AG EDITOR

Module of Environmental Science to Improve Environmental Worldview in Students of Higher Education

Módulo de Ciencias Ambientales para Mejorar la Visión Ambiental del Mundo en Estudiantes de Educación Superior

Muhammad Syamsussabri[1,2] , Suhadi Suhadi[1] , Sueb Sueb[1] ✉, Murni Sapta Sari[1]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang. Malang, Indonesia.
[2]Nutritional Science, Faculty of Health, Universitas Nahdlatul Ulama Nusa Tenggara Barat. Mataram, Indonesia.

Corresponding Author: Sueb Sueb ✉

ABSTRACT

Introduction: a low environmental worldview contributes significantly to several environmental problems. It often leads to a lack of understanding and appreciation of the environment, which fosters negative behaviour towards environmental conservation and sustainability. Of course, efforts must be made to overcome these problems, one of which is through the education sector. This study aims to analyze the role of the module of environmental science in improving students' environmental worldviews.
Method: this research includes quasi-experimental designs with the type of nonrandomized control-group pretest-posttest design. The participants in this study were students of the biology education study program, with as many as four classes and a total of 78 students. The selected classes were equivalent classes obtained from the results of the equality test, and they were willing to become research participants. The New Ecological Paradigm (NEP) scale measured the environmental worldviews.
Results: the results showed that there was a significant difference in the use of teaching materials of environmental science on environmental worldview with a p-value of 0,000. E-module of environmental science based on PjBL and module of environmental science based on PjBL play an important role in facilitating an environmental worldview by integrating scientific content that can increase engagement through interactive learning.
Conclusions: by utilizing e-modules and modules, educators can educate an environmentally conscious generation ready to tackle today's pressing environmental issues. Applying an environmental worldview is essential to understanding and promoting pro-environmental behaviour. Enhancing the environmental worldview through education can foster more positive environmental behaviour, which is essential for effective environmental management.

Keywords: Module; Environmental Science; Environmental Worldview; New Ecological Paradigm.

RESUMEN

Introducción: una visión del mundo poco respetuosa con el medio ambiente contribuye de manera significativa a varios problemas medioambientales. A menudo conduce a una falta de comprensión y apreciación del medio ambiente, lo que fomenta un comportamiento negativo hacia la conservación y la sostenibilidad del medio ambiente. Por supuesto, hay que esforzarse por superar estos problemas, uno de los cuales es a través del sector educativo. Este estudio tiene como objetivo analizar el papel del módulo de ciencias ambientales en la mejora de la visión del mundo medioambiental de los estudiantes.
Método: esta investigación incluye diseños cuasiexperimentales con el tipo de diseño de grupo de control no

aleatorizado pretest-postest. Los participantes en este estudio fueron estudiantes del programa de estudios de educación biológica, con hasta cuatro clases y un total de 78 estudiantes. Las clases seleccionadas fueron clases equivalentes obtenidas de los resultados de la prueba de igualdad, y estaban dispuestas a participar en la investigación. La escala del Nuevo Paradigma Ecológico (NEP) midió las cosmovisiones ambientales.
Resultados: los resultados mostraron que existía una diferencia significativa en el uso de materiales didácticos de ciencias medioambientales sobre la cosmovisión medioambiental con un valor p de 0,000. El módulo electrónico de ciencias medioambientales basado en el PjBL y el módulo de ciencias medioambientales basado en el PjBL desempeñan un papel importante a la hora de facilitar la cosmovisión medioambiental mediante la integración de contenidos científicos que pueden aumentar el compromiso a través del aprendizaje interactivo.
Conclusiones: mediante el uso de módulos electrónicos y módulos, los educadores pueden formar a una generación con conciencia medioambiental preparada para abordar los acuciantes problemas medio ambientales actuales. La aplicación de una visión del mundo medioambiental es esencial para comprender y promover un comportamiento favorable al medio ambiente. La mejora de la visión del mundo medioambiental a través de la educación puede fomentar un comportamiento medioambiental más positivo, lo cual es esencial para una gestión medioambiental eficaz.

Palabras clave: Módulo; Ciencia Medioambiental; Cosmovisión Medioambiental; Nuevo Paradigma Ecológico.

INTRODUCTION

The environmental worldview refers to the underlying beliefs and values that shape an individual's perception of the relationship between humans and the natural environment. The concept encompasses a variety of perspectives, including ecological, anthropocentric, and biocentric viewpoints, which influence how individuals interpret environmental issues and engage in pro-environmental behaviour.[1,2] The environmental worldview emphasizes the interconnectedness of all living systems and the importance of maintaining ecological balance, which significantly influences pro-environmental actions.[3]

Research shows that an environmental worldview is closely related to environmental behaviour. Individuals with a strong environmental worldview are more likely to engage in environmentally responsible behaviour as their beliefs align with the values of sustainability and conservation.[4,5] The New Ecological Paradigm (NEP) scale is a widely used tool for measuring environmental worldviews because it can reflect beliefs about humans' role in the environment and the need for environmental management.[1,2] This scale is instrumental in understanding how personal experiences and cultural context shape environmental attitudes, suggesting that educational interventions can effectively foster an environmental worldview.[6,7] Understanding this is critical to developing effective environmental policies and education programs that suit a range of conditions.[8]

A weak environmental worldview contributes significantly to various environmental problems. A weak environmental worldview often leads to a lack of understanding and appreciation of ecological systems, which in turn fosters negative attitudes towards environmental conservation and sustainability.[9,10] This gap can manifest in several detrimental ways, including increased pollution, habitat destruction, and lack of engagement in pro-environmental behaviour. One of the problems surrounding students is the smallholder gold mining in West Nusa Tenggara. This problem continues, and there has been no effort to address it. Environmental pollution has reached the level of water, soil, plants, and humans.[11,12] One of these phenomena is certainly caused by the lack of understanding and conservation efforts towards the environment.

Research has explored several dimensions of the environmental worldview and its role in addressing environmental problems. Some researchers have argued that changing the environmental worldview is crucial to addressing environmental issues.[13] The concept of the environmental worldview has been applied to environmental law research and policy development.[14] It is further argued that environmental knowledge, beliefs, and values are critical to promoting pro-environmental behaviour.[8] When individuals have a weak environmental worldview, their values and beliefs may not be aligned with sustainable practices, leading to a lack of action in both the private and public realms.

