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USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES FOR AUTOMATING THE CONDUCTING AND CHECKING OF DICTATIONS

Abstract. In today's rapidly evolving world, the continuous development of knowledge and skills is essential. Accessible Internet and a variety of online platforms for distance learning allow individuals to learn throughout their lives, adapting to the changing demands of the labor market. Online educational platforms allow students to study at any time and from anywhere, which is especially important for people with limited access to traditional education due to geographic, temporal or other reasons. The introduction of artificial intelligence technologies into educational systems facilitates the automation of numerous tasks and enables structured feedback, allowing students to quickly identify and correct their mistakes. This contributes to a deeper understanding of the material and improves learning outcomes. The availability of web-oriented educational systems allows institutions to serve a large number of students simultaneously, expanding their audience without significant additional costs. This is also relevant for distance learning in cases of unexpected disruptions. This article explores how AI can automate the administration and evaluation of dictations in distance learning. The system was developed using JavaScript, Next.js, CSS, Tailwind CSS, and TypeScript, along with cloud-based solutions such as Google Cloud Storage. AI-driven technologies were incorporated, including Google Text-to-Speech for generating dictations in a natural-sounding audio format, Google Diff-Match-Patch for real-time text comparison, and Google Vertex AI for detailed feedback and error analysis. The developed system provides teachers with tools for creating, managing, and evaluating dictations. A convenient interface for working with dictations has been developed for students, including a feedback mechanism based on artificial intelligence. The developed web-oriented learning system, owing to AI integration, represents an innovative approach to personalized language learning, and also shows the potential of AI and cloud technologies in the formation of future educational practices.

Keywords: distance education; intelligent learning systems; e-learning systems; interactive dictation; text comparison; Google Vertex AI

1. INTRODUCTION

The high level of development of information technology makes it possible to improve other areas of human activity. This also applies to the education sector. The spread of high-speed Internet makes it possible for most people to have access to online resources anytime and anywhere. Also, the widespread availability of smartphones, tablets and other mobile devices allows students to study on the go, greatly expanding their ability to access learning. Students can receive education from anywhere in the world, not limited by their place of residence. Not

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having to travel to study or move to another city reduces transportation and living costs. Therefore, in addition to traditional learning, the demand for distance learning and online learning is growing. Learning is becoming more personalized. In this case, the student independently selects the place, time, duration and pace of study. The COVID-19 pandemic also showed the need and effectiveness of online learning, when educational institutions around the world were forced to switch to distance learning in order to continue the educational process under quarantine conditions [1] - [4]. This experience has become very important for supporting education during the war in Ukraine [5], [6], including in a distance format using information and communication technologies [6], [7]. Since our world is rapidly developing, people of all ages are improving their knowledge, undergoing retraining, and improving their skills [8]. In this case, distance learning is also relevant.

The statement of the problem. To organize a distance learning format, you need appropriate software. Today there are already many educational platforms, such as Coursera, Udemy and others [9], [10]. These educational platforms provide a wide range of courses on different topics and difficulty levels, making education more accessible to everyone. Many universities and educational institutions are actively developing online courses and programs, understanding the importance and demand for distance learning [11] - [14]. However, the needs, ages and abilities of students vary. Therefore, the organization, development, implementation and research of various educational systems is a topical task [14] - [18]. One of the forms of training that requires special support in distance learning is dictations.

A dictation is one of the traditional effective ways to develop written language skills. The main idea of this method is that the teacher reads the text, the students listen to it and write it down. After the process is completed, the written text is checked for correctness. The teacher or students check and analyze mistakes made during dictation. This can be an important step in identifying weaknesses and improving the student's skills. Auditory dictations help develop the ability to distinguish sounds and correctly convey them in writing. Dictations are an important tool for learning spelling, punctuation and grammar. Dictation helps improve writing skills, develop attention to detail, and teach you to use words correctly. Typically, dictation is used to develop correct spelling, punctuation, and listening and writing skills. But dictation is not only an exercise in spelling and correct reproduction of text. In fact, this task develops a wider range of students' skills. Students should listen carefully and, avoiding distractions, write the dictated text. This develops their concentration and attention. Dictation requires students to memorize and reproduce information. Therefore, dictation develops students' memory. Students can learn to check their work, correct mistakes and analyze their shortcomings. Therefore, dictation allows you to develop self-control and self-correction.

Thus, the benefits of using dictations include increasing students' attention, training listening and writing skills, improving spelling, and improving spelling and grammar. During distance learning, the problem of conducting dictations by teachers becomes a problem. However, conducting dictations remotely can be automated using modern information technologies, including artificial intelligence capabilities.

Analysis of recent studies and publications. Today, the use of artificial intelligence is becoming a very popular technology, including in the field of education. These issues are reflected in the UNESCO Global Agenda "Education 2030" [17], as well as numerous publications by researchers around the world [4], [18] - [24].

The introduction of artificial intelligence in educational systems allows us to expand traditional teaching methods [14], [20], and increase adaptability in learning [18] - [21]. In the paper [19], the authors draw attention to how achievements in the field of AI are important for the adaptability of learning. At the same time, the authors believe that general artificial intelligence does not exist and, depending on the specific educational system and task, it is necessary to select different AI models. In the paper [20], the author also believes that adaptive

learning based on AI has great potential for further development, but further research is still needed in this area.

