MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL UNIVERSITY OF FOOD TECHNOLOGIES

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Department of Information Technologies, Artificial Intelligence and Cybersecurity_

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December 13, 2024

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December 13, 2024

QUALIFICATION WORK
FOR A MASTER'S DEGREE

in the specialty__122 "Computer Science"_____
(code and name of the specialty)
Educational and Professional Program_ Information Management and Data Analytics___
on the topic:_____Research and implementation of a system for analyzing progress and adaptive learning in learning English_____
_____

Performed by: student of_2_ year, group KN-2-4M

_____Levoniuk Kateryna Viktorivna_____
(surname, first name, patronymic in full) (signature)

Supervisor _____ Kostikov Mykola Pavlovych_____ _____
(прізвище , ім'я та по батькові повністю) (підпис)

Consultants _____ _____
(name and surname) (signature)

_____ _____
(name and surname) (signature)

_____ _____
(name and surname) (signature)

Reviewer _____
(name and surname) (signature)

As a student of the National University of Food Technologies, I understand and support the university's policy on academic integrity. I have not provided or received any unauthorised assistance in the preparation of this work. The use of ideas, results and texts of other authors should be referenced to the appropriate source

Student_____
(signature)

Kyiv - 2024p.

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ХАРЧОВИХ ТЕХНОЛОГІЙ

Інститут (факультет) Автоматизації і комп'ютерних систем
Кафедра Інформаційних технологій, штучного інтелекту і кібербезпеки

«До захисту в ЕК»	**«До захисту допущено»**
Директор інституту(декан факультету)	Завідувач кафедри
_____ Андрій ФОРСЮК	_____ Сергій ГРИБКОВ
(підпис) (ім'я та прізвище)	(підпис) (ім'я та прізвище)
«13» грудня 2024р.	«13» грудня 2024р.

КВАЛІФІКАЦІЙНА РОБОТА
НА ЗДОБУТТЯ ОСВІТНЬОГО СТУПЕНЯ МАГІСТРА

зі спеціальності 122 «Комп'ютерні науки»
(код та назва спеціальності)

освітньо-професійної програми Управління інформацією та аналітика даних
на тему: Дослідження та реалізація системи для аналізу прогресу та адаптивного навчання при вивченні англійської мови

Виконав: здобувач 2 курсу, групи КН-2-4М

Левонюк Катерина Вікторівна _____
(прізвище, ім'я, по батькові повністю) (підпис)

Керівник Костіков Микола Павлович _____
(прізвище , ім'я та по батькові повністю) (підпис)

Консультанти _____ _____
(ім'я та прізвище) (підпис)

_____ _____
(ім'я та прізвище) (підпис)

_____ _____
(ім'я та прізвище) (підпис)

Рецензент _____ _____
(ім'я та прізвище) (підпис)

Я як здобувачка Національного університету харчових технологій розумію і підтримую політику університету з академічної доброчесності. Я не надавала і не одержувала недозволеної допомоги під час підготовки цієї роботи. Використання ідей, результатів і текстів інших авторів мають посилання на відповідне джерело

Здобувач _____
(підпис)

Київ - 2024р.

NATIONAL UNIVERSITY OF FOOD TECHNOLOGIES

Institute (Faculty) of Automation and Computer Systems
Department of Information Technologies, Artificial Intelligence and Cybersecurity
Educational degree master
Specialty 122 "Computer Science"
(code and name)
Educational and professional program Information Management and Data Analytics
(name)

APPROVED
Head
of Department Information Technology, Artificial Intelligence and Cybersecurity

_____ Hrybkov S.
"07" October 2024

A S S I G N M E N T

FOR THE APPLICANT'S QUALIFYING WORK

Levoniuk Kateryna Viktorivna
(last name, first name, patronymic)

1. Topic of the work Research and implementation of a system for analyzing progress and adaptive learning in learning English

supervisor Kostikov Mykola Pavlovych, Associate Professor, Candidate of Technical Sciences,
(surname, first name, patronymic, academic degree, academic title)
approved by the order of the higher education institution dated October 7, 2024 No. 884-ks

2. Deadline for submission by the student 05.12.2024
3. Initial data for work
1) Creating an English learning platform with student progress monitoring.
2) Integrating analytics to assess learning outcomes, including vocabulary, testing, and activity.
3) Using visualizations, such as Radial Gauge, to assess progress on topics and tests.
4. The content of the explanatory note (a list of issues to be developed)
1) Analysis of literary sources
2) Analysis of methods and technologies for monitoring student progress and system analysis
3) Development of an information system

5. List of graphic material

Screenshots of the system interface, screenshots of analog programs and systems

6. Consultants of work sections

Section	Surname, initials and position Consultant	Signature, date	
		The task was issued by	task took
1	Associate Professor Kostikov M.P.	07.10.2024	16.10.2024
2	Associate Professor Kostikov M.P.	17.10.2024	10.11.2024
3	Associate Professor Kostikov M.P.	11.11.2024	29.11.2024

7. Date of issue of the task October 7, 2024

CALENDAR PLAN

nó	Name of execution stages qualification work	Deadline for the implementation of the stages of work	Note
1	Execution of the first section and submission of it to the head	07.10.24 – 18.10.24	Completed
2	Execution of the second section and submission of it to the head	18.10.24 – 03.10.24	Completed
3	Editing sections according to the manager's comments	03.11.24 – 20.11.24	Completed
4	Preparation of the introduction and conclusions	20.11.24 – 04.12.24	Completed
5	Create a presentation	04.12.24 – 05.12.24	Completed

Applicant _____ (signature) Levoniuk K. V. (surname and initials)

Supervisor of work _____ (signature) Kostikov M.P. (surname and initials)

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ХАРЧОВИХ ТЕХНОЛОГІЙ

Інститут (факультет) Автоматизації і комп'ютерних систем
Кафедра Інформаційних технологій, штучного інтелекту і кібербезпеки
Освітній ступінь магістр
Спеціальність 122 «Комп'ютерні науки»
(код і назва)
Освітньо-професійна програма Управління інформацією і аналітика даних
(назва)

ЗАТВЕРДЖУЮ
Завідувач
кафедри Інформаційних технологій, штучного інтелекту і кібербезпеки
Грибков С.В.
"07" жовтня 2024року

З А В Д А Н Н Я

НА КВАЛІФІКАЦІЙНУ РОБОТУ ЗДОБУВАЧА

Левонюк Катерина Вікторівна
(прізвище, ім'я, по батькові)

1. Тема роботи Дослідження та реалізація системи для аналізу прогресу та адаптивного навчання при вивченні англійської мови
керівник роботи Костіков Микола Павлович, доцент, кандидат технічних наук,
(прізвище, ім'я, по батькові, науковий ступінь, вчене звання)
затверджені наказом закладу вищої освіти від 7 жовтня 2024 року №884-кс
2. Строк подання здобувачем роботи 05.12.2024
3. Вихідні дані до роботи
1) Створення платформи для вивчення англійської мови з моніторингом прогресу студентів.
2) Інтегрування аналітики для оцінки результатів навчання, включаючи слова, тестування і активність.
3) Використання візуалізації, така як Radial Gauge, для оцінки прогресу по темах і тестах.
4. Зміст пояснювальної записки (перелік питань, які потрібно розробити)
1) Аналіз літературних джерел
2) Аналіз методів і технологій моніторингу прогресу студентів та системний аналіз
3) Розроблення інформаційної системи

5. Перелік графічного матеріалу

Скріншоти інтерфесу системи, скріншоти програм аналогів та систем

6. Консультанти розділів роботи

Розділ	Прізвище, ініціали та посада консультанта	Підпис, дата	
		завдання видав	завдання прийняв
1	Доц. Костіков М.П.	07.10.2024	16.10.2024
2	Доц. Костіков М.П.	17.10.2024	10.11.2024
3	Доц. Костіков М.П.	11.11.2024	29.11.2024

7. Дата видачі завдання 7 жовтня 2024 року

КАЛЕНДАРНИЙ ПЛАН

№	Назва етапів виконання кваліфікаційної роботи	Строк виконання етапів роботи	Примітка
1	Виконання першого розділу та подання його керівнику	07.10.24 – 18.10.24	Виконано
2	Виконання другого розділу та подання його керівнику	18.10.24 – 03.10.24	Виконано
3	Редагування розділів згідно зауважень керівника	03.11.24 – 20.11.24	Виконано
4	Підготовка вступу та висновків	20.11.24 – 04.12.24	Виконано
5	Створення презентації	04.12.24 – 05.12.24	Виконано

Здобувач _____ (підпис) Левонюк К. В. (прізвище та ініціали)

Керівник роботи _____ (підпис) Костіков М. П. (прізвище та ініціали)

АНОТАЦІЯ

Головною метою цієї магістерської роботи є розробка адаптивної системи для вивчення англійської мови на основі аналітики даних, яка дозволяє персоналізувати навчальний процес, покращити моніторинг прогресу студентів та автоматично адаптувати контент.

Об’єктом дослідження є платформи для вивчення англійської мови, зокрема методи аналізу даних для оцінки та адаптації навчальних матеріалів.

Предметом дослідження є проектування та розробка системи моніторингу прогресу студентів та адаптації контенту на основі зібраних даних.

Магістерська робота містить 115 сторінок, 47 рисунків, 2 додатки та 26 літературних джерел.

Ключові слова: АДАПТИВНЕ НАВЧАННЯ, АНАЛІТИКА ДАНИХ, ПЕРСОНАЛІЗАЦІЯ НАВЧАННЯ, МОНІТОРИНГ ПРОГРЕСУ, ВИВЧЕННЯ АНГЛІЙСЬКОЇ МОВИ, ОСВІТНІ ПЛАТФОРМИ.

ANNOTATION

The main objective of this Master's thesis is to develop an adaptive system for English language learning based on data analysis that allows for personalisation of the learning process, better monitoring of student progress and automatic adaptation of content.

The object of research is English language learning platforms, in particular, data analysis methods for evaluating and adapting learning materials.

The subject of the research is the design and development of a system for monitoring student progress and adapting content based on the collected data.

The thesis consists of 115 pages, 47 figures, 2 appendices and 26 references.

Keywords: ADAPTIVE LEARNING, DATA ANALYSIS, PERSONALISED LEARNING, PROGRESS MONITORING, ENGLISH LANGUAGE LEARNING, EDUCATIONAL PLATFORMS.