Research shows that higher education institutions are critical in fostering sustainability competencies among students, which can be enhanced by aligning educational curricula with the environmental worldview. Universities must respond to students' diverse environmental worldviews to address environmental, social, and economic challenges effectively. This alignment fosters a deeper understanding of sustainability and empowers students to become informed decision-makers capable of implementing sustainable solutions.[15]

In addition, the New Environmental Paradigm (NEP) has been widely used to assess environmental worldviews, revealing that this perspective is significantly correlated with pro-environmental behaviour. Personal moral

norms influenced by one's environmental worldview are critical in fostering pro-environmental behaviour among individuals.[5] This relationship underscores the importance of nurturing such insights, particularly in educational settings, to increase environmental sensitivity and promote sustainable practices. The corporate sector also reflects the importance of an environmental worldview in sustainability endeavours. The analysis shows that companies with a strong commitment to sustainability often embody an environmental worldview that prioritizes ecological considerations.[16]

Furthermore, the role of the environmental worldview in culture and religion in shaping environmental attitudes cannot be ignored. Ecological spirituality can significantly influence environmental action, suggesting that individuals' religious beliefs can motivate their involvement in sustainability efforts.[17] Likewise, environmental sustainability emphasizes the importance of a goal-oriented approach to ecological conservation. [18] These insights highlight the diverse nature of environmental worldviews and their implications in promoting a more sustainable future. The importance of environmental worldviews is multifaceted, influencing educational practices, corporate sustainability, and individual behaviour. By understanding and nurturing this, stakeholders across sectors can better address the pressing environmental challenges of our time and promote a more sustainable society.

Inadequate interdisciplinary teaching of environmental issues can lead to a lack of critical evaluation skills regarding environmental issues among students.[19] This education gap may result in a generation unprepared to address pressing ecological challenges. Meanwhile, the effectiveness of the environmental worldview in environmental philosophy is still questionable.[20] A weak environmental worldview is a significant contributor to ongoing environmental problems. Addressing these issues requires a comprehensive educational strategy that fosters a strong ecological perspective, increases environmental knowledge, and encourages active engagement in sustainability efforts. By fostering an Environmental worldview, individuals can be better equipped to tackle the complex environmental challenges.[21,22] However, integrating the environmental worldview into educational frameworks remains an under-explored area of research. This view reflects individuals' beliefs and attitudes towards nature and society and can significantly influence educational practices and outcomes. Several studies have examined the determinants of this environmental worldview, particularly in the context of higher education, highlighting the need for a more structured approach to incorporating this perspective into the curriculum. Previous research related to environmental worldview has been conducted.[9,10,23] However, it is still rare to integrate teaching materials.

The educational environment plays a vital role in forming the environmental worldview.[24] argue that higher education institutions provide a unique context for fostering environmental awareness among students, as they are at a formative stage in their personal and professional development. Engagement with environmental education modules did not necessarily result in significant changes in students' NEP scores, indicating that the content and delivery of these courses should be carefully considered to increase their impact.[25] Importance of contextualizing environmental education with local issues, which can create more meaningful learning experiences for students and foster a sense of responsibility for the environment.[26,27] Of course, the effectiveness of the environmental worldview in education depends on its design and implementation, which needs to be studied more deeply. One of the efforts made in this study is to teach environmental science according to the context of the problems around students through the environmental science module based on learning models to foster pro-environmental behaviour to overcome environmental issues. This study aims to determine the role of the environmental science module in improving the environmental worldview of higher education students.

METHOD

Participants

The participants in this study were students of the biology education study program at Universitas Islam Negeri Mataram in the even semester of 2024, there were as many as four classes with a total of 78 students. The selected class is an equivalent class obtained from the results of the equality test and is willing to participate in the research process by filling out informed consent.

Research Instrument

The instrument used in this study is a student environmental worldview questionnaire using the New Ecological Paradigm (NEP) scale[1] adopted with five indicators and 15 statements.

Research Design

The research design that will be carried out is quasi-experimental, with a nonrandomized control-group pretest-posttest design. The design is as follows.

Table 1. Implementation of Teaching Materials				
Class	N	Pre-test	Treatment	Post-test
Learning Activities with E-Module of Environmental Science Based on Project-Based Learning (PjBL) (Experiment)	20	O_1	X	O_2
Learning Activities with Module of Environmental Science Based on Project-Based Learning (PjBL) (Positive Control)	20	O_1	X	O_2
Learning Activities with Module of Environmental Science Based on Problem-Based Learning (PBL) (Positive Control)	19	O_1	X	O_2
Learning Activity without Researcher Intervention (Negative Control)	19	O_1	-	O_2

Notes:
X: Treatment.
-: Without Treatment.
O_1: Pre-Test Environmental Worldview.
O_2: Post-Test Environmental Worldview.

Data Collection Procedure

Data was collected before and after the learning activities. Learning was conducted for 10 meetings, including pre-tests and post-tests.

Data Analysis

The analysis was conducted using the Analysis of Covariance (ANCOVA) test to see differences in students' environmental worldviews, provided that the data were normally distributed and homogeneous.

RESULTS

The results showed an increase in the environmental worldview in biology education students after being treated with an e-module and a module of environmental science based on PjBL and PBL. This shows the role of teaching materials in improving students' environmental worldview.

E-Module of Environmental Science Based on PjBL
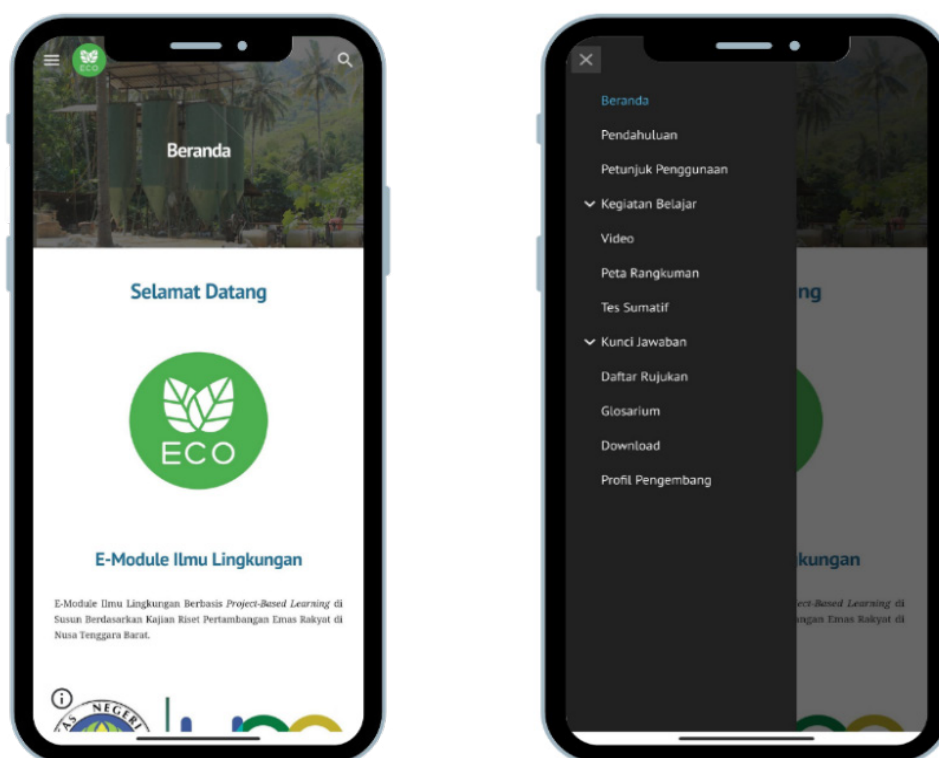

Figure 1. Opening Page of the E-Module of Environmental Science based on PjBL

Figure 1 illustrates the home menu display on the e-module of environmental science based on the PjBL application with the APK format. This application can be installed on smartphones, tablets, and Chrome OS, with a minimum Android version of 6,0 or above. This e-module can adjust to devices with a 16:9 and 4:3 ratio. The e-module has several components that can be accessed through the sidebar, which consists of a homepage, introduction, instructions for use, learning activities, videos, summary maps, summative tests, answer keys, reference lists, glossaries, downloads, and developer profiles.

