepts.

The correlation between the observations in the field and the information they had acquired on pollution science was particularly high on the analysis of water quality, where students received an opportunity to view what occurs to the local water bodies as they are contaminated with nitrates and heavy metals. In class discussions, students were able to make effective connections between these observations and theoretical knowledge, like the environmental and health effects of pollutants, and thereby increase their understanding of this topic.

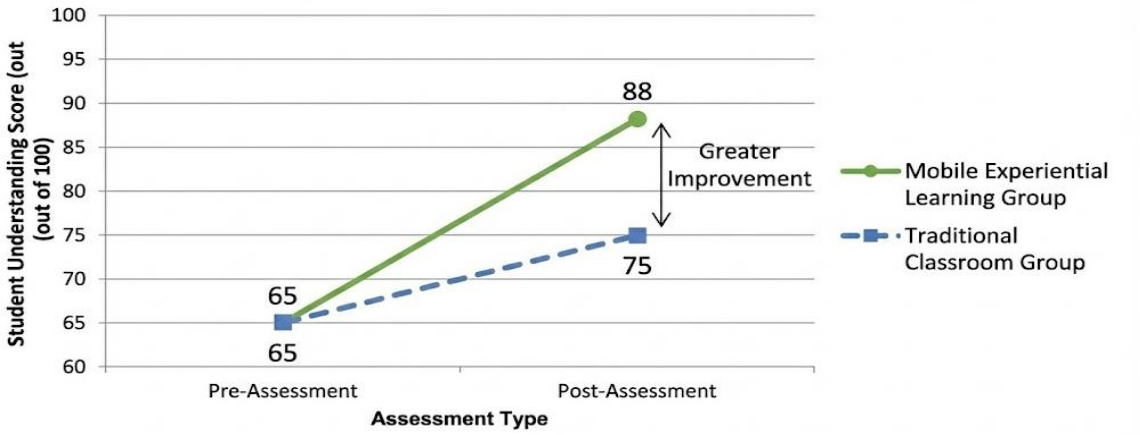

Figure 2. Impact of authentic field data on student understanding

Figure 2 shows the effect of mobile experiential learning on the understanding of environmental pollution concepts in students through the pre- and post-assessment scores of the two groups, the mobile experiential learning group and the traditional classroom group. The mobile experiential learning group (green line) showed greater improvement, where the increase in score was from 65 in the pre-assessment to 88 in the post-assessment. The traditional classroom group, on the other hand (blue line), showed a smaller improvement, going from 65 to 75. The graph emphasizes that the mobile experiential learning approach positively impacted the understanding of pollution science in comparison to traditional approaches in students.

Comparison of Learning Outcomes Between Traditional Classroom Instruction and Mobile Experiential Learning

A comparative analysis of learning outcomes found that the students who took part in mobile experiential learning activities performed better than students who were traditionally taught. The mobile learning group performed better on assessments concerning the environmental pollution concepts, especially regarding the ability to apply scientific principles to real-world situations. The mobile experiential learning group also showed more enthusiasm for the topic of environmental science, as shown through their increased participation in the class discussion and their proactive approach to learning about pollution-related topics.

While both groups demonstrated improvement in their understanding of pollution science, the mobile learning group showed a greater and more practical understanding of the material. They were in a better position to make connections between what they have learned in the classroom and what is happening in the real world in terms of environmental issues, suggesting that students can better use what they have learned in the classroom as knowledge to apply in the real world. Table 3 compares the results of learning outcomes between two different groups (the mobile experiential learning group and the traditional classroom instruction group). The results of the mobile group were superior in a number of key areas.

Table 3. Comparison of learning outcomes

Assessment Criteria	Mobile Learning Group (%)	Traditional Learning Group (%)
Increase in Knowledge of Pollution Sources	95	70
Ability to Apply Concepts to Real-World Scenarios	92	65
Engagement in Class Discussions	88	55
Retention of Pollution Science Concepts	90	65

Impact on Pro-Environmental Behavior

The results also showed a change in the attitudes of students with respect to pro-environmental behaviors. Students who participated in the form of mobile experiential learning exhibited more propensity to practice sustainable living, such as less garbage, conserving water, and raising awareness on pollution. The hands-on experience of collecting data in the field and visualizing the effects of pollution seemed to create a certain sense of responsibility towards the environment. Many students showed that they took proactive steps to make a statement against their environmental footprint after the field activities, both at home and in school.

Figure 3 is the percentage of students adopting different pro-environmental behaviors after participation in mobile experiential learning activities. The graph above indicates that the most students, 35%, focused on Waste Reduction, with Water Conservation following at 28%. Pollution Awareness has been adopted by 22% of students, and 15% took action in the field of Energy Saving. These results show the effectiveness of mobile experiential learning in motivating students to pursue sustainable behaviors.