TABLE OF CONTENTS

INTRODUCTION

Relevance of the topic

There is a growing demand for innovative technologies in education, especially in distance and adaptive learning systems. Adaptive platforms that use data analytics allow for effective tracking of students' progress and help assess learning outcomes with visual indicators. However, many existing platforms lack integrated analytics that track not only progress but also interaction with course content. The relevance of this work is due to the need to improve such platforms with data analytics, enabling personalized learning paths for each user [1].

Modern technologies provide significant opportunities for monitoring students' progress on language learning platforms. Data visualization helps both students and teachers better understand students' achievements and identify weaknesses in learning.

Adaptive learning platforms, especially for learning foreign languages, are becoming increasingly popular due to their ability to provide students with personalized resources. However, even without full personalization of the learning process, it is important to ensure detailed monitoring of students' progress. Studying students' results through data analytics and visualizing progress allows for more accurate recommendations for further learning. Therefore, it is important to create a system that, first, allows detailed progress analysis and, second, generates personalized recommendations for each user based on their results.

Connection of the work with scientific programs, plans, topics of the department, university, or other scientific institutions

This work is part of the scientific program of the Department of Information Technology, Artificial Intelligence, and Cybersecurity, which aims to integrate innovative technologies into education and develop new methods for analyzing big data in online education. The topic of this work also aligns with the university’s scientific programs regarding the use of data analytics to improve learning processes.

The Aim of the Research

The aim of the research is to develop and implement an adaptive platform for learning English, which uses data analytics to personalize the learning process, particularly for automatically adapting content and monitoring students' progress.

The tasks of the research

To achieve the set goal, the following tasks need to be solved:

1. To analyze existing adaptive learning platforms and methods for assessing students' progress.
2. To create a system for monitoring students' progress based on collected data.
3. To develop algorithms for generating personalized recommendations based on test results.
4. To conduct testing and evaluate the effectiveness of the platform.

The object of the research

The object of the research is platforms for learning English and systems for monitoring students' progress.

The subject of the research

The subject of the research is data analytics methods for evaluating students' success, data visualization, and algorithms for generating personalized recommendations.

Research Methods

The following methods are used in the research:

- **Analysis of literature sources.** A review of scientific publications, articles, and studies related to data analytics in education and monitoring students' progress. This will help identify the best methods and technologies.

- **Analysis of methods and technologies for monitoring students' progress.** This involves studying existing platforms and systems for tracking students' success, including data analytics methods (such as test result analysis and student activity assessment). It will help understand the current approaches used to assess student progress and where improvements can be made.
- **System analysis.** This method involves using a systematic approach to analyze the entire platform for learning English, including the interaction between different components: data collection on students' progress, processing this data, and generating recommendations based on the results.

Scientific novelty of the results

The scientific novelty lies in the development of an interactive platform for learning English that combines detailed progress analytics, personalized recommendations, and data visualization for accurate monitoring of student achievements and the adjustment of the learning process.

Practical significance of the results

The developed system provides teachers and students with an accurate Figure of achievements and weaknesses, along with feedback on learning progress. It also allows for generating recommendations for further learning. This can be used in educational institutions to improve the effectiveness of the learning process.

Personal contribution

The system for data collection and analysis, visualizations, and progress monitoring has been personally developed, as well as the personalized recommendations based on test results.

Structure and volume of the work

The master's thesis consists of three chapters, including the introduction, theoretical part, research methods, platform development and conclusions. The total length of the work is 115 pages.

SECTION 1: CHARACTERISTICS OF THE STUDENT PROGRESS ANALYTICS SYSTEM

1.1. The history of learning analytics systems

Progress analytics systems in education began to develop in the 20th century when educational institutions started realizing the importance of effective monitoring and evaluation of learning outcomes. Initially, these systems were quite simple and based on traditional assessment methods, such as written exams and tests. During this period, educational institutions used paper forms to collect data on student performance, and the evaluation process was usually done manually [2].

The first serious attempt to automate the student progress monitoring process occurred in the mid-20th century when the first computer-based systems for knowledge assessment began to emerge. One of the main achievements of this period was the creation of automated testing systems, which allowed tests to be conducted on computers, reducing the need for paper-based materials and speeding up the process of checking results. These systems enabled the collection of more data on student performance, but the analytics itself was limited to simple statistical methods, such as counting correct and incorrect answers.

Since the early 2000s, when new information technologies began to be actively implemented in educational systems, more complex systems for monitoring and analytics of student progress appeared. The introduction of e-learning platforms not only automated the data collection process regarding student activity but also enabled more complex analysis of this data. The technologies used in these systems allowed for monitoring student progress not only through final grades but also through metrics such as login frequency, time spent on the platform, activity in online tasks, and other parameters.

A key step in the development of student progress analytics was the use of big data and machine learning. These technologies allow not only large volumes of data to be collected but also automatically analyzed, revealing patterns and trends that can be used

to predict student success and adjust learning materials. Thus, today's student progress analytics systems are based on powerful algorithms that allow for assessing the current level of knowledge and adapting the learning process to the individual needs of each student, providing a personalized approach to learning.

Since the early 2010s, there has also been growing interest in adaptive learning systems that integrate data analytics to create personalized recommendations and adjust learning content based on student progress. These systems typically use advanced machine learning models to analyze various types of data, such as test performance, number of tasks completed, learning pace, and even student behavior while using the platform.

As a result of the evolution of student progress analytics systems, educational institutions now have a powerful tool for improving the quality of education. The use of such systems has helped identify not only individual student issues but also overall trends in the learning process, enabling teachers to make adjustments to their teaching methods in real time. However, certain challenges still remain, related to ethical issues of data processing, student privacy, and the effectiveness of some analytical models. Despite this, the development of progress analytics systems in education opens new opportunities for improving education, making it more accessible, inclusive, and focused on the needs of each student.

1.2. Current state of student progress monitoring systems in the world

Modern systems for monitoring student progress worldwide are undergoing significant evolution due to the implementation of cutting-edge technologies such as big data analytics, artificial intelligence, and machine learning. These technologies allow not only the automatic collection of large volumes of student data but also the deep analysis of this data to create personalized recommendations and adapt learning programs.

One of the main areas of development is the integration of data analytics into educational platforms. Student progress monitoring systems now cover not only

traditional assessment criteria, such as test and exam results, but also additional indicators, such as student activity on the platform, time spent on tasks, participation in group discussions, frequency of completing exercises, and other metrics. This allows for a more comprehensive understanding of each student's progress.

One of the biggest innovations is the use of adaptive learning systems, which, based on data analytics, automatically adjust learning materials. For example, such platforms can automatically lower or increase the difficulty level of tasks depending on how quickly a student masters the material. This approach allows for providing each student with a personalized learning path, significantly improving the effectiveness of the educational process.

Thanks to the use of machine learning, modern platforms can predict future student success based on their current results. For example, if a student frequently makes mistakes in certain sections of the course, the system can promptly alert the instructor or provide the student with additional resources to review the material. This approach helps prevent falling behind in the course and also adapts the materials to meet the real needs of each student.

In addition, modern educational technologies actively use large amounts of data to create systems that help not only assess the current progress of students but also predict their future learning. For example, platforms can analyze how much time a student spends on each type of task, how often they return to old materials, to determine their tendency toward a particular learning style [3].

In particular, in countries where online education is actively developing, such as the United States, the United Kingdom, and others, platforms like Coursera, EdX, and Khan Academy are widely used, providing students with access to adaptive courses. These platforms use powerful progress monitoring systems that allow real-time tracking of student success, providing accurate recommendations and ensuring personalized assistance.

Progress monitoring systems are also actively used in universities to assess not only academic achievements but also the overall success of students in the learning process. They allow instructors to receive analytical reports on student activity, their level of understanding of the material, and the need for additional support. This enables instructors to more effectively adjust curricula and provide timely interventions in cases of students falling behind [4].

A particularly important aspect is the growing use of mobile technologies for monitoring student progress. Mobile learning apps allow students to instantly access their grades, test results, and statistics on their activity on the platform. This enables students to directly influence their learning process, making it more interactive and outcome-oriented.

In the broader context, student progress monitoring systems are actively being integrated into educational technologies, and their development continues. The main goal is to create systems that not only record learning outcomes but also adapt the learning process according to the real needs of the student. These technologies not only enhance the effectiveness of learning but also promote a deeper understanding of each student's strengths and weaknesses, while providing tools for self-improvement [5].

1.3. Current state of student progress monitoring in Ukraine

The implementation of monitoring information systems in Ukrainian universities and schools began to grow actively after the COVID-19 pandemic, when remote learning became an integral part of the educational process. Online platforms such as Google Classroom, Moodle, and Microsoft Teams are widely used for organizing learning and tracking student progress. These platforms allow data collection on academic performance, activity, task completion, and even student engagement in discussions and learning activities. Such tools provide instructors with the ability to see which students are facing difficulties and offer timely assistance [6].

Ukraine is also actively developing electronic gradebooks and diaries, which are being implemented in general education schools. These systems allow parents and teachers to quickly access students' grades, attendance, and homework completion. Such automation of data collection enables real-time assessment of performance and provides insights into student progress. It is also an important tool for ensuring transparency in the educational process.

One of the challenges faced by the progress monitoring system in Ukraine is the lack of sufficient funding to implement modern technologies in all educational institutions. Many schools and universities still do not have access to powerful analytics systems that could automatically collect and analyze student learning data. Most institutions rely on relatively simple methods, such as standard testing and traditional grading, which do not fully capture the dynamics of student progress. This approach may limit the potential for a personalized learning approach, as it does not take into account the multifaceted aspects of a student's development [7].

However, there are examples of innovative approaches being implemented by individual educational institutions and projects. In particular, some Ukrainian universities have begun to implement adaptive learning platforms that integrate analytics to track student progress and adjust learning materials. These platforms are based on the analysis of data from test results, activity in the learning process, and the assessment of specific knowledge gaps in students.

Despite some challenges, there is a growing interest in using data analytics in the learning process in Ukraine. Some Ukrainian universities have started using machine learning to analyze student success data and predict their future progress. These technologies allow for building personalized learning paths based on student results and forecasting potential difficulties a specific student may face.

At the same time, much of the work of implementing modern monitoring systems falls on individual enthusiasts and educators who aim to improve the quality of learning in their classrooms or universities. Not all educational institutions have equal

opportunities to use modern technologies, which creates a certain inequality in the quality of the learning process between urban and rural schools.

