

Artificial intelligence literacy in secondary education: methodological approaches and challenges

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Abstract

Analysis of recent research and publications has shown that there is a serious problem in Ukrainian society regarding the use of artificial intelligence. The analysis of ZN.UA survey data showed that the majority of respondents do not know what artificial intelligence is and do not use it. Therefore, there are certain prejudices regarding the use of artificial intelligence in education. The concept of “artificial intelligence literacy” as a component of digital competence needs further research. Literacy in the field of artificial intelligence can be the basis for creating methods of using artificial intelligence in secondary education in Ukraine. The article presents the main components of literacy in the field of artificial intelligence. The author proposes to adapt the experience of digital story writing to the secondary education of Ukraine. At the same time, digital storytelling involves the use of artificial intelligence services as aids. It is shown that the toolkit of the European cloud of open science contains not only cloud services of open science, but also services of artificial intelligence (which are both cloud-based and based on the principles of open science). For example, the basic principles of working with the artificial intelligence service AI-GeoSpecies (included in the European cloud of open science) are considered. Within the framework of the performed research, an intermediate section of the ascertaining stage of the pedagogical experiment was conducted. It was found that teachers need further professional development measures on the topic of using artificial intelligence services. There is a need to create methods for secondary education using artificial intelligence in the educational process. The attitude of teachers towards artificial intelligence services is positive. Educators have repeatedly used artificial intelligence and know the interpretation of this term.

Keywords

artificial intelligence, secondary education, use of artificial intelligence, artificial intelligence services, AI

1. Introduction

There are several approaches to what needs to be covered from the point of view of secondary education and the use of artificial intelligence [1, 2]. Perhaps it is necessary to illustrate the list of some means or services of artificial intelligence. Perhaps it is necessary to show their practical use. First of all, it is necessary to study the experience of foreign use of artificial intelligence in secondary education. This experience is described in detail. There are enough methods and methodical recommendations that can be adapted for Ukrainian education. You can choose one specific tool. Then we will describe its interface in detail. We will design a methodology for this service. We will have a temporary result. The methodology should be developed flexibly. It is better not to create a methodology for a specific service. Certain types of artificial intelligence are trending now. The methodology should be universal. So that it can be used after a certain period. So that when a specific service goes out of trend, and another one appears, a new problem does not arise. And then what about the methods? And then what about methods, methodical systems?

CTE 2023: 11th Workshop on Cloud Technologies in Education, December 22, 2023, Kryvyi Rih, Ukraine

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Artificial intelligence can impact the education sector by making it more inclusive and accessible for pupils and students with visual, hearing, mobility and intellectual disabilities. The use of artificial intelligence will not only affect pupils/students with special needs but also educational institutions in creating inclusive pedagogy.

But before using artificial intelligence, it is necessary to clearly understand whether most users understand this term at all. A survey was conducted by the sociological service of the Razumkov Center on the order of ZN.UA about the attitude of users to artificial intelligence [3].

The survey lasted from June 23 to 28, 2023. The theoretical error does not exceed 2.3%. The number of respondents is 2018 Ukrainians. It turned out that only 24% of respondents know well what artificial intelligence is. 42% are roughly imagine what kind of technology it is. But 33.9% do not know what artificial intelligence is. Therefore, before implementing something new or using it, it is necessary to familiarize the listeners with new technologies in detail. Very unexpected results were revealed during the survey about the use of chatbots with artificial intelligence. 64.1% of respondents do not use such technologies at all. Only 5.6% of respondents use chatbots based on artificial intelligence in their education. 8.6% are used in work [3]. That is, most Ukrainians do not know what artificial intelligence is and do not use it. A serious problem arises. There is a rapid spread of artificial intelligence on the territory of Ukraine, and on the other hand, users do not know how to use new technologies correctly. We have a contradiction between the potential of using artificial intelligence services and the inadequacy of methods of their use in education. And first of all, this applies to secondary education. After all, students are always interested in new trends, and banning the use of one or another service would be the wrong strategy. We need to find a way to protect students from errors in use and to develop critical thinking to the results obtained with the help of artificial intelligence. Perhaps one of the priorities will be the study of the principles of artificial intelligence, and its deeper understanding. Students should be taught to use artificial intelligence not as entertainment, but as a tool for education and self-education. As a tool for student research. These thoughts should be conveyed first of all to the teachers. After all, according to the conducted research [3], 34.1% of respondents believe that it is necessary to control and limit the use of artificial intelligence technologies. Only 32.4% of respondents think that there is no need to introduce restrictions on the use of artificial intelligence services. Another part of Ukrainians either cannot give a clear answer or believe that these artificial intelligence services should be completely blocked (3.1%). This indicates a low awareness of the tools of artificial intelligence and the benefits of its use. Therefore, literacy in the field of artificial intelligence needs a more detailed study.

