

# Web-based information system for land surface temperature forecasting: its role in the context of the ecological imperative and educational challenges of the digital society\*

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## Abstract

The peculiarities of the formation of environmental awareness among students in the context of modern educational challenges are analyzed. The role of the ecological imperative as a means of achieving the goals of sustainable development is described. Current climate problems and prospects for their solution are outlined by involving participants in the educational process. The trends of digitization of the educational sector and the use of modern technologies in the educational process, which will allow a comprehensive approach to the training of specialists taking into account environmental problems, are considered. Emphasis is placed on using artificial intelligence to create digital content and data analysis.

## Keywords

Ecological imperative, ecological consciousness, climate change, digitalization, digital technologies, digital society, artificial intelligence

## 1. Introduction

The modern world is dynamically changing. The development of science and technology contributes to the emergence of new technologies that are quickly integrated into all spheres of human life. This creates a need for highly qualified specialists capable of transforming society on the way to prosperity and sustainable development. In the digital society, the problem of adapting the educational sphere to the challenges of civilization is particularly acute.

According to Sustainable Development Goal (SDG) 4: Education is one of the most powerful and proven tools for sustainable development. SDG-4 is aimed at eliminating inequality and provides for free access to quality education [1].

The formation of ecological awareness of participants in the educational process is an integral condition for the future development of humanity, ensuring responsible use of nature and preserving biodiversity. In the context of achieving the SDGs, environmental issues play a critically important role. Their solution will contribute to progress in the areas of SDG-2 (zero hunger), SDG-3 (good health and well-being), SDG-6 (clean water and sanitation), SDG-8 (economic growth), SDG-11 (sustainable cities and communities), SDG-12 (responsible consumption and production), SDG-13 (climate action), SDG-14 (life below water), SDG-15 (life on land). In addition, the involvement of students in solving climate issues will contribute to the search for new and improvement of existing approaches and strategies in the field of climate action.

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## 2. Domain analysis

In previous works it was proposed the concept of information system for land surface temperature forecasting using machine learning methods [2], analyzed different models [3], described peculiarities of development [4, 5] and its role in development of sustainable cities and communities. Although the works outlined a wide range of applications of the proposed information system, the issues of its application in the educational environment and its role in the ecological imperative require clarification.

The formation of environmental culture and worldview is an important component of human environmentalization. This includes awareness of the relationship between human and nature, as well as understanding the need to care for the environment.

Modern ecological consciousness is a new way of thinking that takes into account ecological aspects in all spheres of life. This includes awareness of environmental problems, responsibility towards nature and the desire for sustainable development.

The ecological imperative becomes the regulator of relations between human and nature. This means that decision-making should take place in view of the environmental consequences. The term «ecological imperative» was introduced by the German philosopher Hans Jonas [6] in his book *Das Prinzip Verantwortung* (The Principle of Responsibility, 1979), in which he formulated an ecological maximum of action based on Immanuel Kant's «Categorical Imperative»: «Act so that the consequences of your actions are compatible with the continuation of true human life on earth» [7]. Researchers note that environmental hazards that exist in today's conditions are the result of a low level of environmental culture in the past.

The transformation of the education system is designed to change the approach to environmental problems and contribute to their solution. Environmental education, which is consistently developing in the EU countries, covers a complex of global problems of humanity, becomes one of the main elements of the general education system, it acts as the most important component of building new relations in the system «nature – human – society» and fostering respect for ecological problems of the environment [8].

The educational system should implement models of personal preparation for life and work on planet Earth within the limits of necessary and sufficient natural resources and minerals, taking into account the processes of their natural recovery both within the limits available for human life and dimensions of a biospheric and noospheric nature [9].

Eco-oriented pedagogical technologies should be a translator of such common principles of life in society as efficiency and optimality, systematicity, goal setting, self-development, synergism and humanism [10, 11, 12].

Immersion of students in the considered problem through the use of innovative technologies [13, 14, 15, 16, 17], such as virtual (VR) [18] or augmented reality (AR) [19], in combination with artificial intelligence (AI) technologies [20] can contribute to the formation of a comprehensive understanding of the situation and motivate [21, 22] to find solutions.

In article [23] described integration AI tools in Arab Higher Education.

It should be noted that the development of AI technologies, especially in the field of decisionmaking support, raises a number of ethical issues, and although modern technologies are capable of conducting in-depth analysis and developing models for overcoming crises, including environmental ones, the final decision will be made by a human.

The ecological imperative is a complex socio-cultural phenomenon. Taking into account the role of the information and communication space in the sustainable development of society, the formation of ecological awareness is possible only under the condition of informational transformation of the «human – nature – society» system. Given that the anthropological dimension appears to be a common feature of all the challenges of the modern world, the ecological imperative becomes key in determining the development trends of an eco-oriented society.