Thus, the current state of student progress monitoring in Ukraine is characterized by the active implementation of information technologies, but with certain limitations related to funding and the availability of technologies. There are positive examples of using platforms for remote learning, electronic gradebooks, adaptive platforms, and mobile apps that allow for monitoring student success and providing a more personalized approach to learning. However, for further development in this area, there is a need for more active involvement of public and private investments to ensure equal opportunities for all educational institutions in Ukraine.

1.4. Analysis of methods and technologies for monitoring student progress for English language learning platforms

With the spread of online education, platforms for learning English have become an important part of the learning process. One of the key aspects influencing the effectiveness of these platforms is the student progress monitoring system. Such a system allows not only assessing student performance but also adjusting the learning process, providing a personalized approach for each user. In this context, the use of various methods and technologies for monitoring student progress is crucial, as it provides accurate and useful data for optimizing learning.

However, data analytics on language learning platforms requires improvement. Although many such platforms use tools to collect data and track student progress, only a small number provide detailed visualization of analytical data, which is crucial for effective interpretation of results. This issue becomes especially important when considering learning platforms aimed at personalizing education and creating conditions for students' self-improvement.

The problem is that many platforms are limited to only basic data, such as an overall test score, without detailed analysis and visualization of these results. This approach does

not allow users, whether students or instructors, to clearly understand which specific aspects of the learning material they have mastered well and which topics they need to improve their knowledge in.

Data visualization [9] is an important tool that allows complex information to be presented in a clear and understandable way. Using charts and diagrams can significantly improve users' ability to interpret their achievements. Instead of just receiving numbers or simple grades, users can see their progress on graphs and understand which specific topics they have succeeded in and where additional effort is needed. Interactive elements can allow students to explore their results independently, view test details, or see overall trends in their learning, which enhances motivation and promotes more meaningful learning.

Without detailed data visualization, users may feel that their learning progress is not being properly evaluated, which can lead to decreased motivation or even abandonment of the platform. Therefore, it is important for language learning platforms to integrate advanced analytics with high-quality visualization to provide more effective and motivating learning. As a result, with this approach, platforms can not only provide more detailed information about achievements but also help students better understand how they can improve their knowledge, making the learning process more transparent and adaptive.

Thus, for effective student progress monitoring, it is necessary to improve analytics on language learning platforms by integrating advanced visualization methods. This will allow users to obtain more accurate and useful data for further learning.

1.5 Conclusion to the first section

The development of student progress monitoring systems in education has changed a lot over time, starting from simple paper-based assessments to using advanced technologies like big data, artificial intelligence, and machine learning. At first, these systems only used basic evaluation methods, but with the rise of computer-based

assessments in the mid-20th century and the growth of e-learning platforms, there was more potential for deeper data analysis and personalized learning. Today, modern systems can collect a lot of data on student performance, predict student success, and adjust learning content to meet individual needs. However, challenges like data privacy, the effectiveness of analytical models, and unequal access to technology in some areas still exist.

In Ukraine, the use of student progress monitoring systems grew rapidly after COVID-19, with platforms like Google Classroom and Moodle becoming widely used in universities and schools. Although there are some good examples of adaptive learning systems and data analytics being used, there are still challenges due to limited funding and access to technology. However, interest in using data analytics for personalized learning is growing, and more investments are needed to ensure equal opportunities for all educational institutions in Ukraine.

Overall, the development of student progress monitoring systems has improved the quality of education by giving teachers the tools they need to make informed decisions and improve teaching methods in real time. As technology continues to advance, the ability to tailor education to the individual needs of students is expected to become even more precise, making learning more accessible, personalized, and effective.

SECTION 2: DESCRIPTION OF COMPLEX TASKS AND ANALYTICAL METHODS

2.1. Overview of modern methods of analysing student progress

Modern methods of student progress analytics have become an essential element of educational technologies, as they provide deep insights into the effectiveness of the learning process and offer the possibility of a personalized approach to each student [10]. In a world where technology is rapidly evolving, student progress analytics has started to play a key role in educational platforms, particularly in online education, allowing for the creation of personalized learning paths based on collected data. Technologies such as Big Data [11], artificial intelligence, and machine learning have significantly changed the approach to monitoring student success and have enabled the development of new methods and tools for more effective assessment of learning outcomes.

One of the main methods of student progress analytics is the use of learning monitoring platforms that include various tools for collecting data about students. These platforms gather information about student performance at different stages of learning, considering not only test and exam grades but also other important aspects, such as activity on the platform, time spent on tasks, interaction with learning content, and attendance. This method allows for a comprehensive Figure of a student's progress, including their strengths and problem areas [8].

Data visualization methods not only allow for effective tracking of student progress but also provide instructors and students with easy access to learning results through charts, diagrams, and interactive reports. Data visualization helps to clearly understand which aspects of learning need improvement, enabling timely action to enhance results.

Currently, many language learning platforms use tools to track student data and progress. However, only a few of them offer detailed visualization of analytical data, which allows students and instructors to effectively assess and interpret achievements. Visualization, including charts, diagrams, and interactive reports, can significantly

improve the learning process by helping users better understand their strengths and areas for improvement.

2.2. Analysis of methods for assessing students' activity and their results

Assessing student activity and their results is an important component of modern educational platforms. It provides not only data on students' knowledge levels but also evaluates their participation in the learning process, interaction with the materials being taught, and overall motivation for learning. Activity assessment is essential for creating personalized learning paths, allowing for a more accurate identification of students' strengths and weaknesses, as well as timely adjustments to the learning process [12].

One of the main methods for assessing student activity is monitoring the time spent on the platform [13]. This method allows determining how much time a student spends on learning, completing tasks, and taking tests. This indicator can be important for evaluating the level of student engagement in the learning process. If a student spends little time on the platform, it may indicate low motivation or difficulties in mastering the material. However, it should be noted that time spent is not always an accurate indicator of learning success, as the quality of tasks completed and test results are also important factors.

Another method for assessing activity is counting the number of tasks and exercises completed. Evaluating not only the quantity of tasks but also their difficulty and effectiveness provides a deeper understanding of the student's level of activity. Completing tasks is an important indicator of participation in the learning process, and the more tasks a student completes, the more engaged they are. However, it's not just the number of tasks that matters, but also their quality—whether the student completes the tasks correctly and whether they reflect their true level of knowledge. Therefore, evaluating the results of tasks and exercises should be combined with other activity indicators.

Another important method is analyzing the student's interaction with the learning material. This can include the number of video views, the frequency of using additional materials such as textbooks or articles, as well as participation in discussions and forums on the platform. Such activity not only indicates the amount of time spent on learning but also the depth of the student's engagement in the process of mastering the material. Students who actively interact with the material are likely to achieve better test results, as they are not just going through the content but are actively processing and applying it.

The use of data analytics [14][15] to assess student activity and their results has become an important innovation in recent years. Systems that apply big data allow for the collection of vast amounts of student information, which is then analyzed using machine learning algorithms. This not only enables the monitoring of current results but also predicts future achievements. For example, the system can, based on the student's history of success, identify potential issues and suggest additional tasks or materials to improve results.

Test result analysis is also an important method for assessing student progress. Tests and exams are traditionally used to evaluate students' knowledge; however, they can be combined with other methods to get a more accurate Figure of success. For example, tests that include different types of tasks—ranging from open-ended questions to multiple-choice—allow for evaluating not only knowledge but also students' analytical abilities, their capacity to understand context, and their ability to apply the information they have learned.

The modern methods for assessing student activity and their results allow for creating a comprehensive Figure of the learning process, considering both quantitative and qualitative aspects. The use of various methods, such as activity assessment, interaction with materials, platform behavior, and data analytics, enables the creation of personalized learning strategies that enhance the effectiveness of the learning process. All these methods together provide an accurate and efficient assessment of student progress, which is a crucial condition for improving the quality of education.

2.3. Using data analytics to predict student success

Data analytics is a powerful tool that is actively used in various fields, including education. Specifically, using analytics to predict student success opens up new opportunities for improving the learning process, helping instructors and educational administrators provide more personalized and effective learning strategies. Predicting student success with data analytics allows for identifying not only current strengths and weaknesses but also forecasting future achievements, which significantly improves the organization of the learning process and ensures timely support for each student.

One of the main applications of data analytics is predicting test results [16]. Analyzing data on how students perform tasks and tests allows for the creation of models that predict future success based on their historical achievements. For example, if a student consistently receives low scores in certain categories of tasks, the system may predict that they will struggle to achieve high results on the final exam. Based on such predictions, timely interventions can be made in the learning process, offering the student additional resources or alternative learning methods to improve their results.

Machine learning models are an important tool in predicting student success. The application of such methods allows for the automatic analysis of vast amounts of data, such as student grades, time spent on tasks, activity on the platform, and other parameters. Using machine learning algorithms, a model can be created that makes predictions about how a student will perform on future tasks or assessments based on this data. For example, these algorithms can estimate how successfully a student will complete a course or what grade they will receive on the final exam, enabling better planning of the learning process.

Another important aspect is the use of big data analytics [17] to analyze student behavior. Web analytics allows tracking how students interact with learning materials, when they log in to the platform, how much time they spend on tasks, and whether they return to old materials for review. All this data can be used to predict student success, as platform activity can indicate the level of student engagement in the learning process. If a student shows low activity or does not interact with the platform frequently enough, it

may signal that they will struggle to achieve high results, and the system can recommend additional resources or motivational measures.

Data analytics also allows for forecasting based on comparing students with different characteristics, such as study time, past achievements, and test results. Creating such models enables not only predicting the success of a specific student but also comparing their results with those of other students, which helps determine their standing within the group and forecast their future development.

By using data analytics to predict student success, instructors gain new tools for responding quickly to potential issues. The system can automatically identify students who are at risk of failing the course or who need additional help, allowing for timely support and a personalized approach. Such predictions not only improve student success but also reduce dropout rates, as they help identify problems early and work on resolving them.

Personalized recommendations, created based on data analytics, are another important element in predicting student success. These recommendations can be provided as automated messages or tasks that adapt to the student's needs and progress. For example, if a student performs poorly on a particular topic, the system might offer additional resources to help them better understand that topic. This allows for the creation of an individualized learning plan for each student, significantly improving their results and helping them achieve better academic outcomes.

Thus, the use of data analytics to predict student success is an important aspect of the modern learning process. It allows for the creation of personalized learning paths, optimization of the learning process, enhancement of educational platforms, and helps students achieve high results. Data analytics not only enables the assessment of current student progress but also provides the ability to predict their future success, allowing for timely interventions to improve results and the learning experience as a whole.