Today, artificial intelligence literacy has become a new topic in educational research on digital competence. Artificial intelligence literacy is widely recognized as a new set of technological attitudes, abilities, and competencies that enable people to effectively and ethically use artificial intelligence in their everyday lives. In mainstream secondary education, despite the popularity of AI tools such as Siri and chatbots, students are unaware of the underlying concepts and technologies or aware of the potential ethical issues associated with AI. As AI learning tools become more age-appropriate for learners, they are no longer just end users of AI technologies. Teachers need to use different pedagogical approaches to develop students' artificial intelligence literacy. It is necessary to educate the next generation taking into account digital skills and the formation of knowledge about artificial intelligence. This will help to have a better base for use in future professional responsibilities. Artificial intelligence is becoming increasingly important in the work environment and everyday life. Students who possess these skills can use digital technology and computers at a higher level to gain new knowledge. Students should learn to use artificial intelligence technologies wisely and distinguish between ethical and unethical practices [4]. As AI has emerged as one of the essential technology skills of the twenty-first century, educators must combine AI and literacy to equip students with the essential skills and mindsets to live, learn and work in our digital world with AI-driven technologies. Literacy in the field of artificial intelligence should be formed and developed during the entire period of study in a general secondary education institution [5].

Today, AI-powered tools can even be used through web browsers. Therefore, AI tools can be used not only through personal computers, but also through smartphones and tablets. Although these tools are

used primarily for entertainment, most of them have the potential to be used for educational purposes.

Due to the fact that distance and blended learning prevails in Ukraine at the moment, while it is not always possible to conduct online lessons (due to stabilization or emergency power outages), the problem of diversification and better visualization of educational material arises (as for pupils and students). Methodically balanced use of artificial intelligence tools and cloud services of open science can be a possible solution to this problem.

The effectiveness of the use of digital technologies in secondary education has already been shown in the following studies: Beltozar-Clemente et al. [6] use of an augmented reality application during the study of astronomy; research by Campos-Pajuelo et al. [7] is aimed at using an augmented reality application to study chemical elements; Antoniadi [8] dealt with the problem of using an augmented reality application to study plants in primary school.

A review of the educational possibilities of ChatGPT was conducted by İpek et al. [9]. The impact of COVID-19 on education and how the use of ChatGPT has grown in popularity due to this is shown by Karaköse et al. [10]. Wide use of artificial intelligence by students outside the educational process creates the problem of correct use of artificial intelligence services and systems for educational purposes.

Artificial intelligence literacy is widely recognized as a set of skills that enable people to effectively and ethically use artificial intelligence in their everyday lives. In school education, teachers began to use various methodological strategies to develop student's literacy in the field of artificial intelligence. Using digital storytelling is an effective inquiry-based pedagogy for developing literacy by improving language and technology skills across disciplines. In a study by Ng et al. [5], 82 primary school students in Hong Kong participated in a three-month digital history writing program to learn how to use artificial intelligence. They passed a knowledge test at the end of the program. It was found that students were able to propose a new scenario, apply their knowledge about artificial intelligence and come up with interesting solutions based on artificial intelligence in their stories [5].