Figure 2 illustrates the presentation of the learning activities page. The learning activities consist of components of course learning outcomes, case studies, material descriptions, learning activities, summaries, formative tests, self-evaluation, and self-reflection. This e-module has six chapters, including (1) human and environment, (2) environmental ethics, (3) environmental pollution, (4) environmental management, (5) environmental development, and (6) environmental management analysis. This e-module is also equipped with videos that support student learning. The e-module used must have been valid, practical, and legible.
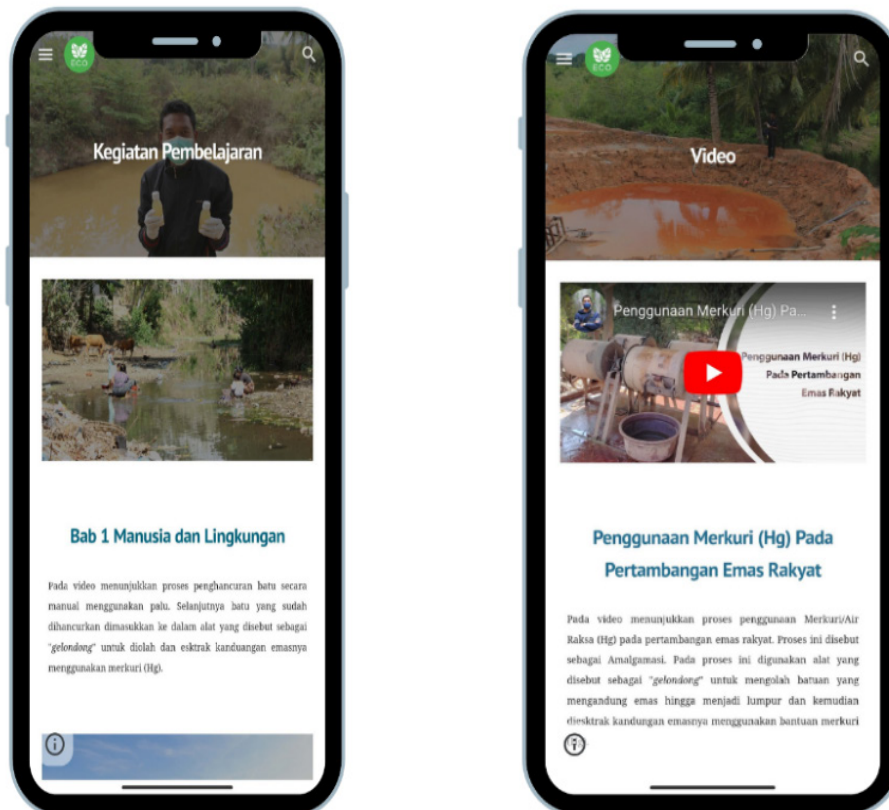

Figure 2. Learning Activities and Videos

The results of the validation of the e-module from the teaching materials side showed an average assessment of 97,5 % with a very valid category, as for the material side, with an average of 96 % with a very valid category, in terms of practicality has an average of 98,7 % with a very practical category, and readability with an average of 94,2 % with a very legible category. These results indicate that the e-module shows a high level of quality in terms of teaching materials, materials, practicality, and readability, thus making it a suitable tool that can be used in the learning process.

Figure 3. Download Link for E-Module of Environmental Science Based on PjBL

Module of Environmental Science Based on PjBL and PBL

Figure 4 illustrates the initial appearance of the module of environmental science based on PjBL and PBL. The form of this module is a printed book with a letter size (21,5 x 27,9 cm). This module has several

components, such as the front cover, identity page, preface, table of contents, list of tables, list of pictures, instructions for use, chapters, summary map, summative test, answer key, reference list, glossary, and author history. The chapter description consists of the components of course learning outcomes, case studies, material descriptions, learning activities, summaries, formative tests, self-evaluation, and self-reflection. This module has six chapters, including (1) humans and the environment, (2) environmental ethics, (3) environmental pollution, (4) environmental management, (5) environmental development, and (6) environmental management analysis. The module used is certainly valid, practical, and legible.

Figure 4. Cover Page of the Module of Environmental Science Based on PjBL and PBL

The results of the PjBL module teaching materials show an average assessment of 98,3 % with a very valid category, as for the material side, with an average of 96,5 % with a very valid category, in terms of practicality has an average of 98,1 % with a very practical category, and readability with an average of 92,3 % with a very readable category. These results indicate that the e-module shows a high level of quality in terms of teaching materials, materials, practicality, and readability, thus making it a suitable tool that can be used in the learning process.

The results of PBL module teaching materials show an average assessment of 97,9 % with a very valid category, as for the material side, with an average of 96 % with a very valid category, in terms of practicality it has an average of 98,1 % with a very practical category and readability with an average of 92,5 % with a very readable category. These results indicate that the e-module shows a high level of quality in terms of teaching materials, materials, practicality, and readability, thus making it a suitable tool that can be used in the learning process.

Environmental Worldview

The environmental worldview score in the experimental class taught using the e-module of environmental science based on PjBL has increased from the pre-test and post-test. The lowest score in the pre-test was on rejecting exceptionalism, with a score of 52,3, while the highest was on the indicator of damage to the natural balance, with a score of 70,7. In the post-test, the lowest score is on rejecting exceptionalism, with a score of 63,3, and the highest is on the indicator of damage to the natural balance, with a score of 94. Regarding the increase, the lowest score is on the indicator of rejecting exceptionalism, with a score of 11, and the highest is on the anti-anthropocentrism indicator, with a score of 31,3. More complete results can be seen in figure 5.