The ecological imperative determines that a person has the right to a healthy and fulfilling life in harmony with nature. The new economy of nature use should be based on the use of renewable

energy sources and processing of industrial waste. The ecological imperative is a dynamic concept that changes according to the level of development of society, technologies, consciousness and institutional environment.

The imperative defines the requirements for the formation of environmental policy and its implementation in all spheres of life. It promotes sustainable development, ensuring harmony between human and nature. This is especially important in the context of climate change and environmental awareness that helps preserve our planet for future generations.

### **3. Methodology**

The purpose of the article is to study modern educational challenges in the context of the formation of environmental awareness of pupils and students, taking into account the rapid digitalization of society.

Research methodology (Figure 1) covers a wide range of scientific approaches. In particular, the problem includes the following aspects:

- ecological;
- ethical;
- pedagogical;
- philosophical;
- information technologies.

The scientific apparatus of the research makes it possible to form a hypothesis that the development of education in the conditions of digitalization is possible only under the condition of timely and comprehensive introduction of modern technologies into the educational process.

The use of such approaches will increase the interest of education seekers in academic disciplines, and promote adaptation to civilizational challenges.

Theoretical research is aimed at a comprehensive analysis of the problem, using an interdisciplinary approach.

A survey was conducted to determine the level of interest of participants in the educational process in the use of modern technologies, in particular AI. Respondents were asked to evaluate their experience of using software tools with implemented AI models, express their opinion on the impact of digital content created by AI models on the educational process, and on their interest in further application of technology for educational purposes.

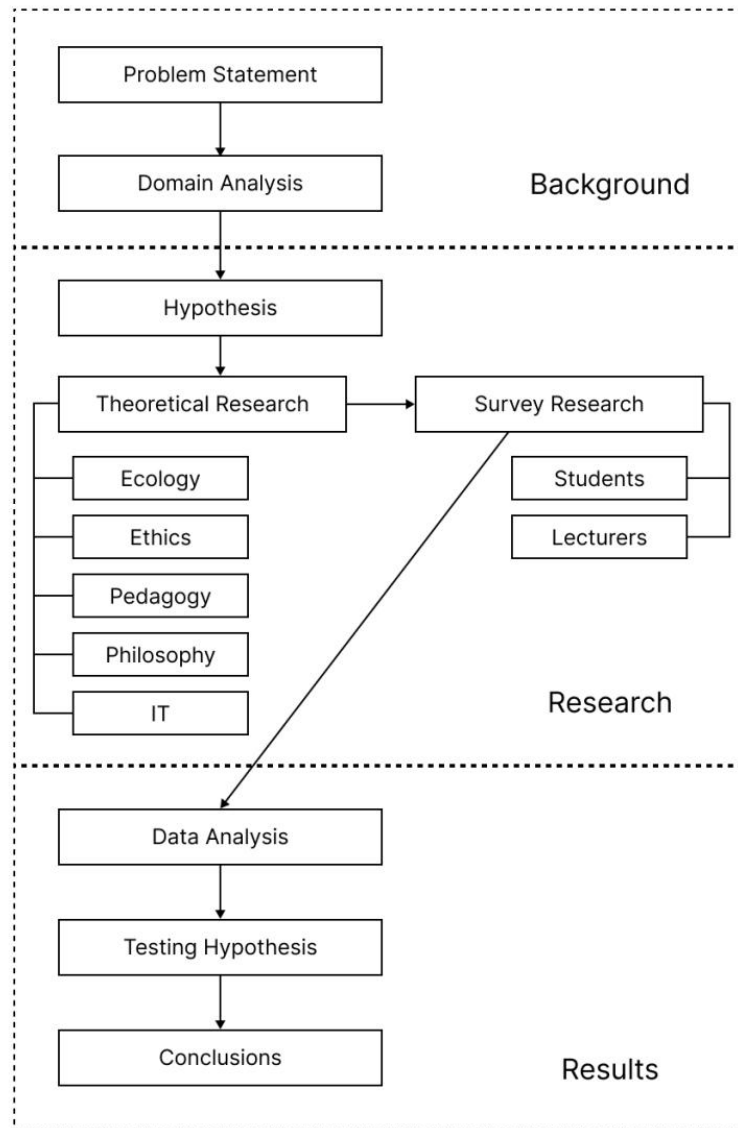
The obtained data represent a valuable resource and can serve as a basis for developing strategies for the further development of the educational sector, taking into account the use of the modern technologies.

### **4. Results and discussions**

Nowadays, environmental problems are extremely relevant. Ignoring them can cause irreparable consequences both for individual regions and for the planet as a whole. The search for a solution to these problems is one of the key aspects of the further existence and development of mankind. The development of strategies to avoid or mitigate the effects of climate change is becoming increasingly important in the context of the emergence of new threats. The problem of adaptation to climate challenges is particularly acute, and its holistic understanding becomes possible only thanks to an integrated approach. In this way, the formation of environmental awareness among students is critically important in the context of achieving the SDGs, which determine the path to sustainable development and prosperity.