Garg and Sharma [11] tried to analyze how artificial intelligence has affected the education of students with special needs. Data collection was based on qualitative research, interviews with teachers and students with special needs. The study proposed a basis for inclusive education [11].

A review by Su et al. [12] evaluated, summarized and reflected on 16 studies of artificial intelligence literacy in early childhood education. Curriculum development, artificial intelligence tools, pedagogical approaches, research designs, evaluation methods, and conclusions are included. Su et al. [12] identified several challenges and opportunities for artificial intelligence literacy. The main problems are the:

- lack of knowledge and skills of teachers in the field of artificial intelligence;
- lack of a curriculum;
- lack of training manuals.

Su et al. [12] believe that the number of educational programs and tools for the appropriate age and level of children will increase. They provide some recommendations for future researchers and educators to improve research on artificial intelligence literacy and early childhood learning.

Some machine learning initiatives also focus on pedagogy and curriculum [13, 14, 15]. Unified curricula for teaching literacy in the field of artificial intelligence from kindergarten to high school and university were developed. Also, separate educational programs were developed for different levels of the school [16]. Extensive learning material packages have been developed to help high school students learn about machine learning. One group presented five “big ideas in AI” that children should learn: sensing with sensors, reasoning about the world with models, learning by example, interacting with people, and the impact of artificial intelligence on society. Another group described the principles behind a constructivist AI curriculum for grades 1-9 based on the PopBots robot toolkit, AI ethics, and the creative game Doodle [16].

Teaching the basics of artificial intelligence has presented fundamental challenges to early childhood education: why artificial intelligence is necessary and suitable for early learning, what subset of key ideas and concepts of artificial intelligence can be used, how to engage children in specific experiences that will allow them to acquire these fundamental concepts of artificial intelligence. Yang [17] discusses key

considerations for developing an artificial intelligence curriculum for young children. Yang's research provides an innovative pedagogical model for teaching artificial intelligence literacy in early childhood. In this model, literacy in the field of artificial intelligence is shown as part of digital competence for all citizens in society. Basic AI lessons that can be learned with young children are: Using large amounts of input, AI algorithms can be continuously trained to detect patterns, make predictions, and recommend actions, even with limitations. In [17], a curriculum called "Artificial Intelligence for Kids" is presented to demonstrate this pedagogical model and explain how educators can provide opportunities for children to learn culturally responsive interactions and understanding of artificial intelligence technologies. A synthesis of AI knowledge for young children provides a new way to engage them in STEM and understanding digital technologies.

Shyshkina and Nosenko [18] considered the main promising digital technologies, appropriate for use in the professional development of teachers: cloud computing, immersive technologies and technologies with elements of artificial intelligence. Scientists have singled out the trends that currently characterize promising areas of development and the use of modern technologies for the personalization of learning. The prerequisites for achieving the effectiveness of the use of augmented and virtual reality, including elements of artificial intelligence, have been determined. Recommendations are provided regarding the use of modern promising technologies, including elements of artificial intelligence, for the professional development of teachers.

The aim of the study is to investigate the main challenges that arise for the use of artificial intelligence in the secondary education of Ukraine and to formulate prospects for the further use of artificial intelligence in education.

2. Results

In most publications, such a concept as "literacy in the field of artificial intelligence" is found. For secondary education, scientists recommend paying attention to this. This literacy can be useful for students' familiarity with the concepts and technologies underlying artificial intelligence. Every student has already used artificial intelligence in his life. He just didn't know about it. He does not know about the principles that exist. It does not know when this resource or service gives the correct answers. The development of this literacy will make it possible to get rid of caution. It is necessary to first explain to students how to use AI. Not just technically, but from a teaching point of view, from a research point of view. It is emphasized that literacy in the field of artificial intelligence can be implemented starting from the first grade. During the entire study at school. This literacy will be useful for awareness of potential ethical problems. Developing AI literacy will benefit AI research through gamification and online collaboration. Examining the works of scientists in recent years, we note that before the ChatGPT boom [9], Ukrainian scientists primarily considered artificial intelligence from the point of view of gamification and in the context of STEM education and combination with adaptive technologies and adaptive systems.