AI technologies allow you to analyze student data, their mistakes and therefore make more personalized recommendations. The authors of article [19] studied how machine learning was used to predict student performance and provide feedback to teachers. They believe that the use of machine learning in online education provides teachers with additional knowledge to develop effective interventions and achieve precise educational goals.

The relevance of using artificial intelligence technologies in distance education is also confirmed by the authors [21]-[22] who have conducted research on a large pool of publications in this area. The results of these studies [22] show the main groups of AI use in education: analysis and analytics of educational data for adaptive and personalized learning, online educational spaces and online learning based on recognition and prediction. Similar areas of using artificial intelligence technologies in distance education are highlighted by the authors of work [4]. The authors also confirm that intelligent systems can be effectively used to solve a number of pedagogical problems. This includes the development of adaptive learning systems, virtual learning environments and personalization.

An example of the successful development and use of an online learning platform based on artificial intelligence is work [11]. The authors developed an online learning platform using a decision tree algorithm and convolutional neural networks based on fuzzy data. The proposed online learning platform with built-in resource management and time tracking capabilities helps improve the efficiency of student learning and provides a new way of personalized learning, allowing students to better adapt to different learning styles based on their own needs.

Successful experience in developing virtual learning environments has also been shown for solving Olympiad problems in programming [12], for laboratory work in physics [13], and others [14] - [16], [23].

AI technologies for natural language processing allow recognizing the student's language, whether it is text or speech, which is also important in learning. Thus, the authors of the work [25] show the relevance of using artificial intelligence technologies for learning and teaching languages. And in the work [26], the authors describe their study of the benefits and use of an assistant with artificial intelligence to strengthen students' writing skills.

Thus, thanks to artificial intelligence technologies, it is possible to automate various learning processes, as well as make learning more individual. This is especially important in the context of distance learning.

The research goal. The purpose of this work is to increase the effectiveness of dictations in distance learning by developing and implementing a multi-user web-based learning system, which will facilitate language learning through interactive dictations. This article is devoted to the process of automating the conduct and verification of dictations through the development of a learning system using artificial intelligence technologies.

2. THE PROCESS OF AUTOMATING THE CONDUCT AND VERIFICATION OF DICTATIONS

To organize dictations, the following processes need to be automated: reading (sounding) the text and comparing the text typed by the student with the source text.

The process of reading (sounding) text can be organized thanks to language synthesizers. A language synthesizer is software that allows you to generate audio speech from text or other forms of data. This technology is based on artificial intelligence and natural language processing. Language synthesizers can take text input and produce audio speech in different languages or voices.

The main stages of speech synthesis include text analysis (word recognition, grammatical analysis), phoneme synthesis (small sounds), prosody synthesis (intonation, tone, speed of speech) and the reproduction of sounds through speech. Language synthesizers are widely used for various purposes, such as audio books, assistants in home devices and smartphones, voice assistants, language recognition, applications for people with disabilities and other areas where creating a broadcast from text is an important element. Language synthesizers continue to improve and find new applications in various industries and walks of life, helping to make it easier for people to communicate with technology. Therefore, we can explore their use for voicing dictation texts.

2.1 Using methods and technologies of artificial intelligence

In the article [26], using the expert assessment method, a comparison of speech synthesis libraries from Microsoft, Google, Amazon for their use in the Ukrainian language was carried out. It was determined that the Google developer library has the best indicators for the quality of pronunciation, legibility, correctness of stress and intonation. Therefore, the Google Cloud Text-to-Speech AI (TTS) library [27] was selected for further use.

Google Text-to-Speech AI is a cloud service that turns text into synthesized speech. TTS uses the latest deep learning innovations such as neural network based speech synthesis, automatic speech segmentation, and pronunciation modeling. The library allows you to select different languages, voices, read speed, type of audio file created and where to save it. Supports both English and Ukrainian languages. For English, the model “en-US-Neural2-H” is used, and for Ukrainian– “uk-UA-Standard-A”. In general, the process of information processing in a web-based training system for conducting and checking dictations includes the following stages:

- preliminary processing of the dictation text;
- converting the source text of the dictation from a text format into an audio format in natural language;
- comparison of the text received from the user with the source text;
- additional error analysis.

Each of these stages involves a separate processing method. Pre-processing of the text is necessary for the following reason. Traditionally, during dictation, the teacher repeats each sentence 3 times and makes the necessary logical pauses. Therefore, the original text must be processed by a specially developed algorithm that adds tags, which the artificial intelligence then perceives as commands. For example, adding the tag to the text will mean that when synthesizing a sentence, the AI will pause for 2 seconds at the place where this tag was used. This algorithm also duplicates each phrase in the text three times with pauses of two seconds at the end of each repetition and three seconds at the end of the last repetition. Thanks to this processing, the audio dictation generated by the Google Text-to-Speech AI artificial intelligence implements the traditional model of conducting dictations. Converting the original dictation text from text format to natural language audio format is done directly using Google Text-to-Speech AI. Thus, the dictation text is converted into an audio signal, which the student will later listen to. Since the synthesizer from Google was chosen as the main tool, it is convenient to use other tools from the same developer. So, the Google Cloud Storage [28] service was chosen to store objects- this is a service for storing objects in cloud storage. In this project, this service is used to store and obtain temporary access to audio files generated by the Google Text-to-Speech service.