Environmental problems have a significant impact on society, and their consequences can have a colossal impact on all areas of human life. Digitalization has become a powerful tool for spreading knowledge and involving students in environmental issues.

The use of digital technologies in education is extremely relevant, as they contribute to better assimilation of the material and play a significant role in increasing the level of environmental awareness and conscious consumption of students and ensuring the goals of sustainable development.



**Figure 1:** Research methodology.

Artificial intelligence is a powerful tool with a wide range of applications in educational activities. Generative AI models allow you to visualize the possible consequences of environmental disasters, potential climate changes and their impact on nature and society. Another important aspect of using AI to build environmental awareness is the use of statistical data for analytics and forecasting. Prediction of changes in climate indicators using AI models provides an idea of future threats both to individual regions of the globe and to the planet as a whole. Such material is a valuable tool for further climate research.

The generation of digital content is carried out by using a prompt (exclusive request). Based on it, the AI model creates images, videos or other media files. Let's consider an example of a prompt for generating video content (short films) about how a certain territory of the Earth will look after a certain period of time, taking into account the current environmental situation, to increase the environmental awareness of the global population and achieve the goals of sustainable development.

Prompt: «Create a video showing what will happen to territory in next years due to climate change. Keep the duration under 5 minutes. Keep the language easy to understand. Use an authoritative sounding language voice for the voiceover».

Video can be generated using various services. Within the framework of the study, the Invideo AI service [24] was used to create an informative video about the problems of Australia in the coming decade. The resulting content outlines the main issues identified independently by different researchers, including the impact of climate change on natural landscapes (such as the Great Barrier Reef), flora and fauna (including threats to endemics), and agriculture.

In addition, generative AI can help create virtual field trips to nature reserves, ecosystems, landscape parks, and other places where students can see the richness of biodiversity and understand its vulnerability. The use of AI allows modeling various scenarios of the future, warning of potential changes, and demonstrating the consequences of irresponsible human behavior towards nature.

The use of statistical data makes it possible to carry out analytics, to compare changes in climatic indicators over the past centuries, and also to use historical data to predict future values. Such a forecast is carried out taking into account the main patterns, and can warn of future problems.

The visualization of such data clearly indicates the main trends of climate change, and the study of possible consequences provoked by them allows to form a clear picture of the dangers and will stimulate the development of environmental awareness.

Figure 2 presents the analysis of historical data of the earth's surface temperature in the Netherlands and the study of their changes by month for the period from 1743 to 2013.

Figure 3 and figure 4 demonstrate the difference in the dynamics of changes between the 19<sup>th</sup> and 20<sup>th</sup> centuries.

To determine relevance of implementing proposed information system into educational process it was provided an analysis of using AI tools in educational institutions.

As part of the research, a survey of the participants of the educational process was conducted on the basis of the Khmelnytskyi National University and the State Educational Institution «Khmelnytskyi Center of Vocational and Technical Education of the Service Sector», regarding the use of AI technologies for educational purposes. Two target audiences were identified:

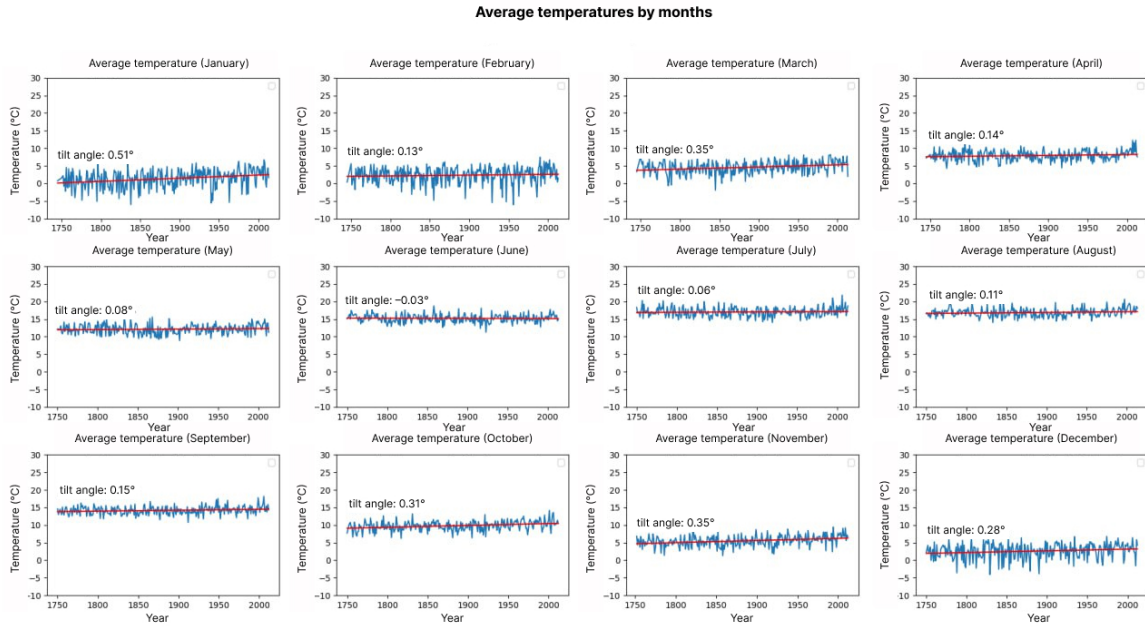
- students;
- lecturers.