Therefore, literacy in the field of artificial intelligence is needed for:

- students' familiarity with the concepts and technologies underlying artificial intelligence;
- awareness of potential ethical problems;
- the combination of artificial intelligence and literacy during the entire education in institutions of general secondary education;
- artificial intelligence research using gamification and online collaboration.

What are the components of this literacy? It is necessary to teach students to know and understand what artificial intelligence is. It should not be just a theory. It should be explained specifically that the resources are artificial intelligence. It is necessary to explain how they work when there are errors in their use. Don't be afraid to use artificial intelligence. After that, learn to evaluate and create something new with the help of artificial intelligence. At the highest level, we are talking about the ethics of using

artificial intelligence. They believe that these are four steps for the development of the literacy of school students.

Components of literacy in the field of artificial intelligence:

- know and understand artificial intelligence;
- use artificial intelligence;
- evaluate and create something new with the help of artificial intelligence;
- ethics of using artificial intelligence.

A significant body of research has shown that digital storytelling is an effective inquiry-based pedagogical approach for improving 21st century digital skills, including information, media, and technology literacy in disciplines such as STEAM education, informatics, and health research [5]. Digital storytelling is a good practice [19] (figure 1).



Figure 1: The digital storytelling process [20].

The digital storytelling must be combined with the incremental steps of learning artificial intelligence. The idea is this: to introduce students to what artificial intelligence is and how it works. First, there is an idea. Students from junior high school can master this literacy. It should be in a playful way. Explain how artificial intelligence works. At the simplest level. After that, the child may have an idea for digitally writing a story. It can be a fairy tale. Writing a fairy tale after interacting with artificial intelligence services. So that the child can see how AI works in general. The second step is gaining experience. These can be resources that can be used as part of gamification. The next step, the third, is writing the story. Creating a plan. In this connection, new ideas arise. Thus, the ideas can be used in subsequent student projects. Or develop in the following classes. New ideas appear. Implementation of student projects can be developed to the level of work of the Junior Academy of Sciences. This is as much as the potential of a student or a team of students is sufficient. Step five: create pictures, audio and video. It can be with the use of artificial intelligence. It is necessary to learn not only how to create a picture. Students must be taught how to use artificial intelligence. It should be an impetus for new ideas, for creating a new picture or video. Teachers note that when thoughtful use of artificial intelligence begins, more ideas appear in the child. It is necessary to make artificial intelligence an assistant. Then -

present this project together. If it will be a project work of students - share it, show it. Maybe show the whole class and get recommendations. You can divide the students of the class according to interests and plan discussions.

Separate topics or lessons can be devoted to elements of artificial intelligence. You can add some elements or explanations. As a result, we will get a combination of computer science and mathematics. This is about digital history writing. First of all, it is a combination of Ukrainian language and computer science lessons. The work is being written but in combination with artificial intelligence. Examples can be given when styles are studied in visual arts. In drawing lessons, it will be easier to explain and show the picture. It is not always interesting to give an example of a photograph of a famous painting. It is better to apply filters in the style of Van Gogh to the photo of the student. Or another style, such as cubism. Styles are better remembered in practice. This will not be just a dry presentation of the material. Create an illustration in the appropriate style in the form of a game form. The styles or characteristic features of the artist's paintings are better remembered. By analogy, you can act in the same way with music. Interdisciplinary connections are traced here. What can we say about the digital writing of history? What does it stimulate? Why does it help? It stimulates thinking and encourages critical research questions. Digital storytelling helps in gaining new knowledge. Children learn that artificial intelligence. Artificial intelligence and does not always give correct answers does not always respond correctly to requests. In this way, students begin to analyze. How to ask a question to get the right answer. Which questions usually have wrong answers. It makes you think and analyze the requests. This helps in analyzing the resources found and expanding the acquired knowledge through discussion and collaboration with other students. Digital story writing can be implemented even in junior high school. These can be fairy tales in which new artificial intelligence services are invented. For example, fairy tales where artificial intelligence helps in inclusion. Children describe it as helping people with disabilities. Or services to facilitate the work of a waiter. A list of ingredients is provided. What can you offer from the cafe menu? Digital storytelling deepens students' understanding and broadens their horizons. It helps in researching information from many educational sources. Illustrates challenges for a variety of solutions based on existing experience. It improves students' understanding of a particular subject through inquiry-based learning.