The Google diff-match-patch library [27] was chosen as a method for text comparison and error detection. This library combines the following tools:

- Diff (differences) component used to compare two text fragments and identify differences between them in the form of an array. This particular method is used in this project. Basic principles of operation: The algorithm takes two strings as input and compares them to find sequences of the same characters and sequences that differ. For large texts, diff-match-patch first finds line level differences to quickly identify differences between lines. It then drills down to perform character-level differences in the differing strings. The algorithm identifies “common substrings” (character sequences that appear in both texts) and marks everything else as differences. To optimize performance, the algorithm tries to find "half-matches" (regular substrings found at the beginning or end of text) and divides the problem into smaller ones. The algorithm calculates the "edit distance" between two texts, which is the number of insertions, deletions, or substitutions required to transform one text into the other.
- Match component designed to determine the best alignment of a substring in a larger string. This is useful for implementing features such as search and typo correction.
- Patch component involves applying a series of differences (corrections) to text. This is useful for updating texts based on changes.

Additional error analysis is implemented using artificial intelligence Google Vertex AI [27]. Google Vertex AI is a powerful and unified machine learning (ML) platform. It provides a simplified and scalable solution for developing, deploying, and managing ML models. Vertex AI brings together a range of ML tools and services, simplifying the entire ML lifecycle and allowing developers and data scientists to focus on building and developing powerful ML programs. The main reason for choosing Google Vertex AI is the availability of a wide range of pre-trained models. In this project, for additional verification of the written dictation and the formation of recommendations, a model of the text base supporting the controlled setting “text-bison@002” is used. To date, this model only supports dictations that were written in English.

2.2 Development of a training system

To organize the work of the educational system for checking and conducting dictations, it was decided to use two types of user roles: teacher and student. The options for using the system for each of the roles are as follows:

- for teachers: log in, view all dictations, view details of a specific dictation, edit a dictation, create a dictation, delete a dictation, view the results of all students, view a specific result with details;
- for students: log in, view published dictations, view details of a specific dictation, start a dictation, view the archive of the results of your completed dictations, view your specific result with details.

The use cases of the teacher training system are shown in Figure 1 using a UML diagram.

The learning system can be used for self-education. In this case, the user has all the functions of a teacher. The use of the training system is expected in a distance format. In this case, students should have access to the system from anywhere, at any convenient time. Therefore, the system interface is assumed to be web-oriented and modern web technologies are required for implementation. A JavaScript framework called Next.js was chosen as the basis for implementing the system. It is based on a JS library called React. This combination was chosen for several reasons:

- reuse of components;
- low development costs (there is a free training plan);
- built-in support for the Tailwind CSS framework;
- fast-refresh– updating results in the browser in real time without the need to restart the server;

- a hybrid of SSR (Server Site Rendering) and SSG (Static Site Generation) allows you to create very fast and adaptive pages;
- automatic configuration and compilation TypeScript is a high-level programming language that adds static typing to JavaScript with optional type annotations, which greatly facilitates handling and future error detection;
- automatic compilation and merging of code.