2.4. Overview of existing English language learning platforms

With the development of technology and access to online resources, learning foreign languages has become much more accessible. Platforms for learning English have gained great popularity among people of all ages and from different parts of the world.

They offer a variety of learning methods, self-assessment tools, and opportunities for interactive engagement, making the language learning process convenient and effective. Today, there are many platforms that help learners master English, and each of them has its unique features and advantages.

Duolingo

One of the most well-known platforms for learning English is Duolingo [18]. It is a free platform that allows users to learn a language through interactive exercises. Duolingo uses gamification to motivate learners: the platform includes points, levels, and rewards, making the learning process fun and engaging. The platform offers courses for both beginners and advanced learners, covering all the main aspects of language learning: grammar, vocabulary, pronunciation, and listening. Additionally, Duolingo has mobile apps for iOS and Android, allowing users to learn English anywhere and anytime. However, while Duolingo is a popular tool for beginners, it may be less effective for deeper language mastery, as the system does not provide enough challenging materials for more advanced students.

On the main page of Duolingo, there are several key elements that provide the user with easy access to different features of the app. On the left is the navigation menu, which includes icons for various sections, such as the homepage, sounds, leaderboards, quests, store, profile, and additional options. In this case, the "Learning" tab is active, highlighted in blue. This lets the user know that they are currently in the learning process.

In the center, the current learning section is displayed. It is titled "Discuss traveling solo," indicating the lesson's topic, and there is a "START" button that can be clicked to begin the lesson. It also shows the user's progress, including their current status in the

"Silver League," and specifies the daily task, which requires earning 10 points by completing quests.

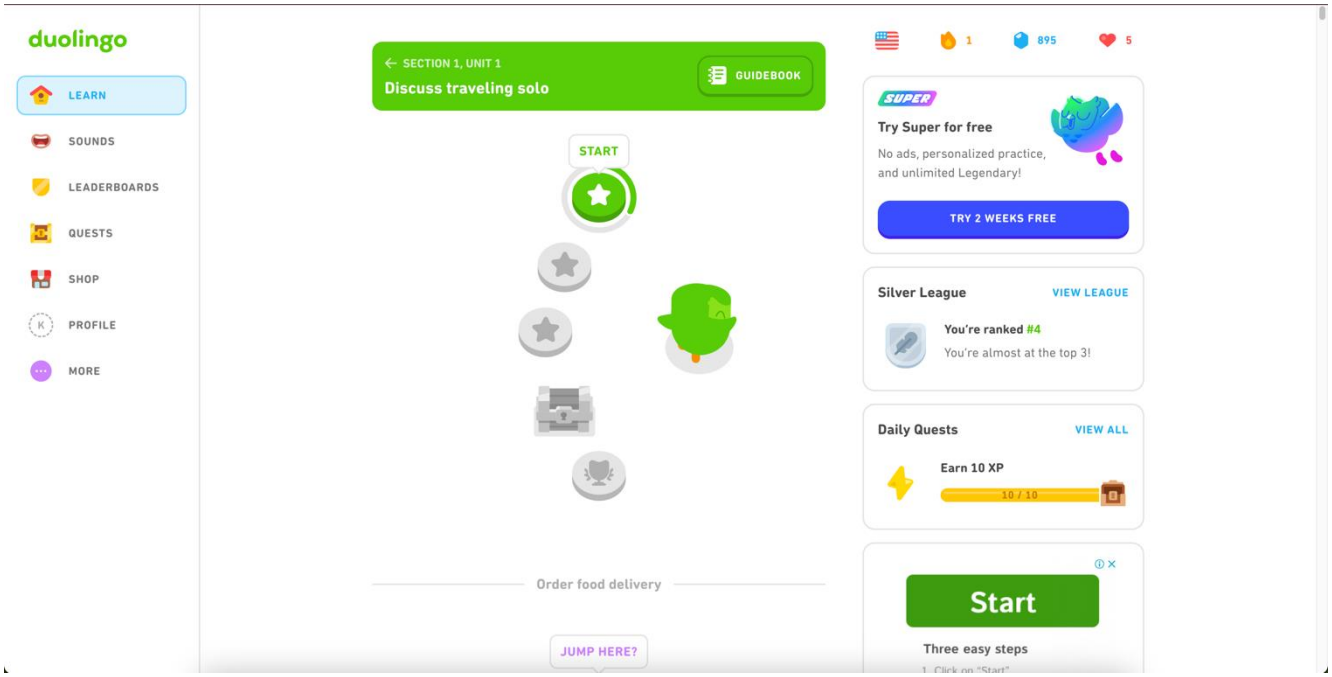

Figure 2.1 - Home page of the Duolingo platform

Figure 2.2 is part of the first section of the Duolingo course, which focuses on learning grammar and key phrases related to travel. It features the phrase "Discuss traveling solo," which is the topic for this section. The user has the opportunity to listen to several key phrases used in the context of solo travel.

Each phrase is accompanied by an audio recording, allowing the user to hear the correct pronunciation.

The page structure not only helps the user learn useful expressions but also develops listening skills by listening to each phrase and then repeating it.

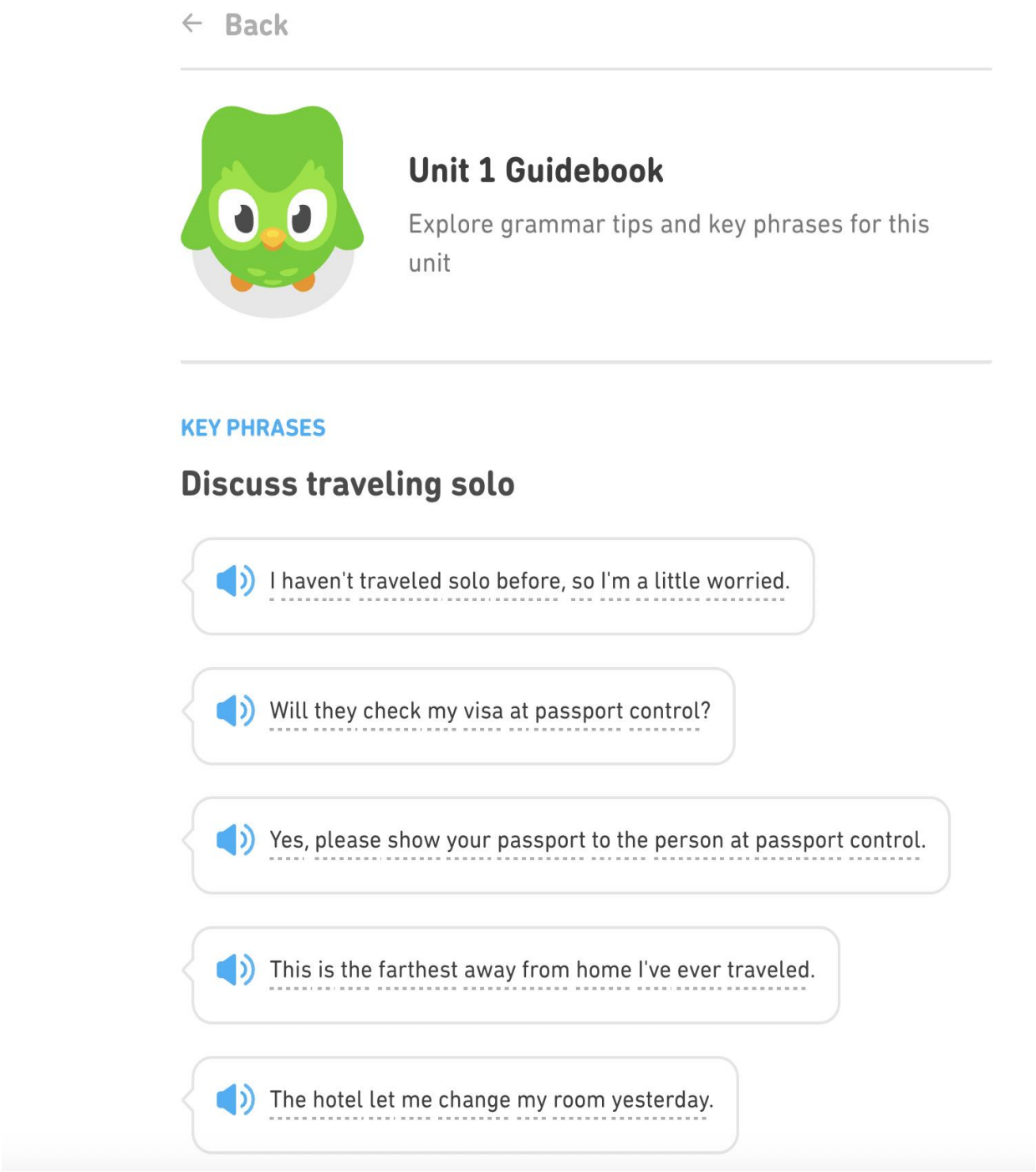

Figure 2.2 - Guidebook on the Duolingo platform

Figure 2.3 shows the statistics and achievements on the Duolingo platform. This part of the page displays statistical data, including the number of days the user has been actively learning, as well as the total number of points the user has earned — 2439. Additionally, it indicates that the user is in "Week 1" of the current section and holds a

status in the "Silver League." The information also shows that the user has not yet made it into the top 3 of the league.

Below is the achievements section, where progress can be viewed. In the "Fire" category, the user has reached level 2 by completing tasks related to achieving 7 consecutive days of learning. The progress in this category stands at 4 out of the 7 required steps. In the "Wise" category, the user has reached level 6, earning 2465 out of the 4000 required points. In the "Scientist" category, the user is at level 9, having learned 1305 out of the 1500 words required for the course.

This Duolingo page provides the user with an overall analysis of their progress in learning, but it does not focus on identifying specific areas that need improvement. Information about the number of points, achieved levels, and completed tasks offers a general Figure, but it does not highlight weaknesses or areas where the user may have difficulties. There is no specificity regarding whether there are gaps in learning certain topics or language aspects, such as grammar, vocabulary, or pronunciation.