First of all, it is necessary to explain to students about the resources and services they have already used. But they did not know that this is artificial intelligence. For example, let's list the simplest ones. With which everyone has already worked. Those that the students used. It is necessary to explain that this is also artificial intelligence. As one of the varieties of image search in Google Search. Now we have a very wide range of this use. For example, find the source of the image. It is enough to download the picture and you can find an exact match. On which sites is this picture posted. Let's start entering a phrase in double quotes in Google Search. Even before starting the search, the most common queries pop up as a hint. This is also an example of artificial intelligence. It can be seen that artificial intelligence services improve over time, learn based on entered queries. Consider Google Lens. Some of the students knew about this service. Some did not know. Some did not even know from the community of teachers. This artificial intelligence service makes life very easy. But you need to analyze, you need to learn how to use it correctly. How can be used for educational purposes. So that there are no mistakes in the work. For example, you can select the translation mode. The service translates the text in real-time. Translates into the specified language and independently sets the original language. This is already an example of artificial intelligence. And it is not necessary to take pictures. It is enough to aim the lens. Next feature: real-time image search. Fixes the first site – the official one on which this item is presented. By analogy, you can find where to buy an item captured by a smartphone camera (it is not necessary to take a photo). You can find a menu from a restaurant and find the address of a cafe or restaurant by specifying the name of the dish. If you point the lens at an object that is not a dish (or its name), the search will be suspended. A hint will appear that is incorrect. Something else must be entered. Such should be done a little research. In this way, it should be illustrated exactly how to use artificial intelligence for students.

In a previous study [21], the toolkit of the European Open Science Cloud (EOSC) was described and its structure was analyzed. To train teachers in the basics of using open science cloud services, a methodological learning system was developed aimed at educating teachers and facilitating their pro-

fessional development, expanding access to free cloud services, increasing the level of ICT competence and in particular the open science competence. A significant increase in the open science competencies for various categories of educators has been established. A study on the effectiveness of implementing special training methods for a wide contingent of teachers was conducted, the experimental groups included four groups of learners (a total of 395 respondents) and the control groups included 141 respondents [22]. The statistical analysis of data obtained from the experiment was verified using Fisher's test [21]. It should be noted that artificial intelligence services are included in the European Open Science Cloud. These services can also be used in the educational process: Machine Intelligence platform for research, DEEP training facility, FASTCAT-Cloud: Flexible AI SysTEM for CAmera Trap images on the cloud, GPU Grant Program for scientific research projects and prospective startups, and AI-GeoSpecies. In addition, the specified artificial intelligence services are at the same time cloud services of open science (this is related to the policy of creation and functioning of EOSC).

For example, consider the AI-GeoSpecies service. AI-GeoSpecies is a web service that uses artificial intelligence to return potential plant species for observation in a set area. The principle is to enter a precise geographical area (geo-coordinates) and the system returns a list of plant species that are most likely to be observed in that area. This allows web or mobile app developers to integrate this feature into their app and show end users the species they can find in a given area. AI-GeoSpecies can have many applications for biodiversity conservation, citizen science, sustainable management of natural and urban areas, environmental education, ecotourism, etc. [23].