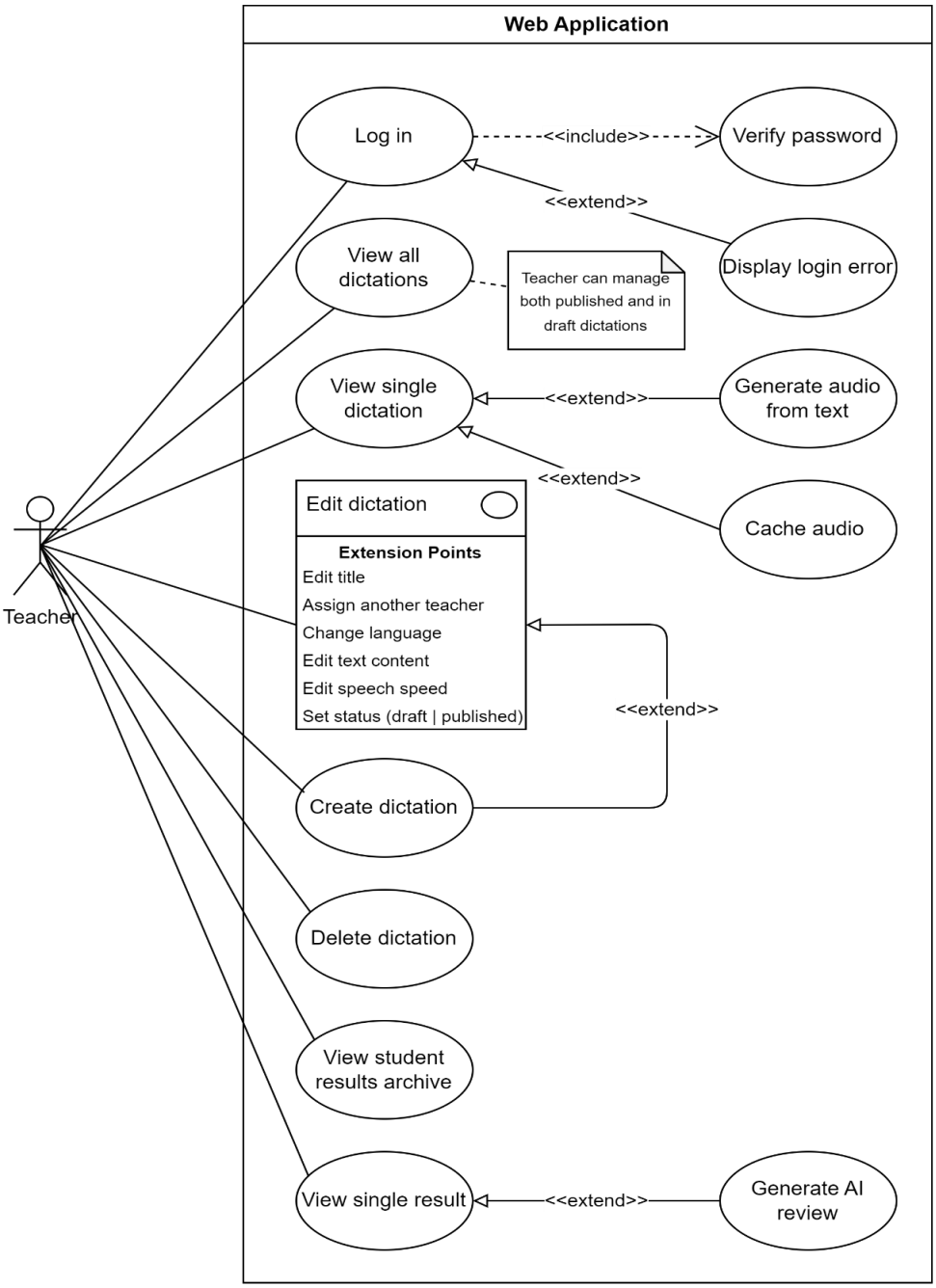

Figure 1: Teacher Use Case Diagram

This project also needs to store various data about users, dictations, student results, and more. For this purpose, the well-debugged PostgreSQL relational database was chosen. Its integration into the Next.js backend enables efficient operations with the data needed for user registration, content management and transaction tracking1. This database choice provides a reliable and secure basis for storing and querying data within the educational system,

maintaining the overall functionality and integrity of the system. The database itself is located on the servers of the Vercel cloud platform, which also acts as hosting for this project. At its core, Vercel is a cloud platform for static sites and serverless functions. This allows developers to easily create and deploy web projects.

3. RESULT

When a user first opens a web application, they see the home page (Figure 2). After clicking the “Enter Your Classroom” button, the user, if he has not previously logged in, is taken to the authorization page where he needs to enter his login and password.

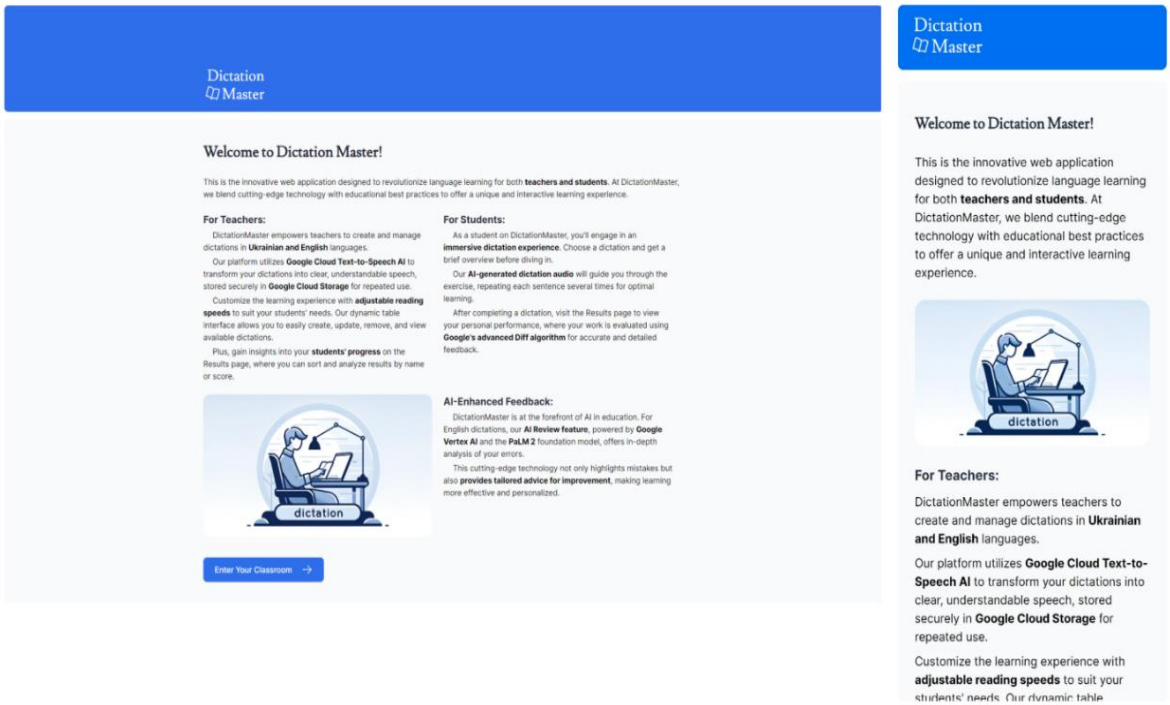

Figure 2: Home page

If the user has the role of teacher, he will see a list of all dictations, including draft ones (Figure 3).

To view the dictation for the teacher, you need to click the button with the eye icon opposite the desired dictation and the dictation viewing page will open. To open the dictation editing page, you need to click on the pencil icon. To delete a dictation, you need to click on the trash can icon. To create a new dictation, you need to click the button “Create Dictation” in the upper-right corner, this will open the page for creating a new dictation (Figure 4). To create a new dictation, the teacher needs to enter the name of the dictation, select the language of the dictation, and add text. The teacher can also set the speed of text playback for the future dictation. Additionally, the teacher can mark "Published" or "Draft" for the dictation.