The survey was conducted anonymously, in compliance with ethical principles. Confidentiality of respondents' personal information is ensured. All data are presented in a generalized form. 135 students (among them 84 students of higher education institutions and 51 students of professional education institutions) and 45 lecturers took part in the survey.

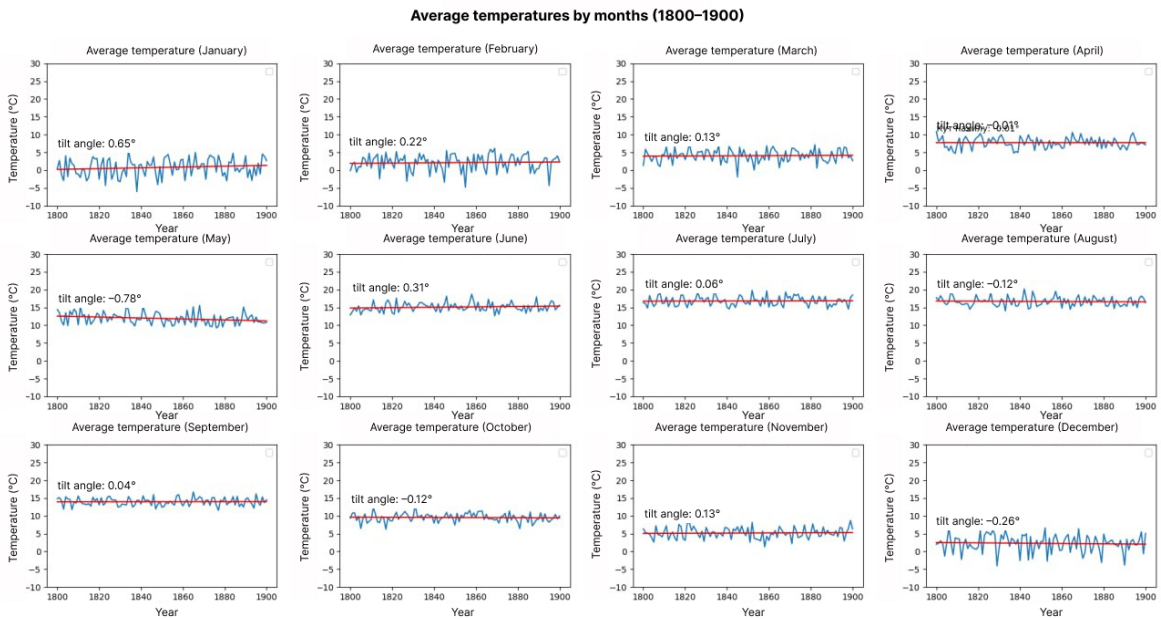
The distribution of education seekers by courses is presented in Figure 6.

Among the surveyed education seekers, 17% indicated that they use artificial intelligence technologies very often, 30.4% – often, 28.9% – sometimes, 18.5% – rarely, at the same time, only 5.2% do not use AI in everyday life. The survey among lecturers noted that 4.3% use AI technologies very often, 31.9% – often, 34% – sometimes, 23.4% – rarely, 6.4% – do not use them (Figure 7).

Education seekers noted that they most often use AI for learning (75.6%) and as a source of information (72.6%). Technology is most rarely used for entertainment (29.6%). 36.3% of respondents use AI models for work. 31.9% use AI for data analytics. It should be noted that among students of IT specialties, this indicator is about 45%. The main areas of application of AI models among lecturers are work (66%) and the use of technology as a source of information (51.1%). 23.4% of surveyed lecturers use AI for training, 10.6% for entertainment. 19.1% of lecturers use AI models as a means of data analysis (Figure 8).