The technology underlying the service is the so-called deep species distribution model (deep-SDM), the principle of which is to accept as input various data characterizing the local environment (bioclimatic data, satellite data, altitude, etc.) and predict a list of species likely to inhabit that environment. Such deep learning models are trained on millions of species derived from large-scale public science initiatives such as iNaturalist and Pl@ntNet [24]. As a demonstration, AI-GeoSpecies is integrated into a user-friendly web application available on the Pl@ntNet portal.

This artificial intelligence service can be used during biology lessons. The effectiveness of the use of digital technologies in the study of plants is shown in the study [8]. The main principle of the work is that the student can choose a specific location on the world map and view the main types of plants represented in this area. The obtained results can be viewed in three modes: GBIF, Species_plural, Families. The list of plants looks like cards with small photos, names, descriptions and tiles. Photos can be enlarged if desired, the description can be expanded. By clicking on the name of the plant, the user goes to the page where the location of the plant and detailed information about it are shown on the world map (figure 2). At the same time, you can choose a sufficiently large area in terms of area and gradually narrow it down.

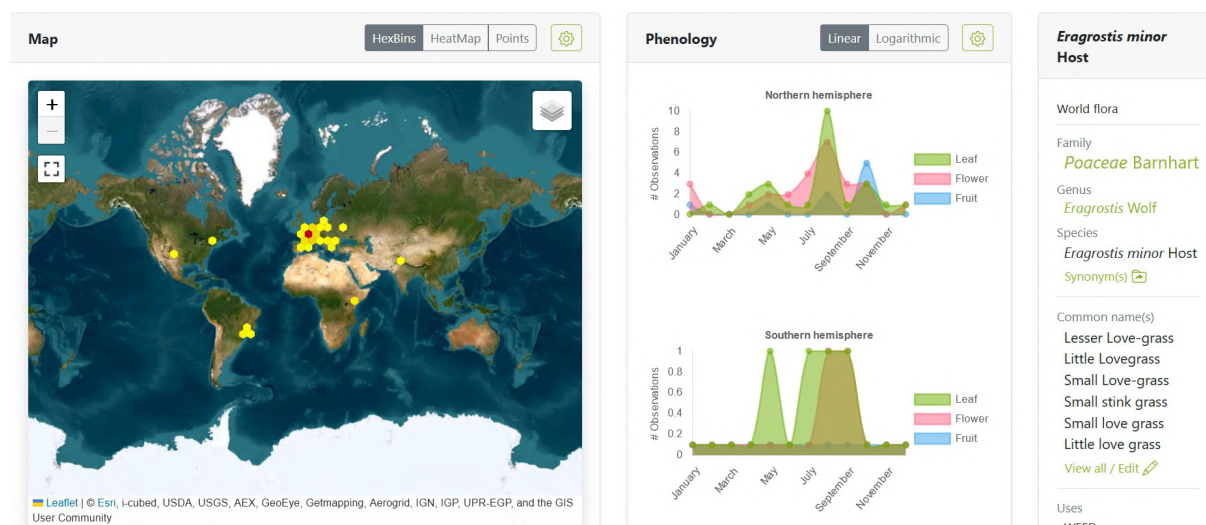


Figure 2: *Eragrostis minor* host.

In this way, interdisciplinary connections between biology and geography are followed (it is possible to study several topics). The basic principles of working with AI-GeoSpecies can be considered in computer science classes. That is, there is a combination of three school subjects: computer science, geography and biology. There are already examples of the use of applications and services in the profession of studying individual school subjects [6]. The involvement of several subjects makes it possible to use the project method. It will be advisable to divide the students of the class into groups and assign an individual task. To diversify the task, you can involve the study of several artificial intelligence services that will have similar functions. In this case, several groups of students will demonstrate different services, which will be of interest for further study. Another option should be considered: comparing the results of performing similar tasks and checking their accuracy. When studying any artificial intelligence service, it should always be emphasized that the results obtained with its use should always be subject to doubt and additional verification (in individual cases). The question often arises among teachers, how to avoid the unethical use of artificial intelligence by students? Maybe it should be completely banned? Research [5] proves that learning the correct use of artificial intelligence by students solves this problem. That is, it is necessary not to prohibit, but to teach how to use it correctly. For example, when conducting student research, performing laboratory or practical work, writing papers for the Small Academy of Sciences of Ukraine. At the same time, the first acquaintance with artificial intelligence can take place already in the junior grades and continue (deepen, expand) during all years of study in a general secondary education institution.