The environmental worldview score in the positive control class taught using the module of environmental science based on PjBL has increased from the pre-test to the post-test. The lowest score in the pre-test was in the anti-anthropocentrism indicator, with a score of 52,3, while the highest was in the indicator of damage to the natural balance and ecological crisis, with a score of 68,7. Meanwhile, in the post-test, the lowest score was on rejecting exceptionalism, with a score of 63, and the highest was on the anti-anthropocentrism indicator, with a score of 90. Regarding the increase, the lowest score was on the indicator of rejecting exceptionalism, with a rise of 8,3, and the highest was on the anti-anthropocentrism indicator, with an increase of 37,7. More complete results can be seen in figure 6.

The environmental worldview score in the positive control class taught using the module of environmental science based on PBL has increased from the pre-test to the post-test. The lowest score in the pre-test was on the indicator of rejecting exceptionalism, with a score of 49,1, while the highest was on the indicator of damage to the natural balance, with a score of 71,6. In the post-test, the lowest score is on rejecting exceptionalism, with a score of 53, and the highest is on the indicator of ecological crisis, with a score of 92,6. Meanwhile, regarding the increase, the lowest score is in rejecting exceptionalism, with an increased score of

3,9, and the highest is in the anti-anthropocentrism indicator, with an increased score of 28,4. More complete results can be seen in figure 7.
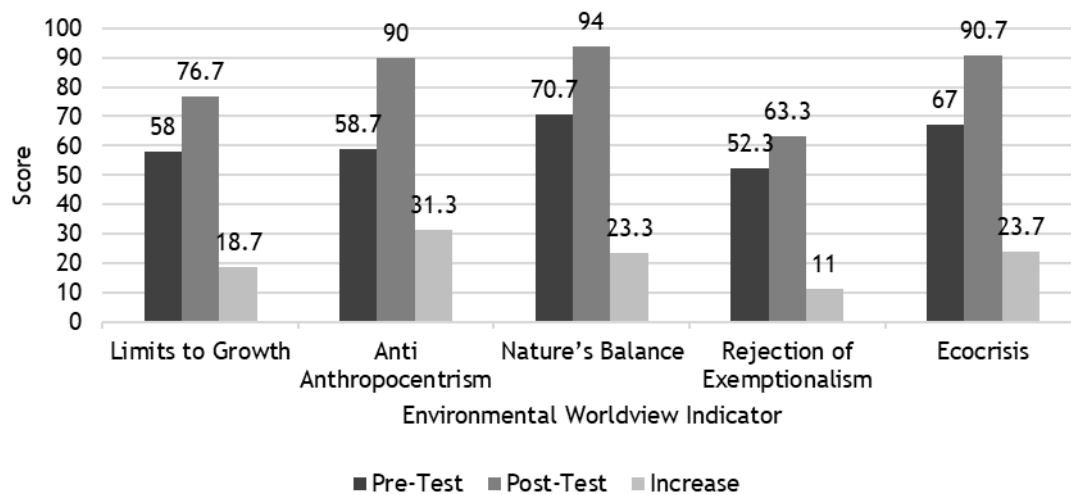

Figure 5. Environmental Worldview Score in Class of E-Module of Environmental Science Based on PjBL (Experiment)
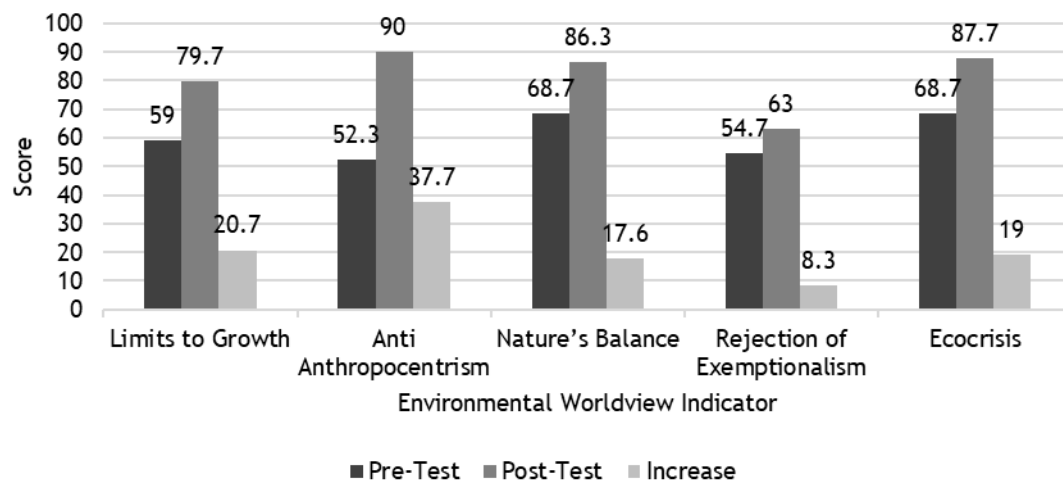

Figure 6. Environmental Worldview Score in Class of Module of Environmental Science Based on PjBL (Positive Control)
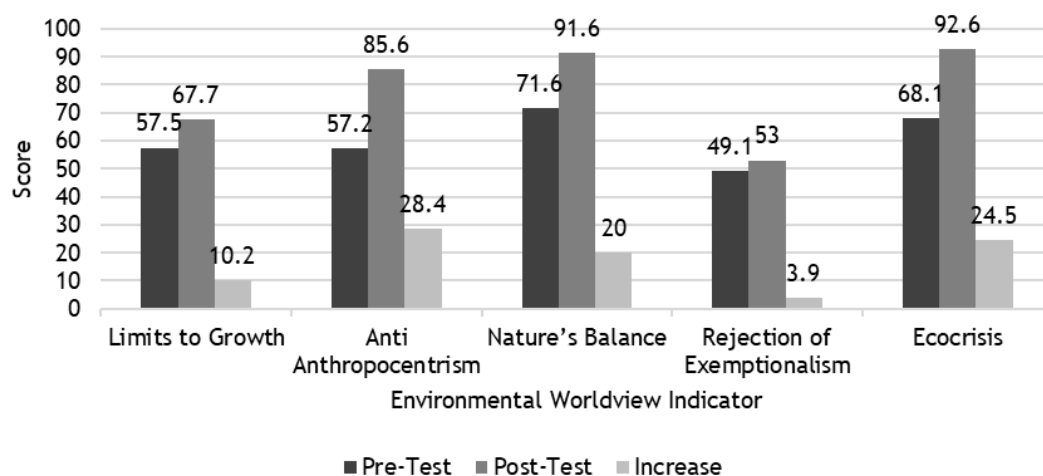

Figure 7. Environmental Worldview Score in Class of Module of Environmental Science Based on PBL (Positive Control)