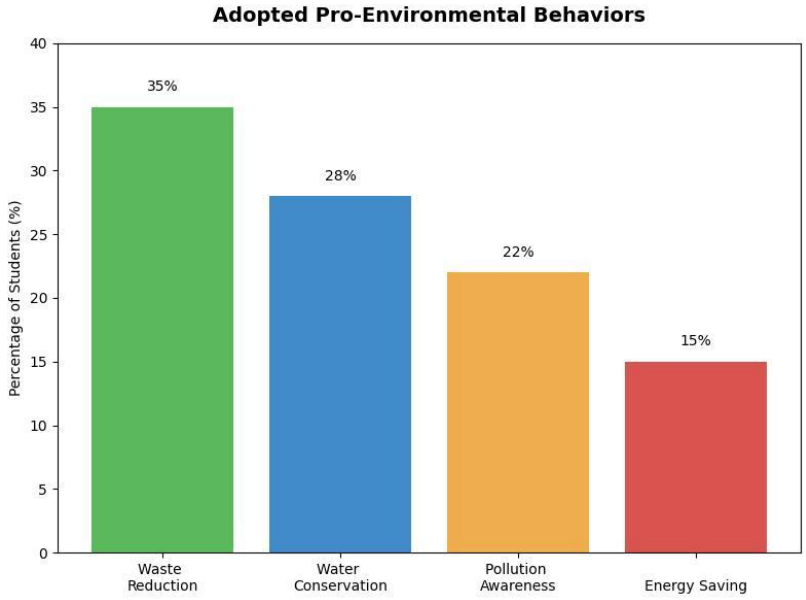

Figure 3. Pro-Environmental behavior after mobile learning activities

Discussion

Implications of the Study Findings for Environmental Science Education

The results of this study have a number of important implications for environmental science education. The results suggest that mobile experiential learning can be effective in improving student engagement, understanding of environmental pollution concepts, and pro-environmental behaviors. By pointing out the real-world combination - gathering real data, then sending it to the classroom - bridges the gap between the theory and the technician. Students who participated in the mobile learning activities showed not only a greater understanding of pollution science but also an increased interest in environmental issues, which is important in developing a sense of responsibility towards the environment in the long run.

The importance of having authentic field data in improving the learning experience is also recognized. By observing and collecting information about the pollution in the environment first-hand, students were able to connect the concepts from the classroom to the real world, and so the learning process became more meaningful and relevant. This approach not only helps students better understand the issues in the environment, but it can also help foster a sense of responsibility and empowerment, which can inspire students to take action in their communities.

Challenges and Limitations for Using Mobile Experiential Learning in the Science of Environmental Pollution

While the study showed the effectiveness of mobile-based experiential learning, there are some challenges and limitations associated with the research. One of the key challenges was to make available reliable mobile devices and environmental monitoring applications to all students. In some cases, technical problems such as app errors became an obstacle to the smooth collection and analysis of field data. In addition, the success of the learning activities was also dependent on the availability of appropriate outdoor areas for carrying out data collection, which may not always be possible, particularly in urban areas.

Another limitation was the potential variation in technical skills among students, which could have affected their ability to fully interact with the mobile learning tools. Although the primary objective of the study was to provide sufficient training, it is within the domain to assume that some students had difficulties with the technology, which could have impacted their overall learning experience.

Conclusion

This research indicates that mobile experiential learning in environmental science education has a great potential as it was found out that such an education significantly enhances the interest of students, their awareness of the issue of environmental pollution, and promotes sustainable behavior. Through mobile technology and confronting real field data collection, there is a possibility that the students would be able to focus on the practical side of relating theoretical concepts to real field problems of the environment, resulting in a significant learning process. The future of such an approach towards education is very bright, and there are some prospects of growth and development. Future studies can also be done on the scalability of mobile experiential learning in various fields of environmental education, educational stage and geographic locations especially in regions with limited resources or increased pollution. As mobile learning and technological trends, including virtual reality (VR), augmented reality (AR), or artificial intelligence (AI) come together, the environmental education can be revolutionized by offering more immersive and interactive learning experiences. These technologies would make students visualize complicated environmental issues and simulate ways of approaching pollution in real-time, which would close the gap between local situations and international challenges. The combination of mobile learning systems and cloud-based data analytics may also lead to collaboration and learning networks worldwide, in which students may share and analyze the data on the environment of other parts of the globe to enhance the knowledge. Research over time may examine the impact of such an approach on the pro-environmental behavior and learning of students out of the classroom and how these experiences affect their attitudes and behavior towards sustainability when they get older. With the ever-increasing concern of the environment in the global society, introduction of new and interactive forms of learning like mobile experiential learning will be instrumental in producing a new breed of environmental conscious and problem-solving individuals who will be prepared to approach the challenges of sustainability as they come in the future.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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