During 2024-2025, it is planned to carry out the research work “Design and use of an open educational environment with elements of artificial intelligence for the professional development of teaching staff”. The research work will be carried out in the Department of Cloud-Oriented Systems of Education Informatization of the Institute for Digitalisation of Education of the NAES of Ukraine. To illustrate the problem of using artificial intelligence in the education of Ukraine, the author of the article performed one of the intermediate sections of the ascertaining stage of the pedagogical experiment. The department of cloud-based education informatization systems often organizes and conducts educational trainings and seminars for educators. After one of the master classes on increasing the level of open science competence, a survey of 36 educators was conducted regarding the use of artificial intelligence. Educators who are interested in implementing digital technologies in the educational process participated in the survey. It turned out that all respondents know what artificial intelligence is. 33 respondents expressed interest in further training in the use of artificial intelligence (91%). 92% of respondents have already used artificial intelligence services (figure 3).

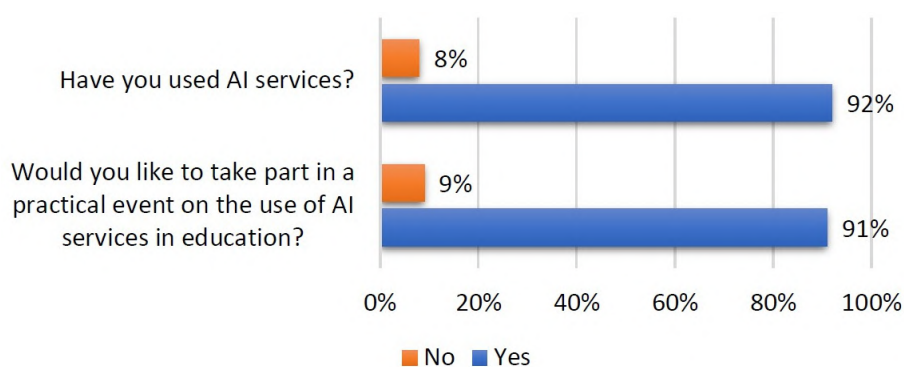


Figure 3: Attitudes toward the use of artificial intelligence by educators.

It was established that educators often use artificial intelligence services (53% of 36 respondents). At the same time, only 3 respondents answered that they do not use these services at all (figure 4).

A survey on the benefits of using artificial intelligence illustrates interesting results (figure 5). It should be noted that all respondents positively evaluate the use of artificial intelligence. However, 10 (28%) respondents believe that it is necessary to have appropriate methods for this.

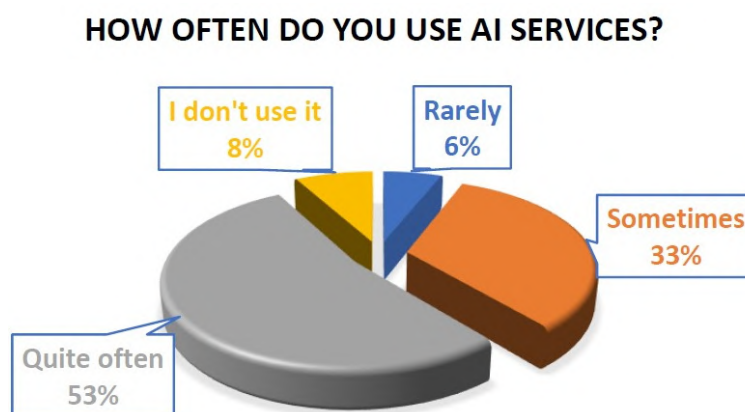


Figure 4: How often do educators use artificial intelligence.