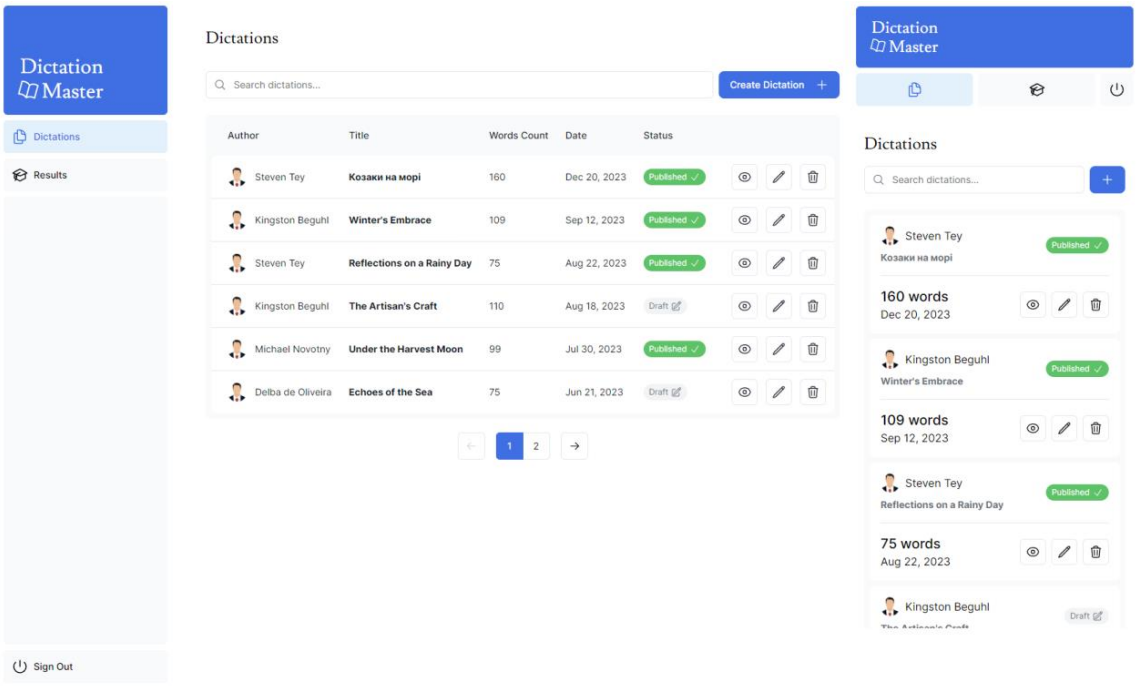

Figure 3. Teacher's page: list of dictations

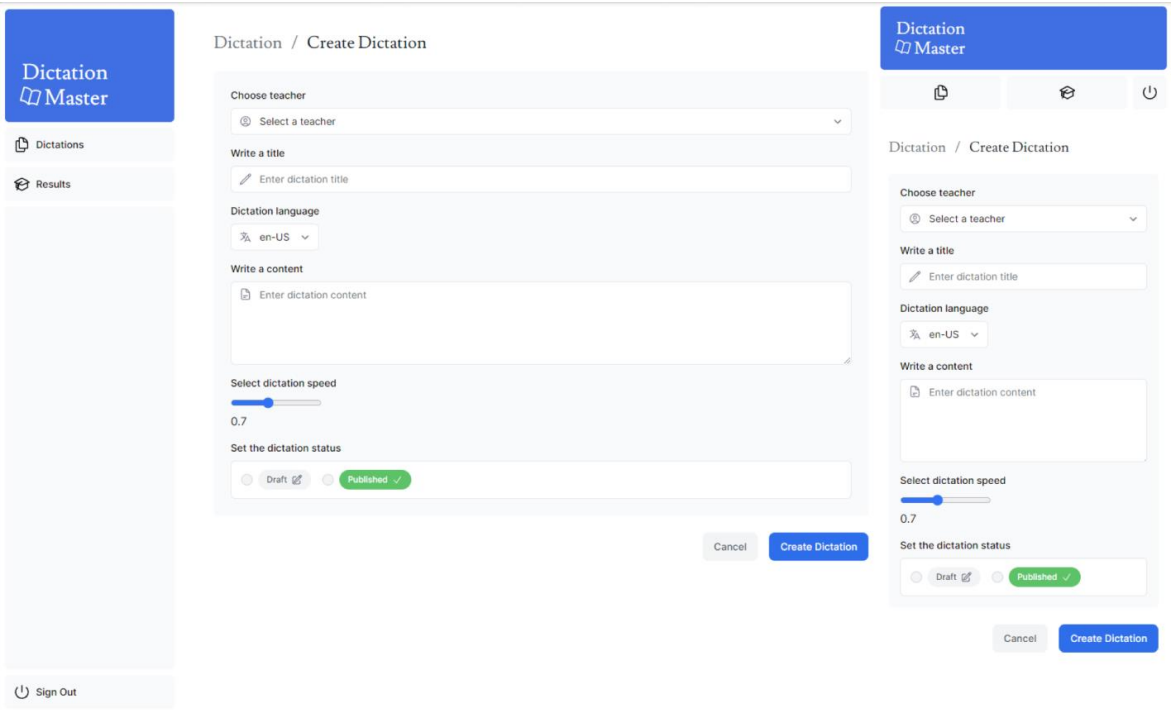

Figure 4. Teacher's page: create a New Dictation

If you click "Results" in the left panel, a page with the results of dictations for all students will open (Figure 5). This page displays a list of students. For each student, the name of the dictation he wrote, the date of writing, and the grade are indicated.