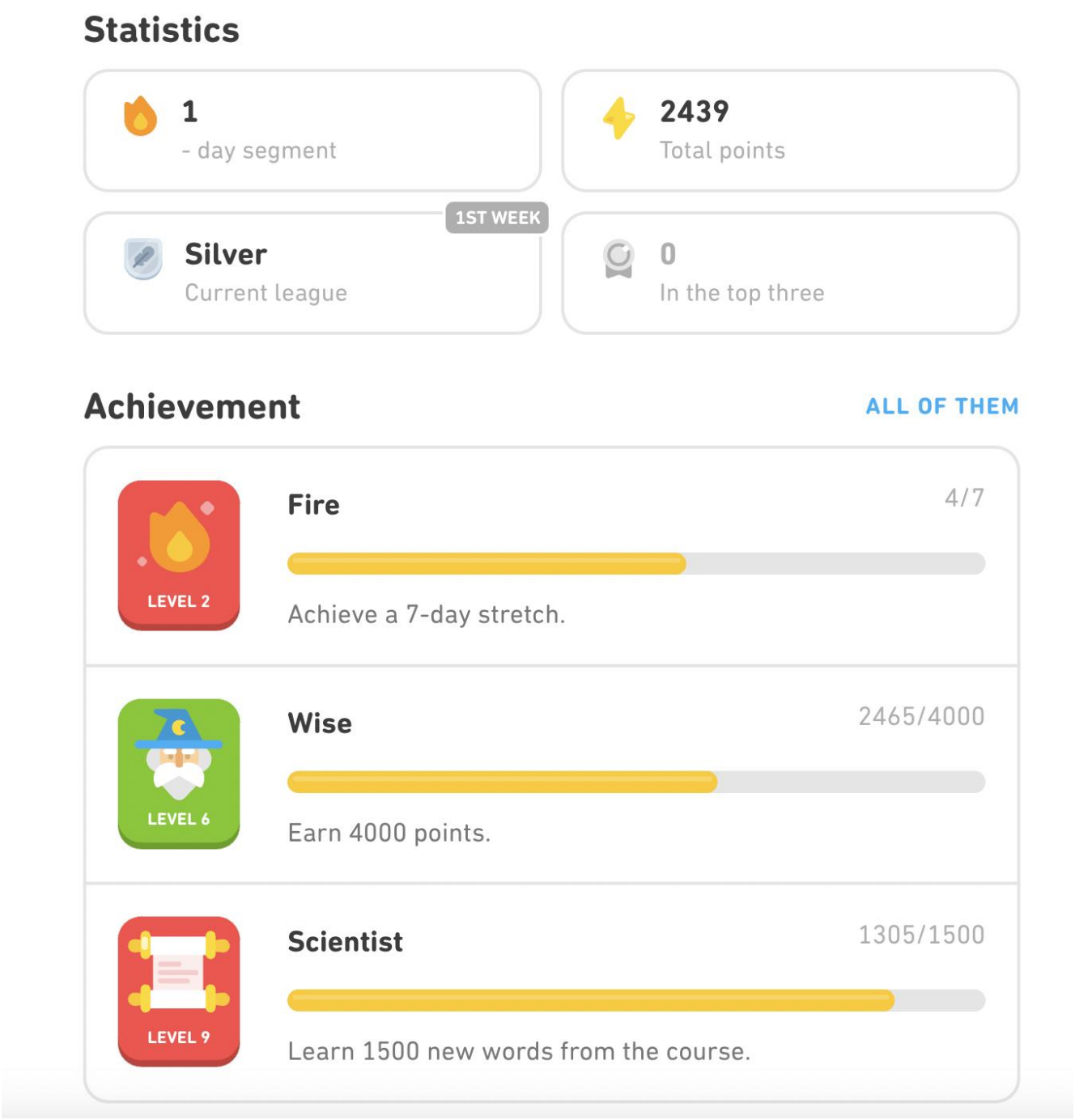

Figure 2.3 - Statistics and achievements on the Duolingo platform

In the next Figure 2.4, the International Phonetic Alphabet (IPA) for learning English vowel and consonant sounds is displayed. The "Vowels" section includes a variety of vowel sounds. Each sound is accompanied by an example from a specific word, helping the user understand how that sound is pronounced in words.

For each symbol on the card, there is a graphical indicator showing the level of progress in mastering that sound through a test. Figure 2.4 illustrates this.

The "Consonants" section includes consonant sounds as well as other sounds typical for the English language. Like in the vowel section, each consonant sound is also accompanied by an example, which helps the user understand the pronunciation and application of the sound in words.

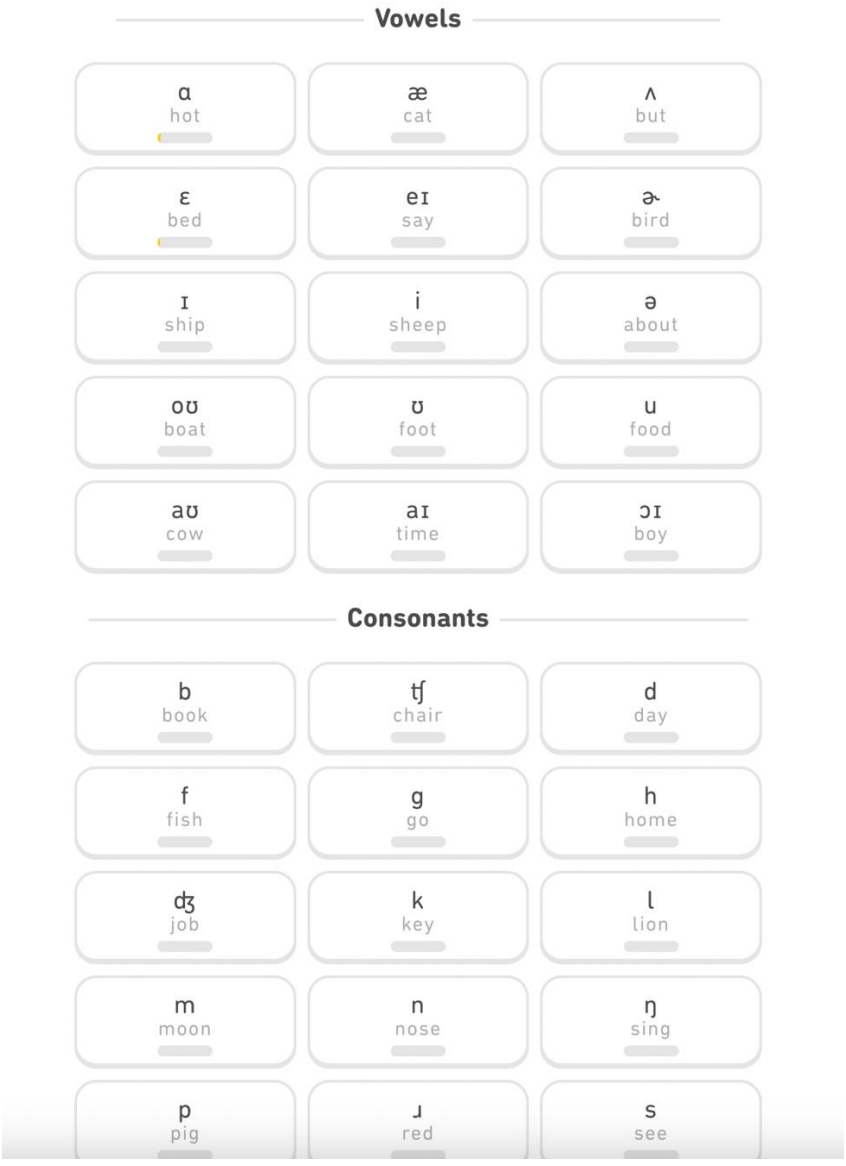

Figure 2.4 - International phonetic alphabet on the Duolingo platform

Figure 2.5 is part of a listening test to check the recognition of phonetic sounds in English. The user is asked to listen to a recording and choose which of the two words they

heard. At the top, there is a speaker icon, which allows the user to listen to the sound related to the question. The user must select one of the two options that corresponds to the word they heard, distinguishing the sounds.

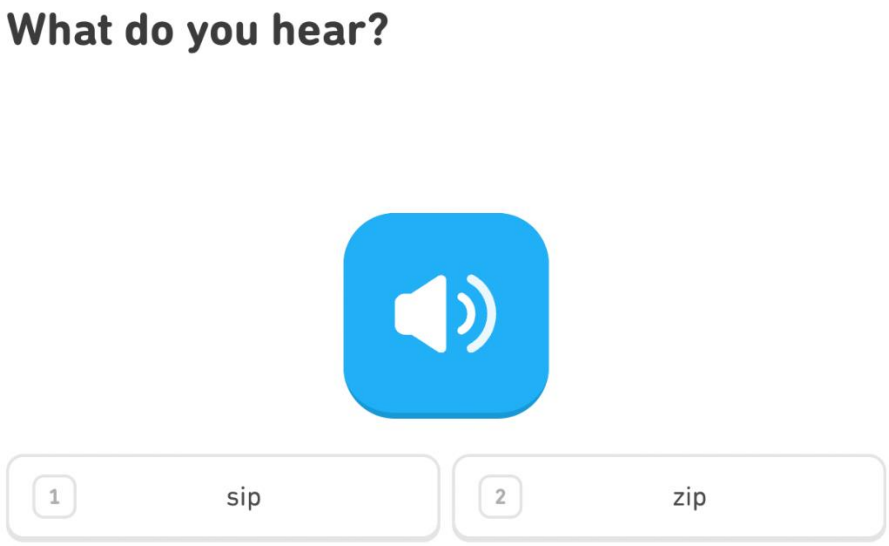

Figure 2.5 - Phonetic sounds test

This page is part of a Duolingo test aimed at checking listening skills and word recognition. It includes the instruction "Tap what you hear," requiring the user to select the correct word from a list that matches the sound they heard. There are two audio playback buttons: one with a speaker, which plays at the standard speed, and another with a turtle icon, which reduces the playback speed for better comprehension. After the user listens to the sound, they need to choose a word from several options, such as "the," "your," "on," "other," "friends," and others.

This type of exercise helps develop listening skills and improves word recognition, which is an important part of language learning. The user must not only correctly hear the word but also quickly find it among several options. Exercises of this kind help improve the ability to understand spoken language and also increase vocabulary by interacting with commonly used words in English.