The environmental worldview score in the negative control class that was not given the intervention obtained the lowest score during the pre-test on rejecting exceptionalism with a score of 53, while the highest was on

the indicator of damage to the natural balance with a score of 69,5. In the post-test, the lowest score is in the indicator of rejecting exceptionalism, with a score of 54,7, and the highest is in the indicator of damage to the natural balance, with a score of 74. While in terms of the increase in the lowest score is in the indicator of growth limits and rejecting exceptionalism, with an increased score of 1,7, and the highest is in the anti-anthropocentrism indicator, with an increased score of 4,6. More complete results can be seen in figure 8.
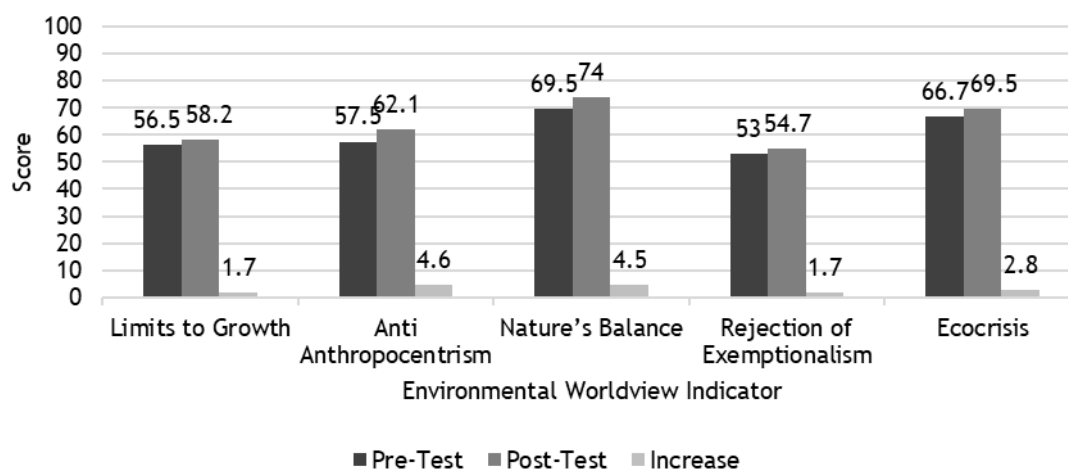

Figure 8. Environmental Worldview Score in Class Without Researcher Intervention (Negative Control)

Environmental worldview scores in experimental and control classes have increased. In the pre-test, it is known that the negative control class that was not given the intervention got the lowest average initial score with a score of 60,6 and the highest was the experimental class taught with the e-module of environmental science based on PjBL with a score of 61,3. In the post-test, it is known that the lowest score is in the negative control, which is not given an intervention, with a score of 63,7, and the highest in the experimental class, with a score of 82,9. At the same time, the lowest score increase is known in the class that is not given an intervention with a score of 3,1, and the highest in the experimental class with an increase in value of 21,6. More complete results can be seen in figure 9.
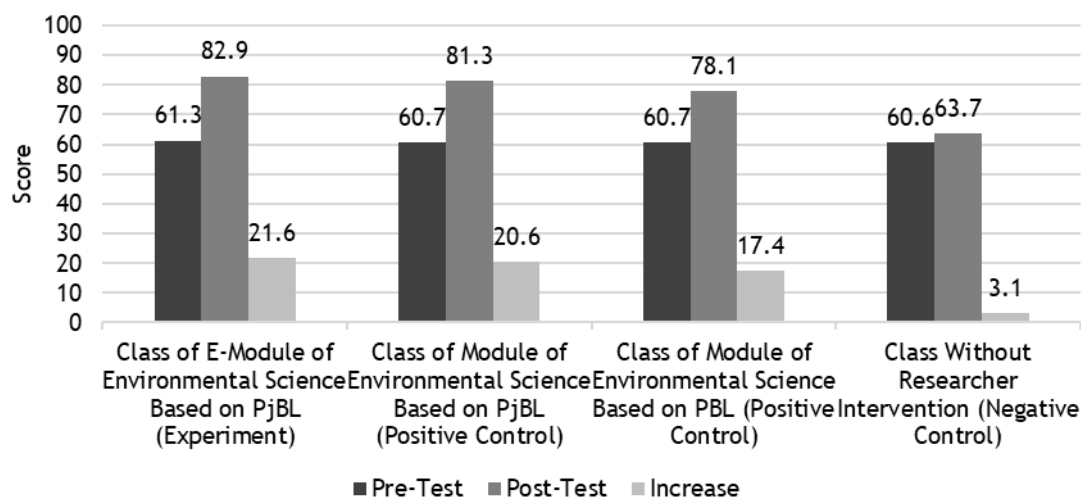

Figure 9. Comparison of Environmental Worldview Scores of Experimental and Control Classes

Prerequisite Test

Environmental worldview scores were tested for normality using the Kolmogorov-Smirnov test. The normality test results show that all data have a p-value above 5 %, so it can be concluded that the data is normally distributed. The summary results of the normality test are in table 2.

The environmental worldview score was tested for homogeneity using the Levene Test. The test results show that each data set has a p-value above 5 %, so it can be concluded that each data group is homogeneous. The summary results of the homogeneity test can be seen in table 3.

Table 2. Data Normality Test Results					
No	Data	N	p-value	α	Decision
Class of E-Module Environmental Science Based on PjBL					
1	Pre-Test Environmental Worldview	20	0,131	0,05	Normal
2	Post-Test Environmental Worldview	20	0,105	0,05	Normal
Class of Modul Environmental Science Based on PjBL					
1	Pre-Test Environmental Worldview	19	0,200	0,05	Normal
2	Post-Test Environmental Worldview	19	0,200	0,05	Normal
Class of Modul Environmental Science Based on PBL					
1	Pre-Test Environmental Worldview	20	0,147	0,05	Normal
2	Post-Test Environmental Worldview	20	0,200	0,05	Normal
Class of Without Researcher Intervention					
1	Pre-Test Environmental Worldview	19	0,200	0,05	Normal
2	Post-Test Environmental Worldview	19	0,164	0,05	Normal

Table 3. Data Homogeneity Test Results					
No	Data	N	p-value	α	Decision
1	Pre-Test Environmental Worldview	78	0,105	0,05	Homogeneous
2	Post-Test Environmental Worldview	78	0,752	0,05	Homogeneous

Hypothesis Test

Hypothesis testing uses the Analysis of Covariance (ANCOVA) test to determine whether differences in teaching materials affect students' environmental worldview. Table 4 summarizes the results of hypothesis testing.

Table 4. ANCOVA Test Results of Between-Subjects Effects					
Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4583,648[a]	4	1145,912	108,076	0,000
Intercept	586,086	1	586,086	55,276	0,000
Pre-Test Environmental Worldview	138,039	1	138,039	13,019	0,001
Teaching Materials	4360,568	3	1453,523	137,088	0,000
Error	774,006	73	10,603		
Total	463818,187	78			
Corrected Total	5357,654	77			
a. R Squared = 0,856 (Adjusted R Squared = 0,848)					

The ANCOVA test results on tests of between-subjects effects show a significant difference in the use of teaching materials on environmental worldview with a p-value below 5 %. Of course, these results need to be tested further to determine the comparison of each teaching material with independent variables. This can be seen from the results of the pairwise comparisons test using Bonferroni in table 5.