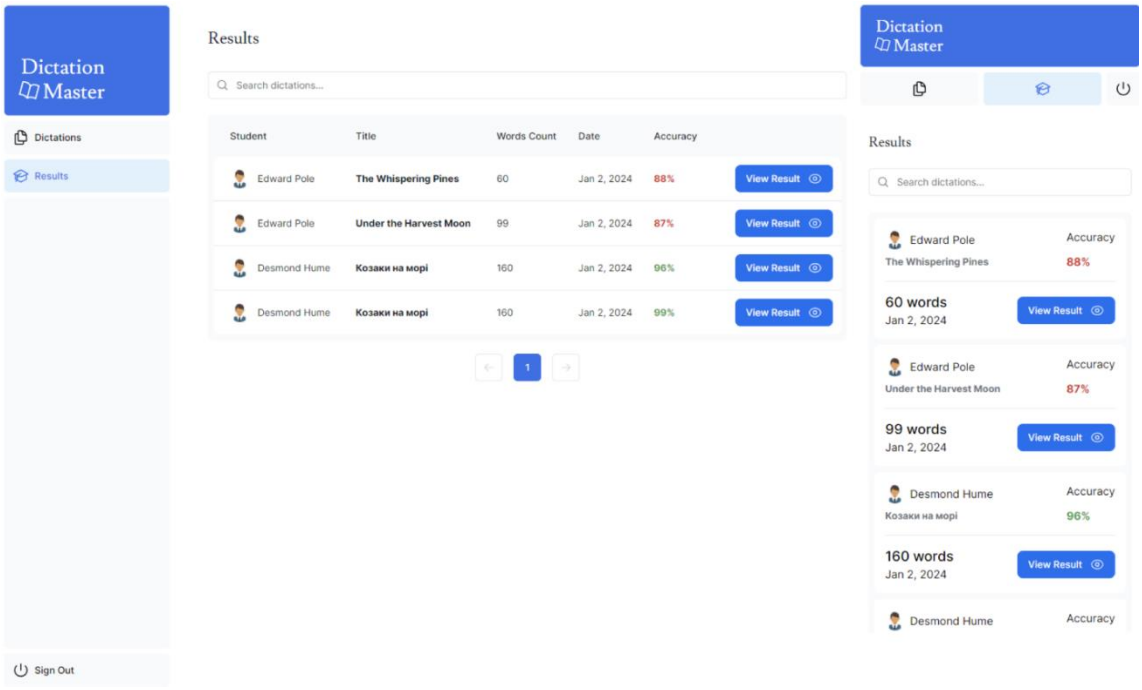

Figure 5. Teacher's page: results of each student

The teacher can click the "View Result" button to view the student's result in detail (Figure 6). Additionally, both the teacher and the student can generate an AI review from Google Vertex AI (Figure 6) using the button "Generate AI Review".