**Figure 2:** Temperature change in the Netherlands from 1743 to 2013.



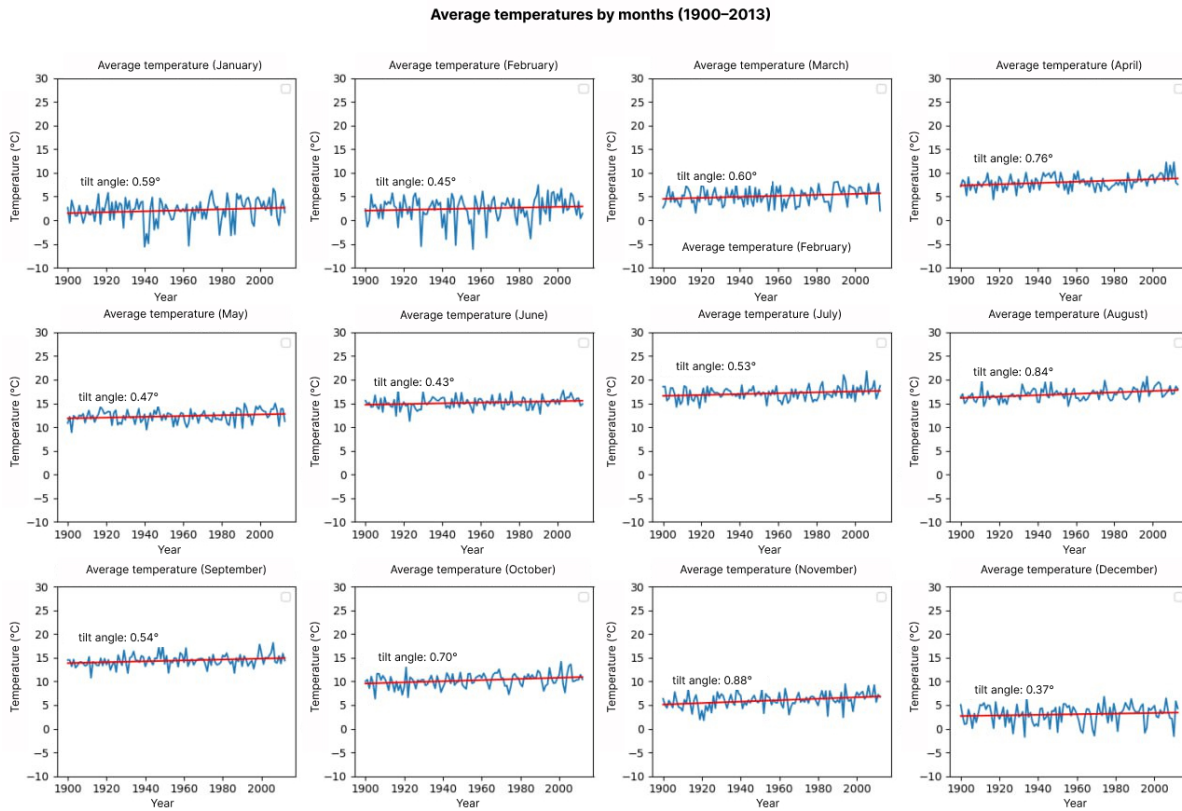
**Figure 3:** Temperature change in the Netherlands in the 19<sup>th</sup> century.

In general, the majority of respondents positively evaluate their experience of interacting with software products with implemented AI models (60% among students and 53.2% among lecturers). 35.6% of students and 44.7% of lecturers described their experience as neutral, and 4.4% of students and 2.1% of lecturers described their experience as negative (Figure 9).

According to the majority of students, AI technologies exert a positive influence on the educational process (66.7%). 17.9% of respondents did not note any impact, and 8.1% noted a negative impact. 70.2% of lecturers positively evaluate the impact of AI technologies on the educational process, 19.2% believe that such an impact is absent, and 10.6% evaluate it negatively (Figure 10). Generalized information is presented in Table 1.

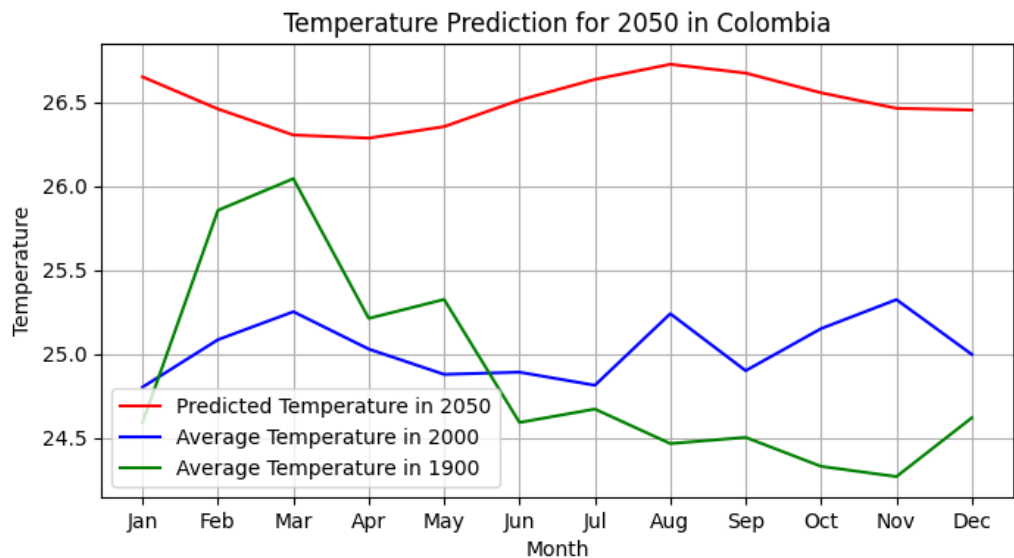
Figure 11 visualizes the frequency of use of digital content created with the help of AI for educational purposes. Among those interviewed, 17.8% of students and 12.8% of lecturers note that

digital content created by generative AI models is often used in the educational process, 38.5% of students and 38.3% of lecturers believe that sometimes. 15.6% of students and 17% of lecturers did not note a single case of using AI-generated digital content.