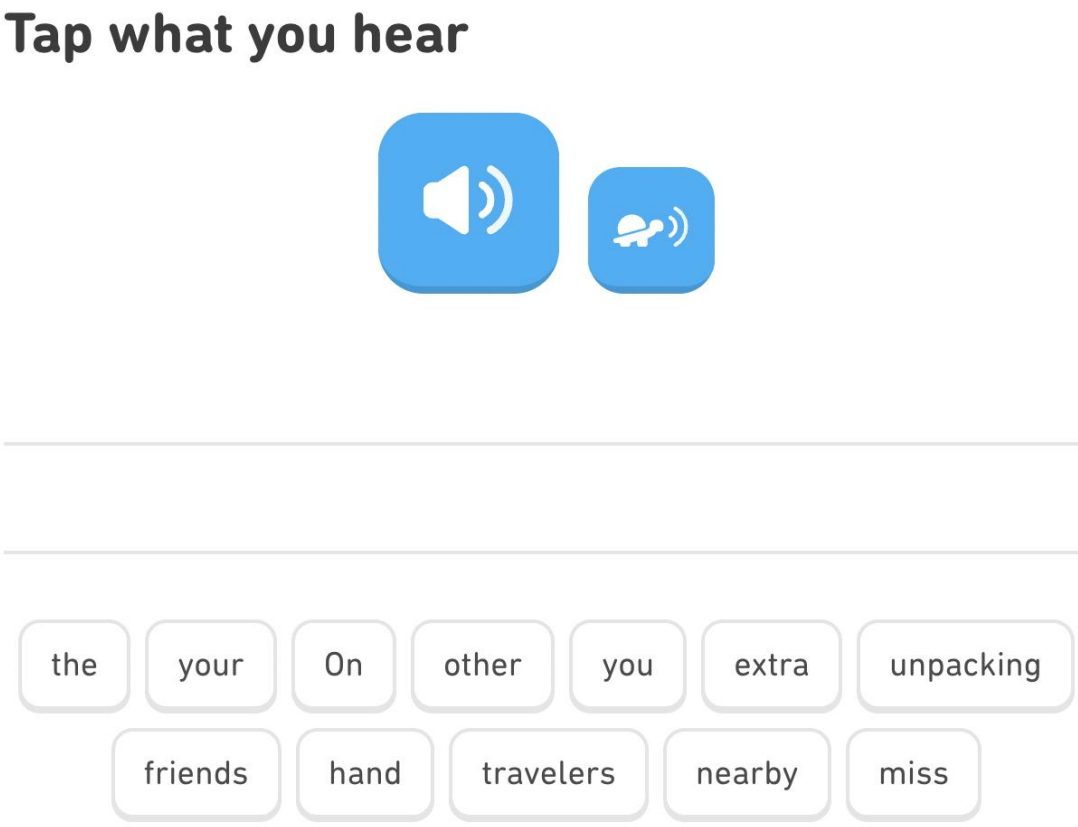

Figure 2.6 - Listening and word recognition test aimed at testing listening skills

This page from Duolingo celebrates the user's achievement for successfully completing three listening tasks within a single lesson.

Below is the statistics section, showing the total score in the form of XP (experience points), with the user earning 13 XP. It also displays an 88% score, which is a positive rating for the completed tasks, marked as "Good!" These indicators help the user understand their progress in learning and boost motivation for further lessons.

After completing the task, the user has the opportunity to review both the correct and incorrect answers, which is an important part of the learning process (Figure 2.8).

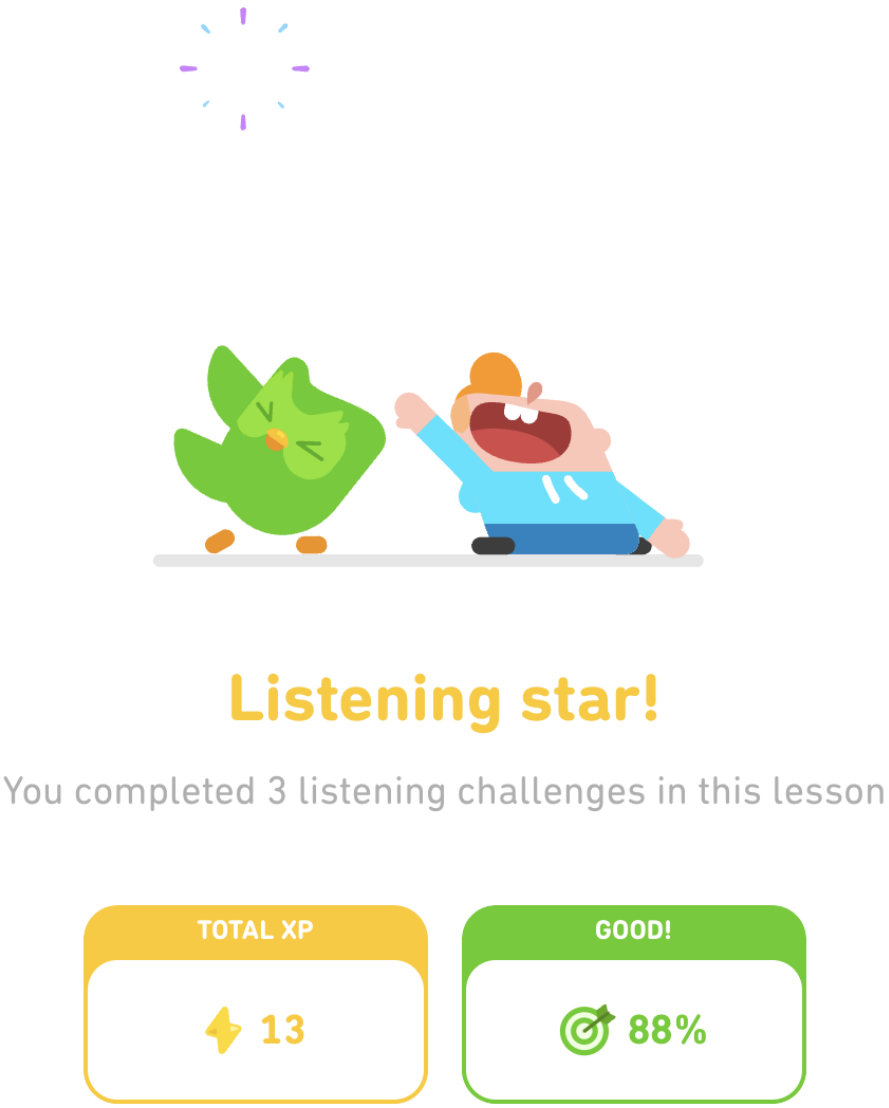

Figure 2.7 - Phonetic sounds test

This page shows the results of the test tasks on Duolingo, where the user can review the correct and incorrect answers after completing the exercises. Each task has cards that can be clicked to view the solutions and answers. Green cards represent correct answers, while red cards indicate incorrect ones.

In the "Read and respond" section, the user mistakenly answered the question incorrectly, and the correct answer can be seen by clicking on the card (Figure 2.9). At the same time, other tasks such as "Fill in the blank," "Complete the chat," and "Read and

respond" were completed correctly, and these cards are marked in green, confirming success in those tasks.

These answer cards help the user understand where they made mistakes and improve their knowledge, allowing them to revisit and review tasks for better retention of the material. Overall, the page serves as a summary of completed tasks and provides the opportunity to view details for each exercise for better learning.

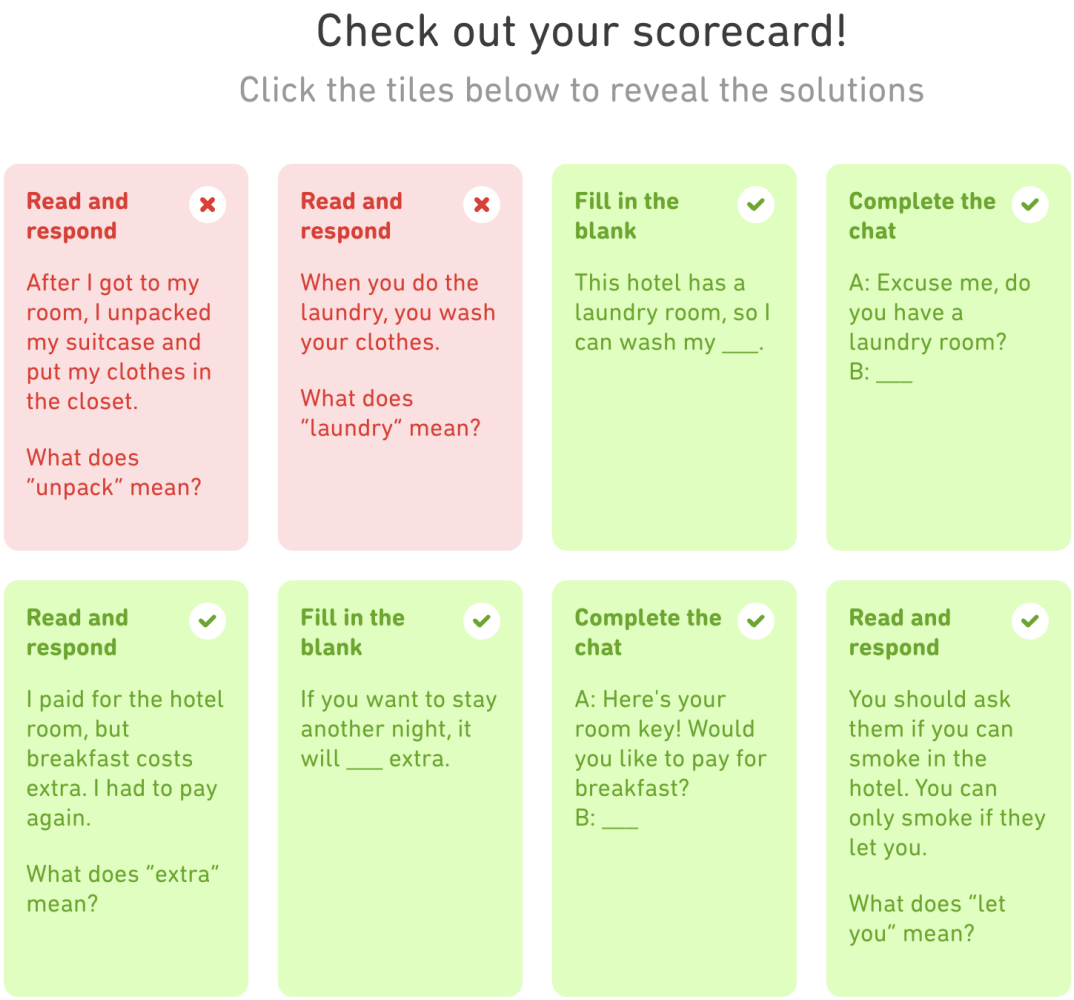

Figure 2.8 - The result of the test tasks on Duolingo

This Duolingo page shows the results of the test tasks and gives the user the opportunity to review their mistakes and correct answers. The page contains several task blocks, each with an indicator of the correctness of the answer: green cards represent correct answers, while red cards indicate mistakes.