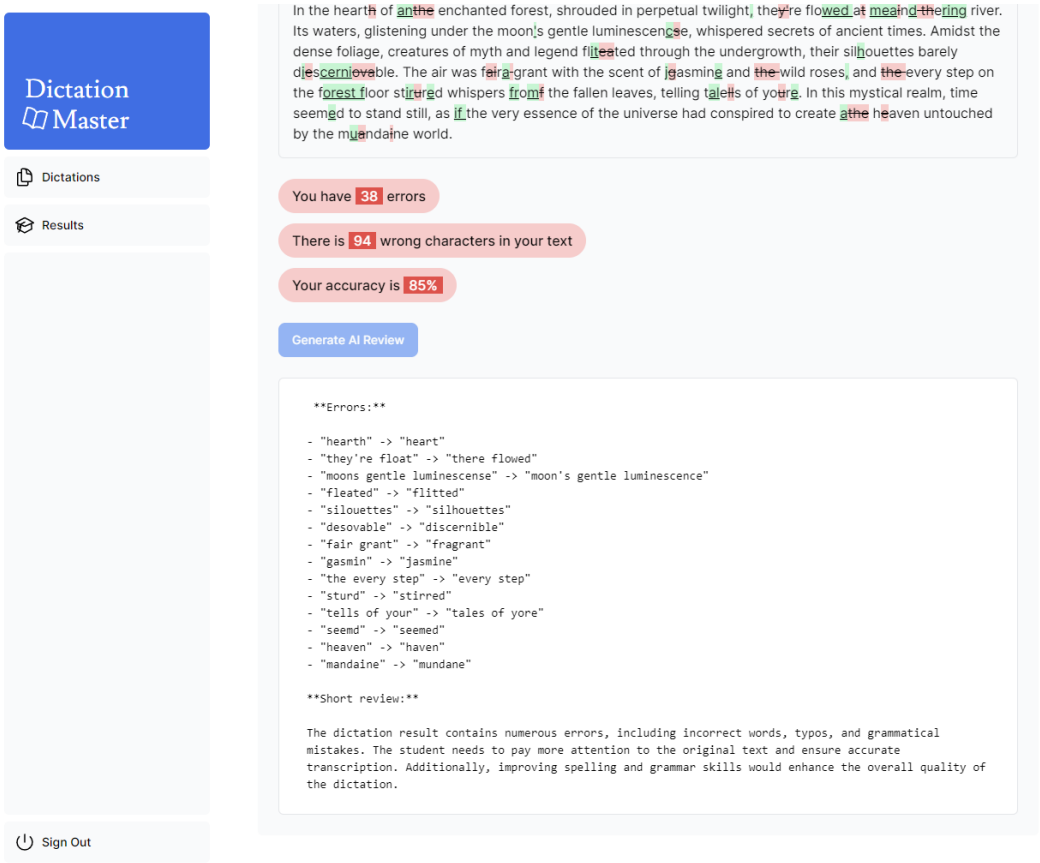

Figure 6. Review by Google's VertexAI artificial intelligence

In the lower left corner there is the button “Sign Out”; if you click it, the current user will log out of their account and will be directed to the authorization page. Now if you enter data and log in as a user with the role of a student, then on the dictation viewing page he will not have the opportunity to see its text, but there will be the button “Start Dictation”. If you click it, the student will go to the dictation writing page (Figure 7).

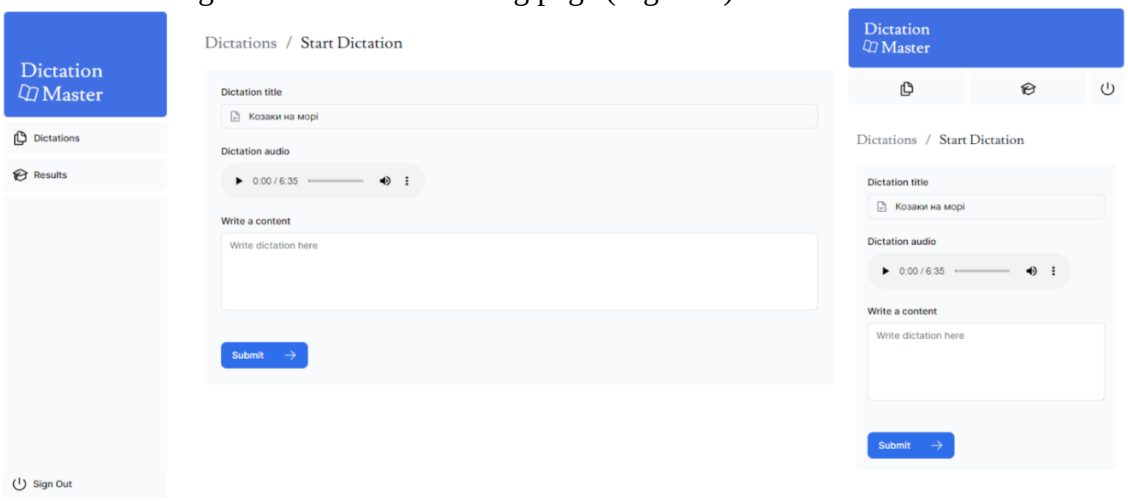

Figure 7. Student’s page: window for conducting dictation

After the dictation is written, the student clicks the button “Submit” and goes to the page for viewing the results of his dictation (Figure 6). The developed training system also allows conducting and checking dictations not only in English, but also in Ukrainian. An example of automated checking of such a dictation is shown in Figure 8.