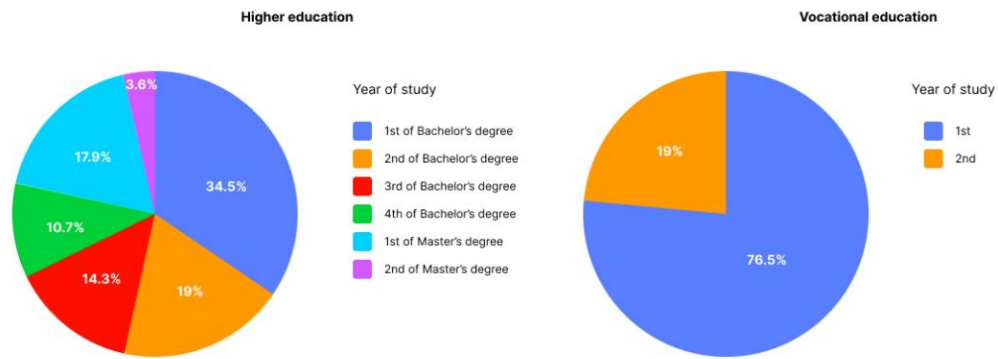


**Figure 4:** Temperature change in the Netherlands in the 20<sup>th</sup> century and in the beginning of the 21<sup>st</sup> century.

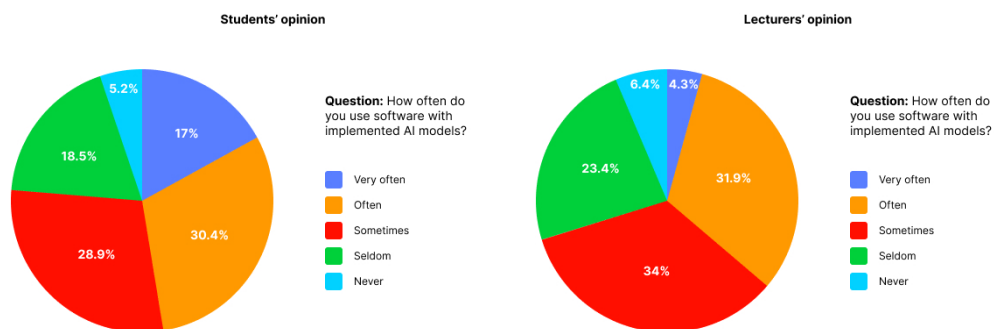
Figure 5 shows a comparison of the predicted temperatures with the temperatures observed in the past. The forecast was provided by web-based information system.



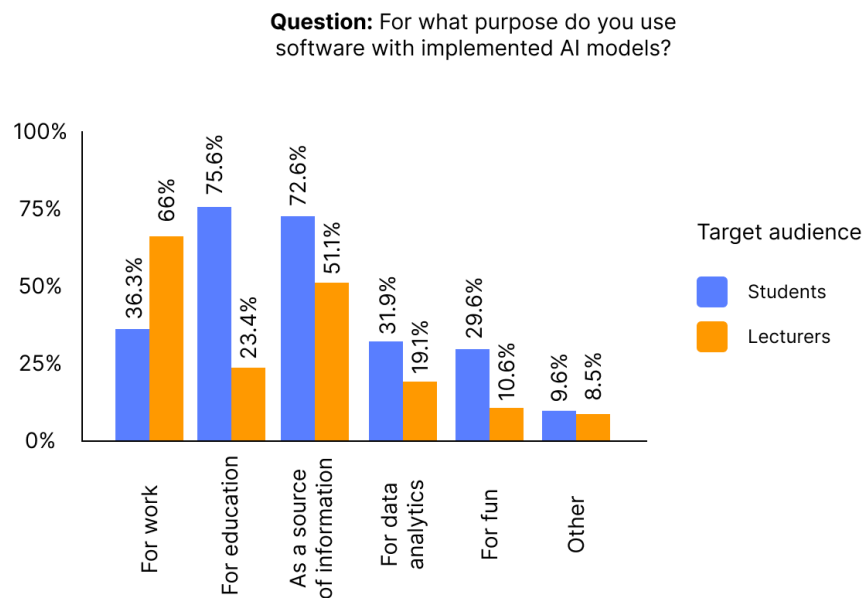
**Figure 5:** Temperature change in the Netherlands in the 20<sup>th</sup> century and in the beginning of the 21<sup>st</sup> century.