The first task is a fill-in-the-blank exercise, where the user has to choose the correct word to complete the sentence. In this case, the user successfully completed the task and received a green card. The next task, which required explaining the meaning of the word "reserve," was answered incorrectly.

For each task, the user can see which answers were chosen incorrectly, as well as the correct options. While providing the correct answer is an important part of the learning process, it is not enough for the user to fully improve their skills. For effective learning, it is essential for the user to understand why one answer is correct and another is not. It is important that after each mistake, the user receives detailed feedback and recommendations to help them understand the errors and better grasp the material.

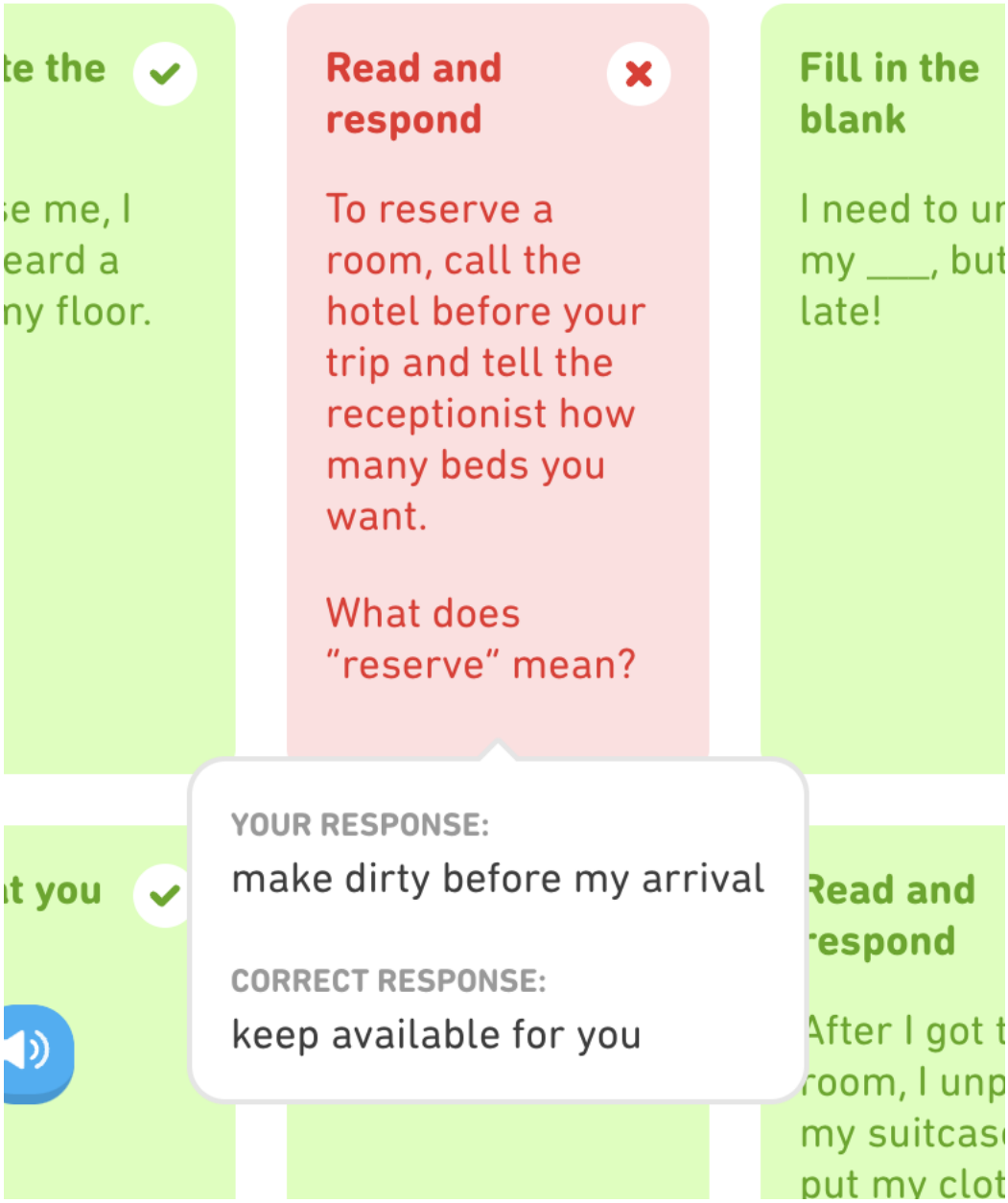

Figure 2.9 - The ability to review your mistakes and correct answers

Lingoda

Lingoda [19] is an online school offering intensive English language courses with live instructors. Using the platform, students can interact with instructors in real-time through video conferences, which helps improve speaking skills. Lingoda also provides the opportunity to receive certificates after completing courses, which is important for those who want to officially certify their knowledge. One of the key advantages of this platform is its high flexibility: students can choose courses based on their level and

schedule. However, like other similar services, a paid subscription is required for effective learning.

The page (Figure 2.10) displays the result of a completed learning stage for a specific topic, in this case, "Making changes to my routine." At the top of the page is a progress bar showing how many stages have already been completed, as well as the current status. The progress bar is filled to 100%, indicating that this stage has been successfully completed.

In the center of the screen, there is a message saying "Good try!" to motivate the user, even if the result is not perfect. Below it is a summary informing the user of their result.

This platform has tests to enhance learning and assess the level of material covered, but it lacks analytics and feedback. Therefore, it would be beneficial to improve the interface by incorporating data analytics to provide feedback on the learning process and visually show the student's progress.

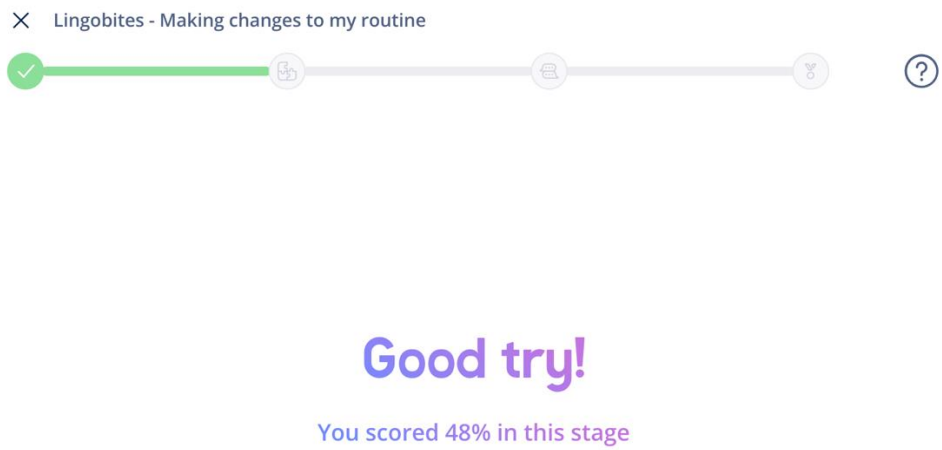

Figure 2.10 - Result of the completed training stage on a specific topic

Figure 2.11 shows a grammar training exercise focused on forming complete sentences. The user is asked to match phrases from the left and right columns to create correct, grammatically accurate sentences. This task aims to help the user improve syntax and sentence structure skills.

On the left side of the page, there are five sentence fragments, while on the right side, there are possible endings for each of them. The user must choose the correct combination from the left and right to form complete, meaningful sentences.

This exercise helps the user practice using different grammatical constructions and enhances their ability to write cohesive and logical sentences in the language they are learning.

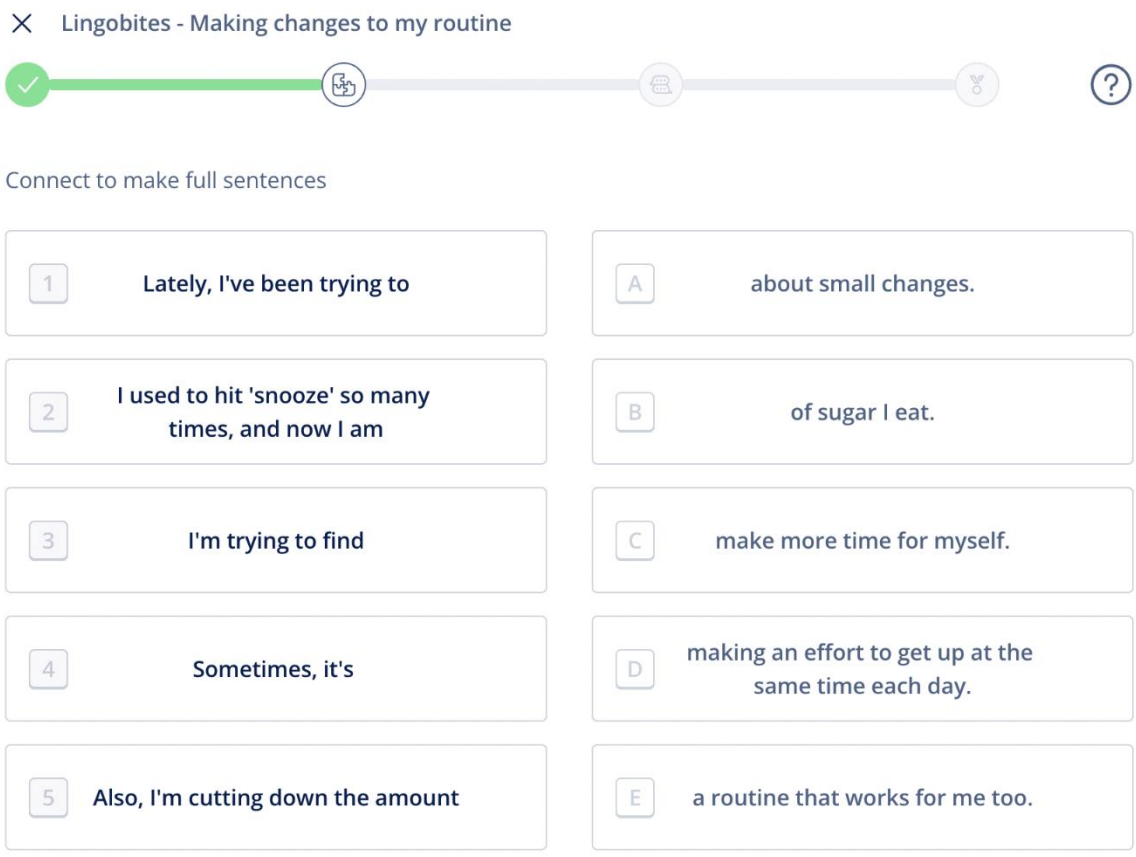

Figure 2.11 - Training in grammar and complete sentences

The result of a completed learning stage on the Lingoda platform can be seen in Figure 2.12. It shows the overall test result, where the user receives a score in the form of a percentage. Next to the percentage, there is a rating represented by stars, where the user received one out of three stars, indicating a low level of performance on the task.