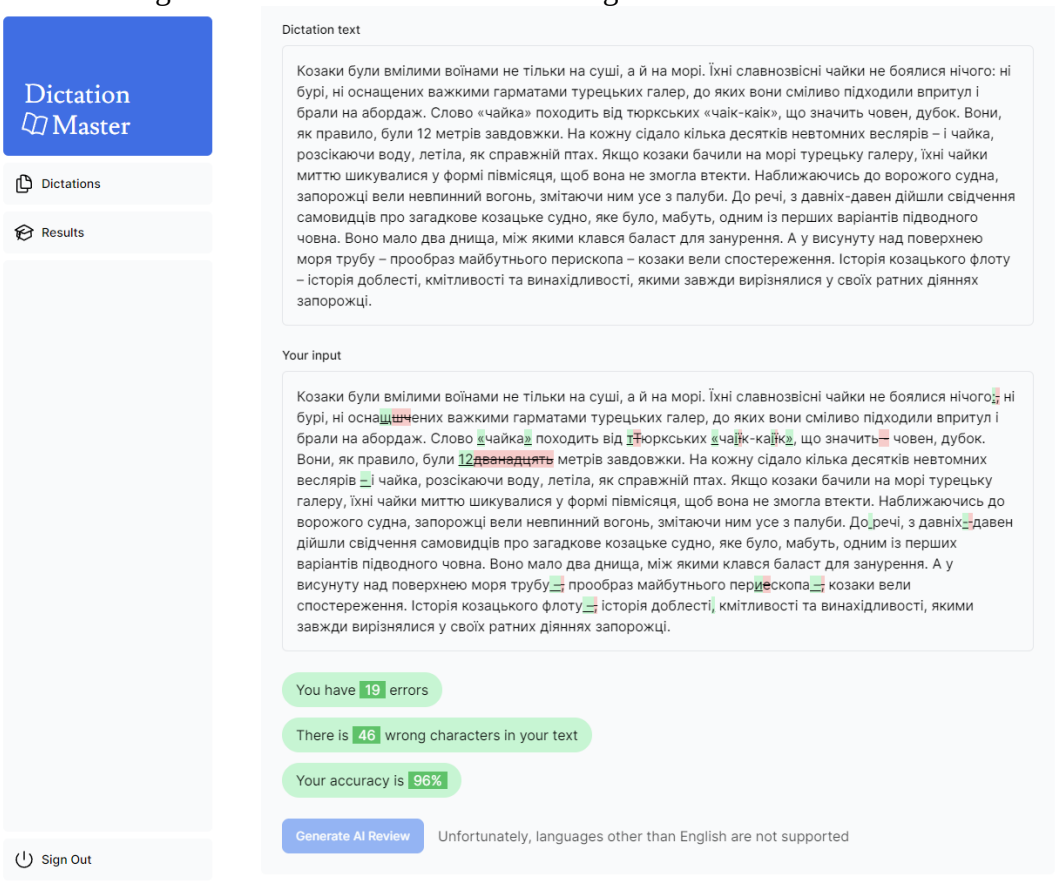

Figure 8. The example of checking a dictation in Ukrainian

4. CONCLUSIONS

Thus, modern information technologies, especially artificial intelligence tools, allow an increase in the efficiency of training. In this work, we demonstrate how this can be used to organize and assess dictations remotely without a teacher. A prototype of a web-oriented educational system was developed with the following functions and modules:

- Registration system. The registration module is designed to collect important information from users and teachers, ensuring data protection and privacy. React forms, accompanied by state management using React Hooks, are used to process user-entered data, and Next.js API routes manage the server-side logic and interaction with the database.
- Student and teacher user interface. Individual interfaces have been developed for different user roles. The teacher admin dashboard is built using stateful React components, which provides a comprehensive view of class progress, dictation presentation, and student performance.
- Dictation text management. A content management system (CMS) has been implemented to allow teachers to add new dictation texts. This is facilitated by a rich text editor implemented in React, allowing teachers to enter and format dictation texts, which are then saved and retrieved from a PostgreSQL database via Next.js.
- Google Text-to-Speech integration. Google's Text-to-Speech (TTS) API is integrated to convert text dictations into audio. Access to the TTS service is organized through Next.js server functions interacting with the Google cloud platform, providing students with dictation text in audio format.
- Error checking. An algorithm for checking text entered by students for errors has been implemented using string comparison methods and natural language processing methods of the Google diff-match-patch library.

Such an online learning system will allow students to take dictations online at a time and place convenient for them. This is especially important for those students who cannot attend traditional classes for various reasons. The developed prototype showed that AI can be used to automatically check papers, which significantly speeds up the assessment process. Machine learning algorithms can recognize errors in spelling, grammar, and punctuation. Speech recognition technologies can be used for text dictation. This allows students to listen to the dictation in real time via the Internet. Additionally, the introduction of AI technology enables detailed feedback, pointing out specific errors and offering explanations. This helps students better understand their mistakes and improve their skills. These technologies make the process of conducting dictations more effective, convenient, and accessible for both students and teachers. Thus, the developed web-based learning system, employing AI, represents an innovative approach to personalized language learning.

Future research may focus on the implementation of adaptive assessment methods that account for individual student proficiency. Additionally, gamification elements could be introduced, allowing students to compete based on the speed and accuracy of their dictations.

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ВИКОРИСТАННЯ ТЕХНОЛОГІЙ ШТУЧНОГО ІНТЕЛЕКТУ ДЛЯ АВТОМАТИЗАЦІЇ ПРОВЕДЕННЯ ТА ПЕРЕВІРКИ ДИКТАНТІВ

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Анотація. У сучасному світі, що стрімко розвивається, безперервний розвиток знань і навичок є необхідним. Доступний Інтернет та різноманітні онлайн-платформи для дистанційного навчання дозволяють людям навчатися протягом усього життя, адаптуючись до змінних вимог ринку праці. Онлайн-платформи для навчання надають можливість студентам навчатися в будь-який час і з будь-якого місця, що є особливо важливим для людей, які мають обмежений доступ до традиційної освіти через географічні, часові чи інші причини. Впровадження технологій штучного інтелекту в освітні системи сприяє автоматизації численних завдань і забезпечує структурований зворотний зв'язок, що дозволяє студентам швидко виявляти та виправляти свої помилки. Це сприяє глибшому розумінню матеріалу та покращує результати навчання. Наявність онлайн-платформ для навчання дає змогу навчальним закладам одночасно навчати велику кількість студентів, розширюючи аудиторію без значних додаткових витрат. Це також актуально для дистанційного навчання у випадку непередбачуваних обставин. У цій статті досліджується, як штучний інтелект може автоматизувати адміністрування та оцінювання диктантів в умовах дистанційного навчання. Система була розроблена з використанням JavaScript, Next.js, CSS, Tailwind CSS і TypeScript, а також хмарних рішень, таких як Google Cloud Storage. Було впроваджено технології, керовані штучним інтелектом, зокрема Google Text-to-Speech для генерації диктантів у форматі природного звучання, Google Diff-Match-Patch для

порівняння текстів у реальному часі та Google Vertex AI для детального аналізу помилок і зворотного зв'язку. Розроблена система надає викладачам інструменти для створення, управління та оцінювання диктантів. Для студентів розроблено зручний інтерфейс для роботи з диктантами, що містить механізм зворотного зв'язку на основі штучного інтелекту. Створена веборієнтована система навчання завдяки інтеграції штучного інтелекту представляє інноваційний підхід до персоналізованого вивчення мов, а також демонструє потенціал штучного інтелекту та хмарних технологій у формуванні майбутніх освітніх практик.

Ключові слова: дистанційна освіта; інтелектуальні системи навчання; інтерактивний диктант; порівняння тексту; Google Vertex AI.

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