**Figure 6:** Distribution of respondents by educational courses.

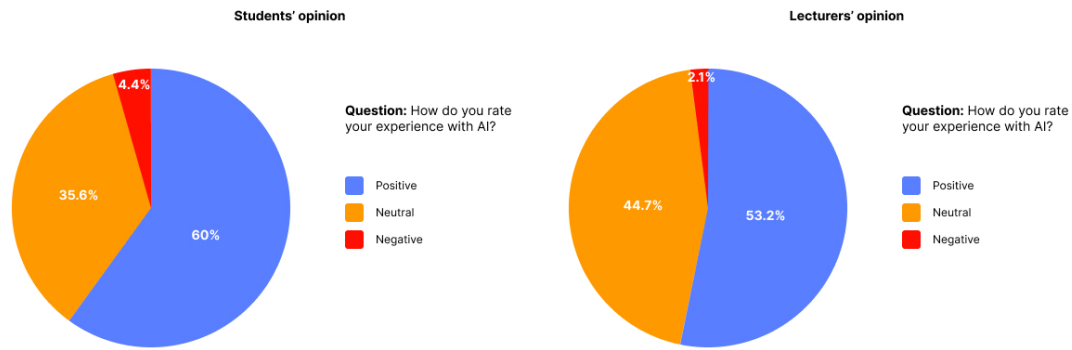


**Figure 7:** Frequency of use of software tools with implemented AI models.

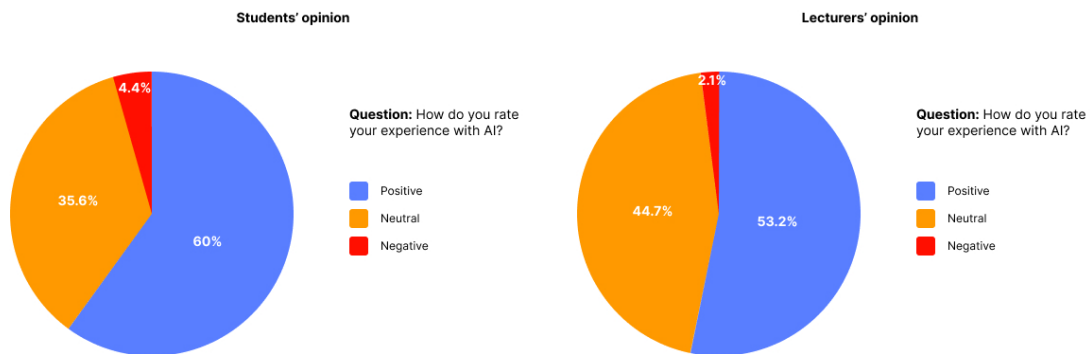


**Figure 8:** Application directions of software tools with implemented AI models.

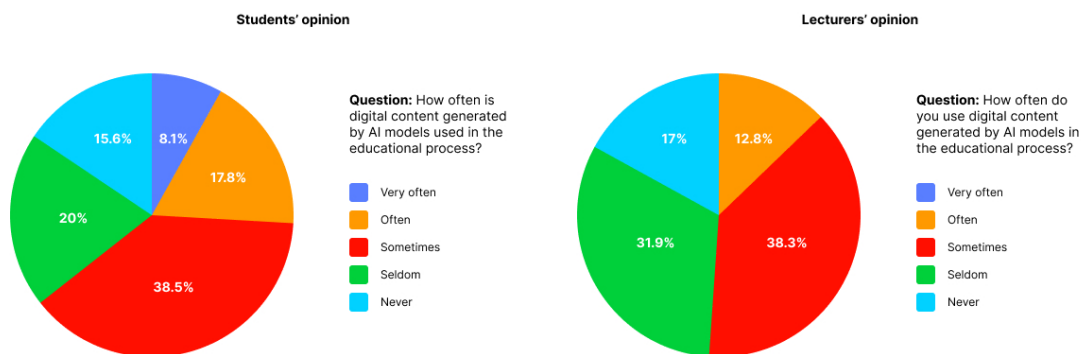




**Figure 9:** Experience of using software tools with implemented AI models.



**Figure 10:** Impact of AI technologies on the educational process.



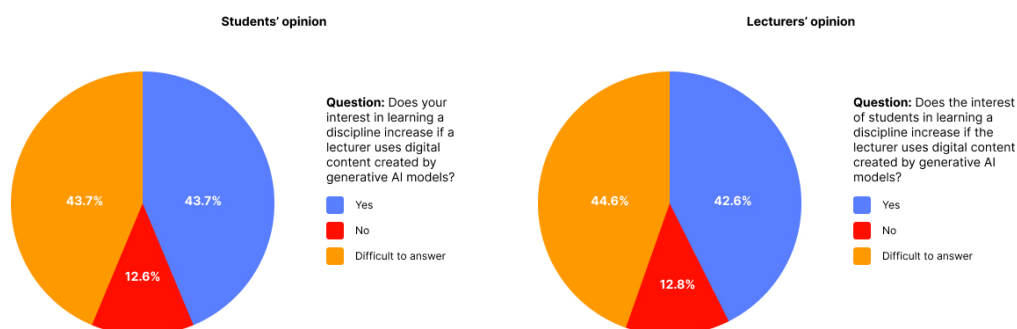
**Figure 11:** Impact of AI technologies on the educational process.