The results of the pairwise comparisons test show that there is a significant difference in environmental worldview between students who are taught with an e-module of environmental science based on PjBL with students who are taught without e-modules and modules with a p-value of 0,000, as well as students who are taught with a module of environmental science based on PBL with a p-value of 0,000. Meanwhile, when compared to students taught with the module of environmental science based on PjBL, there is no significant difference with a p-value of 1,000. With this, it can be said that the environmental science e-module based on PjBL and the environmental science module based on PjBL are equally good at accommodating students' environmental worldviews.

Table 5. Pairwise Comparisons Test Results				
(I) Teaching Materials	**(J) Teaching Materials**	**Mean Difference (I-J)**	**Std. Error**	**p-value**
E-Module Environmental Science Based on PjBL	Without E-Module and Module	18,927*	1,046	0,000
	Module Environmental Science Based on PjBL	1,326	1,032	1,000
	Module Environmental Science Based on PBL	4,569*	1,046	0,000
Module Environmental Science Based on PjBL	E-Module Environmental Science Based on PjBL	-1,326	1,032	1,000
	Without E-Module and Module	17,601*	1,043	0,000
	Module Environmental Science Based on PBL	3,243*	1,043	0,016
Module Environmental Science Based on PBL	E-Module Environmental Science Based on PjBL	-4,569*	1,046	0,000
	Without E-Module and Module	14,358*	1,056	0,000
	Module Environmental Science Based on PjBL	-3,243*	1,043	0,016
Without E-Module and Module	E-Module Environmental Science Based on PjBL	-18,927*	1,046	0,000
	Module Environmental Science Based on PjBL	-17,601*	1,043	0,000
	Module Environmental Science Based on PBL	-14,358*	1,056	0,000

DISCUSSION

E-module of environmental science based on PjBL is one of the teaching materials that can facilitate students' environmental worldview. This e-module serves as an interactive platform that delivers essential content on environmental issues, engages students more actively, promotes a deeper understanding of ecological concepts, and fosters a pro-environmental attitude. One of the key benefits of the e-module is its ability to integrate character education values alongside scientific content. E-modules that address the topics of environmental pollution and global warming are known to enhance students' understanding of these critical issues while instilling character values related to environmental stewardship.[27] It informs students about environmental challenges and fosters a sense of responsibility and ethical judgment towards the environment. E-modules integrated with learners' environmental concepts are known to enhance the environmental worldview.[21] E-modules have the advantage of being interactive because they can significantly increase student engagement and motivation. The e-module of environmental science based on PjBL is prepared in the context of the problems around students, namely pollution caused by artisanal gold mining. This e-module is also supported by videos that add to students' learning experience. The implementation results show that the role of the e-module of environmental science based on PjBL significantly improves the environmental worldview, and the printed version of the module of environmental science is based on PjBL. Project-based e-modules are known to foster scientific process skills among students.[28] This increased engagement is critical to developing an environmental worldview, as it encourages students to actively explore, question, and connect with environmental issues.

E-modules play an essential role in improving pro-environmental attitudes. Educational interventions focused on increasing environmental awareness can increase environmental knowledge, an essential component in developing pro-environmentalism.[29] Although their study showed that values and behaviours did not change as expected, the increase in knowledge suggests that the e-module can serve as a stepping stone towards fostering more profound behavioural change. Furthermore, developing integrated modules that specifically target environmental attitudes is essential. There is a need for educational materials that not only convey information but also actively measure and reinforce students' environmental attitudes.[30,31] By designing an e-module that incorporates assessment and reflection on environmental attitudes, educators can create a more holistic learning experience that encourages students to internalize ecological values.

In addition, the use of scientific social issues in e-modules has been shown to increase environmental awareness. Students can connect theoretical knowledge with the real world, increasing their willingness to take action for environmental protection.[32] This practical approach is critical to developing a strong environmental worldview as it empowers students to see the relevance of their learning in addressing environmental challenges. The environmental worldview significantly influences eco-recreation attitudes, indicating that individuals with a strong ecological perspective are more likely to develop positive affective, cognitive, and behavioural

attitudes towards eco-recreation.[33] This highlights the importance of fostering an environmental worldview to increase individuals' engagement with nature and their commitment to environmentally friendly practices.

Similarly, the environmental worldview positively influences environmental attitudes among different generations, particularly in the context of nature-based tourism.[4] This finding underscores the role of cultural factors in shaping an environmental worldview, which in turn influences attitudes towards environmental conservation. The interaction between worldview and attitudes is further explored, which showed that ecological worldview, along with emotional responses and knowledge gained from environmental interpretation, significantly impacted park visitors' behavioural intentions.[34] This suggests that educational programs that enhance environmental knowledge can effectively shape an environmental worldview and attitude.

The NEP scale to assess the environmental worldview revealed that although certain demographic factors did not significantly influence environmental attitudes, the underlying worldview played an important role.[35] Another statement reveals that NEP statements to evaluate visitors' attitudes towards natural disturbances, further confirming the relevance of the scale in understanding the relationship between worldview and attitudes and ending up with favourable actions towards the environment.[36]

One of the primary mechanisms by which e-modules influence students' environmental perspectives is the incorporation of place-based education, which emphasizes the connection between students and their immediate environment. Students acquire knowledge and develop a sense of responsibility regarding environmental issues, fostering a generative mindset towards local ecological challenges.[37] This is in line with the findings, which assert that integrating environmental education into learning can improve students' environmental literacy, thereby equipping them with the necessary skills and motivation to engage in sustainable practices.[38]

In addition, using e-learning platforms has been shown to increase student participation and engagement in environmental topics. Integrating environmental awareness into e-learning frameworks, mainly through project-based learning, significantly increased students' engagement and awareness of ecological issues.[39] This is further supported, which emphasizes that community-based learning can create real-world connections that enhance students' understanding of and commitment to environmental stewardship.[40]

The effectiveness of electronic modules is also reflected in their ability to foster positive environmental attitudes. For example, literature-based environmental education can foster an ecocentric perspective among students, which is crucial for developing sustainable behaviour.[41] In addition, cultivating environmental attitudes is critical to promoting environmentally responsible behaviour, which suggests that educational approaches should prioritize attitude formation alongside behaviour change.[42]

Furthermore, digital technology is crucial in environmental education. Advances in e-learning technologies enable the creation of easily accessible educational products that enhance students' competencies in environmental analysis and sustainability.[43] Global trends in environmental education increasingly focus on developing public environmental awareness through innovative educational strategies.[44] Integrating environmental science e-modules into the educational environment plays a vital role in shaping students' environmental worldviews. By fostering knowledge, increasing engagement, and promoting positive attitudes towards sustainability, these e-modules prepare students to become informed and active participants in addressing environmental challenges.