Will AI services be useful in the educational process?

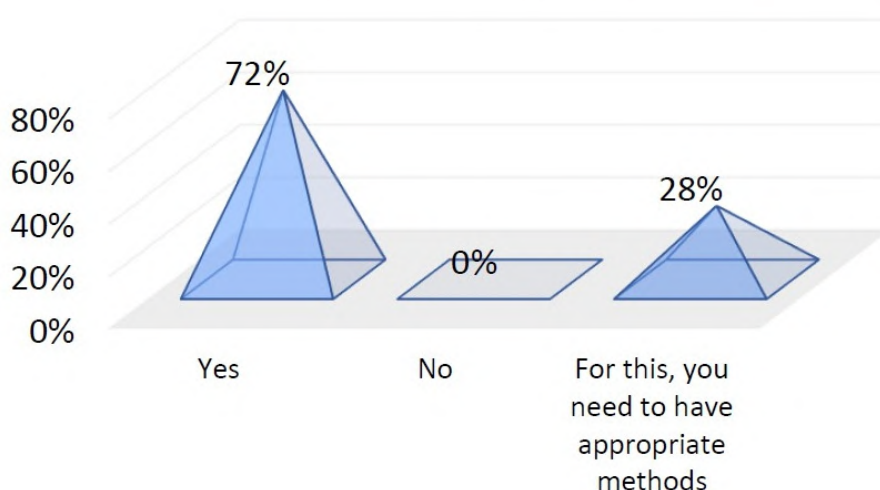


Figure 5: Use of artificial intelligence services in the educational process.

3. Conclusions

The main theses in the publications of Ukrainian scientists about artificial intelligence and STEM are very related. A very large number of publications by Ukrainian scientists, over the last year, are devoted to publications about ChatGPT. But we know that this is not limited to the use of artificial intelligence. Previous studies were primarily related to adaptive technologies. That is, the topic of artificial intelligence is not new. The problem of using artificial intelligence is a natural continuation of the problem of using augmented and virtual reality in education. First of all, it should be noted that artificial intelligence in education abroad began to be actively used precisely in connection with the spread of the COVID-19 pandemic. In secondary education, according to international studies, artificial intelligence is often used in combination with digital storytelling. Therefore, for the development of methods of using artificial intelligence in the secondary education of Ukraine, it is advisable to include the existing methodical recommendations.

Digital storytelling:

- stimulates thinking and encourages asking critical questions to conduct research and gain new knowledge;
- helps in analyzing found resources and expanding one's knowledge through discussion and collaboration with others;

- deepens understanding and expands the scope of students' knowledge;
- helps in researching information from many educational sources and illustrating the problem for various solutions based on existing experience;
- improves student understanding of a specific subject through inquiry-based learning.

As part of the planned research work for 2024-2025 “Design and use of an open educational environment with elements of artificial intelligence for the professional development of pedagogical personnel”, an intermediate section of the ascertaining stage of the pedagogical experiment was conducted. The conducted survey encourages further actions and the creation of methods for the use of artificial intelligence in the secondary education of Ukraine. After all, most educators are sure that the use of artificial intelligence in the educational process will be quite effective. However, there is a problem of lack of methods of their use. Educators want to learn how to use artificial intelligence services. Therefore, it will be useful to hold master classes and seminars on this topic. It was found that the majority of teachers know what artificial intelligence is and use its tools. Analysis and assessment of the state of use of artificial intelligence systems and services in the domestic educational space will be conducted after several series of surveys within the framework of round tables, seminars and conferences.

Literacy in the field of artificial intelligence needs additional research. It requires a detailed analysis of the foreign experience of using artificial intelligence and the adaptation of already existing methods to the modern development of Ukrainian secondary education. What can be taken from a methodological point of view for teachers of Ukraine.

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