Both among students and among lecturers, there is no unequivocal opinion about determining the level of interest of education seekers in studying disciplines, provided that AI technologies are used in the educational process. 43.7% of students and 44.6% of lecturers noted that it is currently difficult to determine the impact of AI on interest in the educational process.

At the same time, 43.7% of students and 42.6% of lecturers note a positive influence, and 12.6% of students and 12.8% of lecturers – negative (Figure 12).

**Table 1**  
Impact of AI on the educational process.

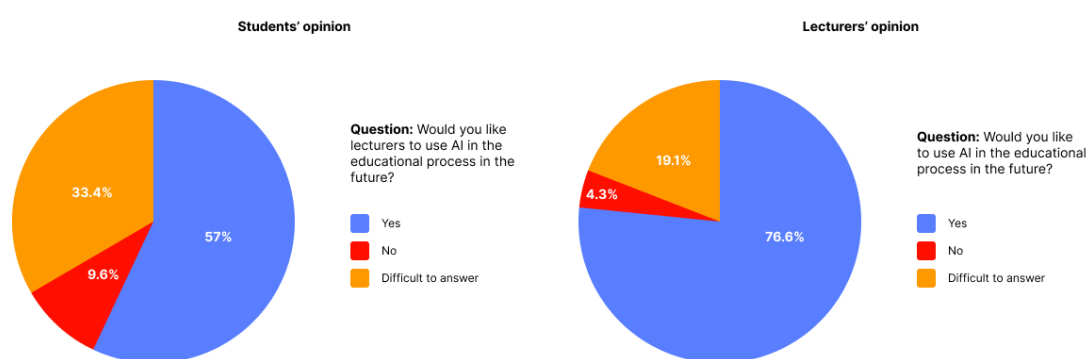
Respondents	Impact of AI on the educational process					
	Positive		Neutral		Negative	
	Quantity	%	Quantity	%	Quantity	%
Students	90	66,7	34	25,2	11	8,1
Lecturers	33	70,2	9	19,2	5	10,6



**Figure 12:** Determination of the influence of the use of digital content created by generative AI models on the interest of education seekers in studying disciplines.

It should be noted that the vast majority of both students (57%) and lecturers (76.6%) expressed interest in using AI technologies in the educational process and plan to use them in the future. 33.4% of students and 19.1% of lecturers were undecided. Only 9.6% of students and 4.3% of lecturers indicated that they are not interested in implementing technology in the educational sector and do not plan to use it (Figure 13).

In general, the use of AI technologies in the educational process will contribute to the development of professional abilities, taking into account environmental problems, responsible use of resources and nature management, as well as achieving the goals of sustainable development, by forming among students a holistic understanding of the current problems of the planet and society.



**Figure 13:** Interest in using digital content created by generative AI models in the educational process in the future.

## 5. Conclusions

Nowadays, environmental challenges present humanity with a double task: the harmonization of relations in the «human – nature» system and the formation of a new type of person who takes into account ecological aspects in his actions.

Achieving the SDGs is a key development point for UN member states on the path to peace and prosperity. Preservation of the ecosystem for future generations is very important to sustainable development.

Directing students to study climate change and responsible environmental management is crucial to the development of many industries. Climate problems affect various aspects of human life, and their solution contributes to the achievement of many SDGs. In particular, the fight against climate change makes it possible to solve not only climate issues (SDG-13), but also to contribute to the fight against hunger, solve the issue of access to clean water, influence human well-being, and support biodiversity.

The vast majority of scientific and pedagogical workers positively evaluate their experience of interaction with AI and positively evaluate the use of AI technologies for educational purposes. At the same time, the survey of education seekers noted the respondents' high interest in the introduction of technology into the educational process.

Thus, web-based information system for land surface temperature forecasting can be integrated into educational process for better understanding environmental processes and potential risks caused by climate change.

The use of the proposed approaches in the educational process will contribute to the formation and development of environmental awareness of students of secondary, professional (vocational), and higher education institutions.

## 6. Declaration on Generative AI

During the preparation of this work, the authors used Grammarly in order to: grammar and spelling check; DeepL Translate in order to: some phrases translation into English. After using these tools/services, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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