CONCLUSIONS

Embedding an environmental worldview is very important because this concept includes beliefs about the relationship between humans and the environment. Personal experiences, emotional connections, cultural context, and educational interventions shape it. Promoting a strong environmental worldview encourages pro-environmental behaviour and fosters a sustainable future. E-modules of environmental science based on PjBL and modules of environmental science based on PjBL play an important role in facilitating an environmental worldview. Integrating scientific content can increase engagement through interactive learning. By utilizing these e-modules and modules, educators can educate a generation of environmentally conscious individuals ready to address our time's pressing ecological issues. Applying an environmental worldview is essential to understanding and promoting pro-environmental behaviour. Enhancing the environmental worldview through education can foster more positive environmental behaviour, which is essential for effective environmental management.

BIBLIOGRAPHIC REFERENCES

1. Dunlap RE, Van Liere KD, Mertig AG, Jones RE. Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. Journal of Social Issues. 2000;56(3):425–42. https://doi.org/10.1111/0022-4537.00176

2. Dunlap RE. The New Environmental Paradigm Scale: From Marginality to Worldwide Use. The Journal of Environmental Education. 2008 Sep 1;40(1):3–18. https://doi.org/10.3200/JOEE.40.1.3-18

3. Ong AKS. 3D Bioprinted Meat: The Values-Beliefs-Norms Evaluation of Perceived Future Food Source Among Younger Generations. British Food Journal. 2024;126(9):3505–28. https://doi.org/10.1108/BFJ-03-2024-0283

4. Lu P. Exploring the Environmentally Responsible Behavior of Generations Y and Z From a Cross-Cultural Perspective in the Context of Nature-Based Tourism. Land. 2023;12(10):1–15. https://doi.org/10.3390/land12101909

5. Wu L. The Relationships Between Environmental Sensitivity, Ecological Worldview, Personal Norms and Pro-environmental Behaviors in Chinese Children: Testing the Value–belief–norm Model With Environmental Sensitivity as an Emotional Basis. Psych Journal. 2018;7(3):111–21. https://doi.org/10.1002/pchj.217

6. Woodworth BL, Steen-Adams MM, Mittal P. Role of an Environmental Studies Course on the Formation of Environmental Worldviews: A Case Study of a Core Curriculum Requirement Using the NEP Scale. Journal of Environmental Studies and Sciences. 2011;1(2):126–37. https://doi.org/10.1007/s13412-011-0013-4

7. Ling S, Landon A, Tarrant M, Rubin D. Sustainability Education and Environmental Worldviews: Shifting a Paradigm. Sustainability. 2020;12(19):1–19. https://doi.org/10.3390/su12198258

8. Liobikienė G, Poškus MS. The Importance of Environmental Knowledge for Private and Public Sphere Pro-Environmental Behavior: Modifying the Value-Belief-Norm Theory. Sustainability. 2019;11(12):1–19. https://doi.org/10.3390/su11123324

9. Sueb, Suhadi, Suwarni, Shofiyah A, Putri DR, Diartika EI, et al. Correlation between Age and Environmental Concern at Tourism Village in Malang, East Java, Indonesia. IOP Conference Series: Materials Science and Engineering. 2019;546(2):1–6. https://dx.doi.org/10.1088/1757-899X/546/2/022025

10. Sueb, Suwarni, Suhadi, Putri DR, Zahroh VRA, Shofiyah A, et al. Community Environmental Awareness of Tourism Area in Jodipan and Arema Village. AIP Conference Proceedings. 2020 Apr 21;2231(1):1–5. https://doi.org/10.1063/5.0002734

11. Suhadi, Sueb, Syamsussabri M. Mercury and Cyanide Pollution on the Aquatic Organism in Sekotong People Gold Mining. Journal of Physics: Conference Series. 2019;1417(1):1–9. http://dx.doi.org/10.1088/1742-6596/1417/1/012032

12. Suhadi, Zubaidah S, Sueb, Farahilda R, Syamsussabri M, Rochmah AN. Identification of Mercury and Cyanide Degrading Bacteria in Sekotong People's Mining. In: Proceedings of the 3rd International Conference on Biology, Science and Education (IcoBioSE 2021). Atlantis Press International BV; 2023. p. 354–62. http://dx.doi.org/10.2991/978-94-6463-166-1_46

13. Woollacott M, Shumway-Cook A, Tassell-Matamua N. Worldviews and Environmental Ethics: Contributions of Brain Processing Networks. EXPLORE. 2023;19(5):630–5. http://dx.doi.org/10.1016/j.explore.2023.03.005

14. Bányai O. The Theory of Worldviews from an Environmental Law Perspective. World Futures. 2021;77(8):613–35. http://dx.doi.org/10.1080/02604027.2021.1929790

15. Hyytinen H, Laakso S, Pietikäinen J, Ratvio R, Ruippo L, Tuononen T, et al. Perceived Interest in Learning Sustainability Competencies Among Higher Education Students. International Journal of Sustainability in Higher Education. 2023;24(9):118–37. https://doi.org/10.1108/IJSHE-06-2022-0198

16. Landrum NE, Ohsowski BM. Identifying Worldviews on Corporate Sustainability: A Content Analysis of Corporate Sustainability Reports. Business Strategy and the Environment. 2017;27(1):128–51. https://doi.org/10.1002/bse.1989

17. Köhrsen J. Eco-Spirituality in Environmental Action. Journal for the Study of Religion Nature and Culture. 2018;12(1):34–54. https://doi.org/10.1558/jsrnc.33915

18. Abu-Rayash A, Sabbah E. Analysis of Environmental Sustainability in the Holy Quran: Maqasid Framework. Journal of Contemporary Maqasid Studies. 2023;2(1):61–94. https://dx.doi.org/10.52100/jcms.v2i1.96

19. Torkar G, Debevec V, Johnson B, Manoli CC. Assessing Children's Environmental Worldviews and Concerns. Center for Educational Policy Studies Journal. 2020;11(1):49–65. https://doi.org/10.26529/cepsj.793

20. Peterson. The Very Idea of an Ecological Worldview. Ethics and the Environment. 2021;26(1):21–55. http://dx.doi.org/10.2979/ETHICSENVIRO.26.1.02

21. Syamsussabri M, Suhadi, Sueb. The Effect of Environmental Pollution Module on Environmental Worldview in Senior High School. Journal of Physics: Conference Series. 2019;1417(1):1–6. http://dx.doi.org/10.1088/1742-6596/1417/1/012076

22. Sueb, Muhdhar MHI Al, Zahroh VRA. The Effect of Inquiry-Based Ecosystem Learning Module from Fishponds as a Learning Resource on Students' Cognitive Ability. Journal of Physics: Conference Series. 2021;1842(1):1–6. https://dx.doi.org/10.1088/1742-6596/1842/1/012041

23. Purnama CY, Srisayekti W, Fitriana E, Djunaidi A. Pro-environmental Behavior to Improve the Quality of Life with Social Value Orientation as Moderator: Findings from Indonesia. International Journal of Environmental Health Research. 2024;1–20. https://doi.org/10.1080/09603123.2024.2415902

24. Starovoitova M, Vodneva S, Klets T, Nikiforova E, Presnyakova N. Ecological Worldview Formation of Engineering Students in the Context of Foreign Language Training. Environment Technology Resources Proceedings of the International Scientific and Practical Conference. 2021;2:267–73. https://doi.org/10.17770/etr2021vol2.6585

25. Goldschagg P, Long D. Influencing Generations: Pre-Service Teachers' Environmental Worldviews at a South African University. Southern African Journal of Environmental Education. 2021;37(1):106–23. https://dx.doi.org/10.4314/sajee.v37i1.8

26. Reddy C. Environmental Education, Social Justice and Teacher Education: Enabling Meaningful Environmental Learning in Local Contexts. South African Journal of Higher Education. 2021 Mar 21;35(1):161–77. https://doi.org/10.20853/35-1-4427

27. Aswirna P. Integrated Science E-Module Assisted by the Flip PDF Professional Application to Integrate Character Education Values in Science Learning for Junior High Schools. Journal of Natural Science and Integration. 2023;6(1):14–27. http://dx.doi.org/10.24014/jnsi.v6i1.16262

28. Tanti T, Kurniawan DA, Anggraini L, Perdana R. Digitalisation Guide Book of Basic Physics Practicum Equilibrium Material. JTP - Jurnal Teknologi Pendidikan. 2021;23(1):70–80. https://doi.org/10.21009/jtp.v23i1.14646

29. Maurer M, Koulouris P, Bogner FX. Green Awareness in Action—How Energy Conservation Action Forces on Environmental Knowledge, Values and Behaviour in Adolescents' School Life. Sustainability. 2020;12(3):1–15. http://doi.org/10.3390/su12030955

30. Retnowati R, Awaludin M, Heryawati ER. Developing an Integrated Biology Module for Students' Environmental Attitude Instruments. JPBI (Jurnal Pendidikan Biologi Indonesia). 2020;6(2):327–34. https://doi.org/10.22219/jpbi.v6i2.11163

31. Sueb S, Damayanti J. The Effect of Macrozoobenthos Diversity Module based on Problem-based Learning on Junior High School Students' Environmental Attitudes. Jurnal Pendidikan IPA Indonesia. 2021 Sep 29;10(3):400–6. https://doi.org/10.15294/jpii.v10i3.30766

32. Susilawati S, Aznam N, Paidi P, Irwanto I. Socio-Scientific Issues as a Vehicle to Promote Soft Skills and Environmental Awareness. European Journal of Educational Research. 2021;10(1):161–74. http://doi.org/10.12973/eu-jer.10.1.161

33. Kement Ü, Çavuşoğlu S, Çalik İ, Durmaz Y. The Effect of Environmental Value and Ecological Worldview on Eco-Recreative Attitude: An Application in Turkey. Tourism & Management Studies. 2023;19(2):7–19. https://doi.org/10.18089/tms.2023.190201

34. Blye CJ, Hvenegaard GT, Halpenny E. Are We Creatures of Logic or Emotions? Investigating the Role of Attitudes, Worldviews, Emotions, and Knowledge Gain From Environmental Interpretation on Behavioural Intentions of Park Visitors. Journal of Outdoor Recreation Education and Leadership. 2023;15(1):9-28. https://doi.org/10.18666/JOREL-2022-11654

35. Asilsoy B, Oktay D. Understanding Environmental Worldview of Famagusta Residents and Its Determinants Through Survey Research. Journal of Civil Engineering and Architecture. 2016;10(5):544-52. http://doi.org/10.17265/1934-7359/2016.05.003

36. Švajda J, Koróny S, Zięba A, Adamski P. Perceptions of Natural Disturbance in Tatra National Park, Poland. Central European Forestry Journal. 2016;62(2):105-9. https://sciendo.com/article/10.1515/forj-2016-0011

37. Flanagan CA, Gallay E, Pykett A, Smallwood M. The Environmental Commons in Urban Communities: The Potential of Place-Based Education. Frontiers in Psychology. 2019;10(1):1-11. http://doi.org/10.3389/fpsyg.2019.00226

38. Tsai MN, Liao YF, Chang YL, Chen HC. A Brainstorming Flipped Classroom Approach for Improving Students' Learning Performance, Motivation, Teacher-student Interaction and Creativity in a Civics Education Class. Thinking Skills and Creativity. 2020;38(September):100747. https://doi.org/10.1016/j.tsc.2020.100747

39. Zunaidah A. Meaningful Synergy in E-Learning Integrating Environmental Awareness and Project-Based Learning in EFL. Academy of Education Journal. 2024;15(1):816-25. http://doi.org/10.47200/aoej.v15i1.2314

40. Dalida CS, Malto GAO, Lagunzad CGB. Enhancing Students' Environmental Knowledge and Attitudes Through Community-Based Learning. In: Kne Social Sciences. 2018. p. 205-20. http://doi.org/10.18502/kss.v3i6.2381

41. Rahmayati R, Rengganis R. Literary Works Based on Environment as Teaching Materials in Literature Learning Oriented Environmental Education. In: Proceedings of the 2nd International Conference on Progressive Education. 2021. p. 1-10. http://doi.org/10.4108/eai.16-10-2020.2305238

42. Eilam E, Trop T. Environmental Attitudes and Environmental Behavior—Which Is the Horse and Which Is the Cart? Sustainability. 2012;4(9):2210-46. http://doi.org/10.3390/su4092210

43. Akhmedova I, Pinigina E, Prituzhalova O, Sulkarnaeva L, Zherebyateva N. Experience of Environmental Education Products Designing. In: Advances in Economics, Business and Management Research. 2020. p. 673-80. http://doi.org/10.2991/aebmr.k.200324.125

44. Zhao H, Chen HX, Huang Z. Comparative Study of Environmental Education at Home and Abroad. Advanced Materials Research. 2012;524(527):2505-9. https://doi.org/10.4028/www.scientific.net/AMR.524-527.2505

FINANCING

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Data curation: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Formal analysis: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Research: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Methodology: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Project management: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Resources: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Software: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.

Supervision: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Validation: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Display: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Drafting - original draft: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.
Writing - proofreading and editing: Muhammad Syamsussabri, Suhadi Suhadi, Sueb Sueb, Murni Sapta Sari.