Below the percentage result is a motivational message encouraging the user to continue learning, offering a review of their results and proceeding to the next stage.

At the bottom of the screen, there is a "Next" button that allows the user to move on to the next result (Figure 2.13).

Figure 2.12 - Overall test result

The main section includes three stages of the lesson: "Memory mixer," "Recall and relate," and "Grammar in action." For each stage, the percentage of the achieved result is shown, allowing the user to assess their progress at each stage. For example, in "Memory mixer," the user scored only 17%, in "Recall and relate" — 100%, and in "Grammar in action" — 33%. This helps the user understand which parts of the lesson need more focus

to improve results. However, it is not enough to identify specific gaps in the grammar knowledge of the student, such as which particular areas of grammar need attention.

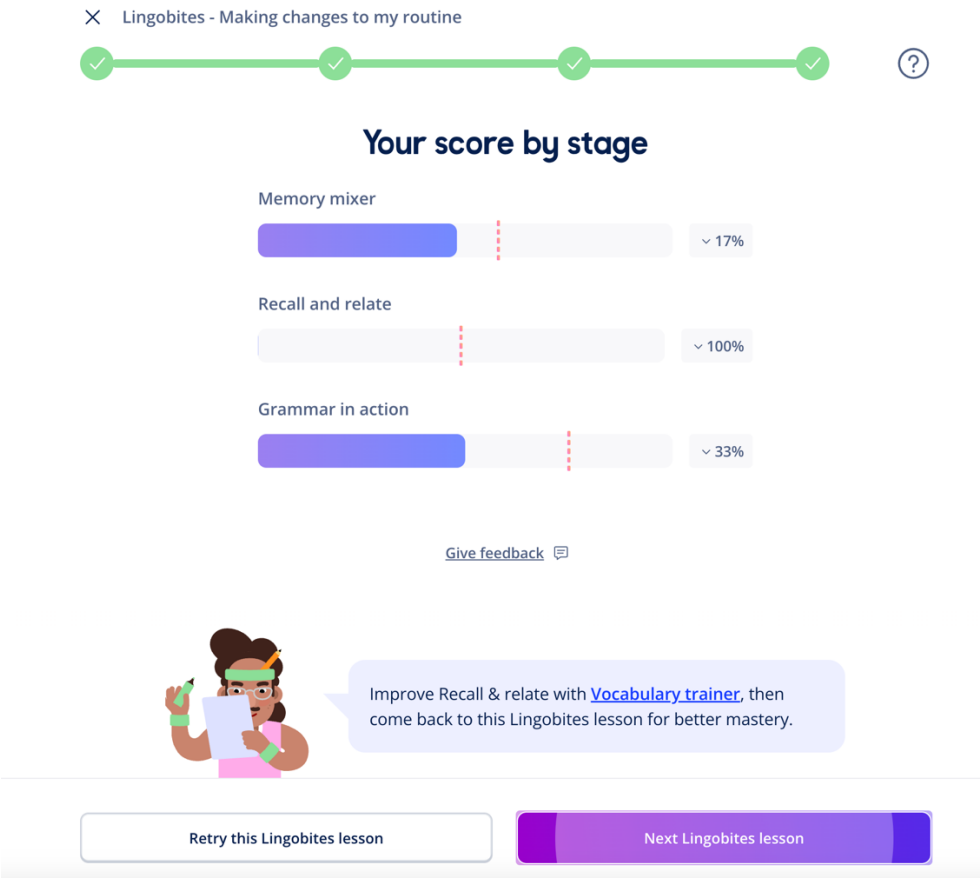

Figure 2.13 - Results of the lesson in three stages in percentage terms

For each stage, there is a graphical progress bar that shows the percentage of the achieved result, as well as a pop-up message that explains how the user performed at each stage.

In the "Grammar in action" stage, the progress bar is barely filled, indicating a low result. The pop-up message says: "You scored 33% lower than your average in this stage" (Figure 2.14).

Figure 2.14 - Graphical progress bar for "Grammar in action"

Busuu

Busuu combines traditional learning methods with interactive elements, offering students practical tasks, tests, and the opportunity to communicate with native speakers. One of the unique features of Busuu [20] is the social aspect of learning: students can receive feedback from native speakers, which not only improves their knowledge but also immerses them in the cultural aspects of the language. The platform offers both free and paid courses, with the paid versions providing additional features and materials for a deeper language learning experience.

This page of the Busuu platform shows the current progress of the user in the "Complete English" course. The course covers levels from A1 to C1, meaning it is suitable for learners with different levels of English knowledge, from beginner to advanced. The course is focused on vocabulary and grammar and takes a comprehensive approach to learning.

On the platform, there are several courses, one of which, "Complete English," is shown in Figure 2.15. The user's progress in the course is only 1%, indicating that the learning has just begun. Below the progress indicator is the "Resume" button, which allows the user to continue learning from where they left off.

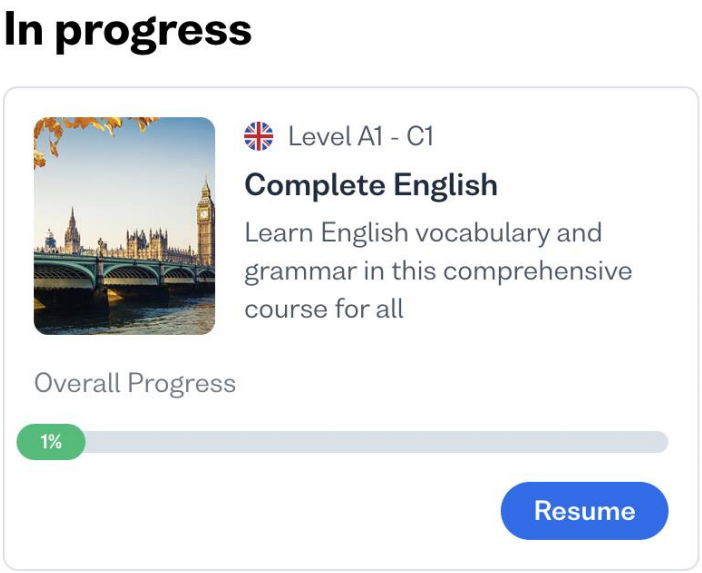

Figure 2.15 – "Complete English" course

Also, the vocabulary analytics is displayed (Figure 2.16). At the top of the page, the overall status of the vocabulary is shown with three categories: "Weak words," "Medium words," and "Strong words." In this case, all 27 words are classified as weak, indicated by a red color.

Below, there is a filter that allows the user to sort the words and view them individually. Further down the page, a list of words is shown, with each word accompanied by its English translation and a strength indicator.

In the top right corner, there is a "Review these words" button, which gives the user the opportunity to start practicing and improve their vocabulary.

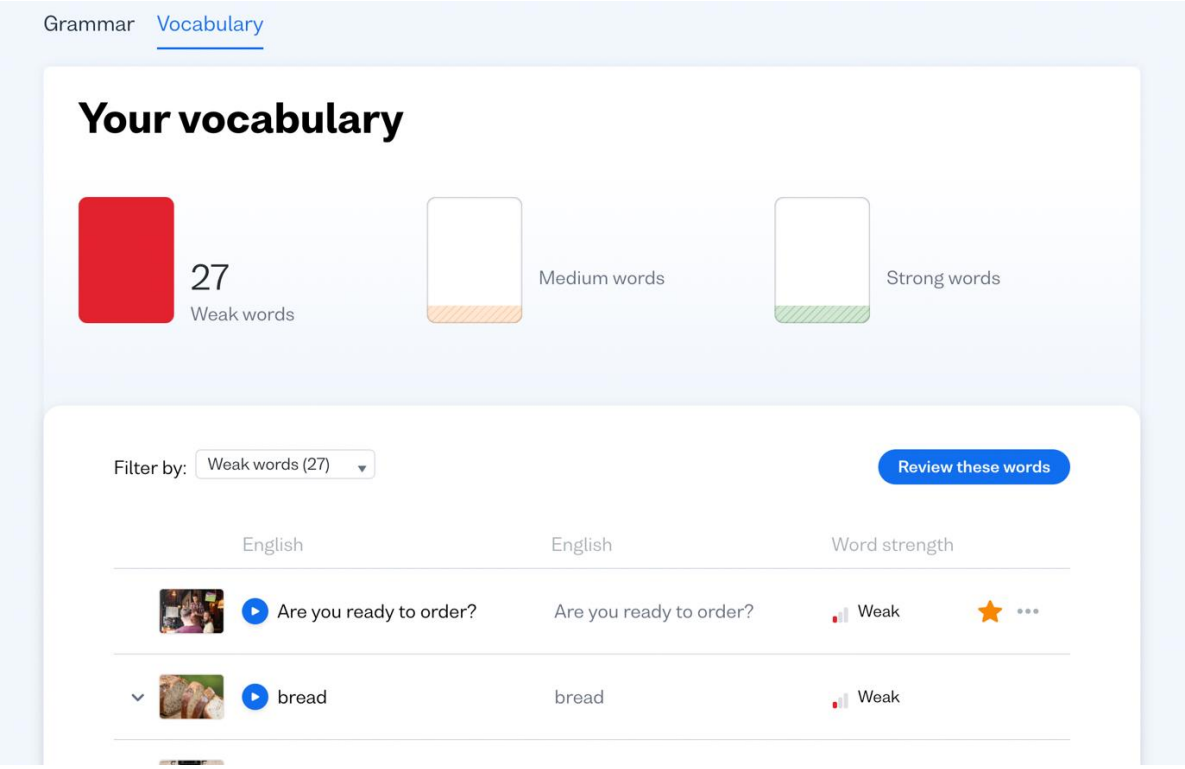

Figure 2.16 - Analytics by vocabulary

The Busuu platform provides the user with a summary of their progress in learning English. At the top of the screen, there is a graphical display of the user's overall language proficiency, which currently shows 0%, indicating a beginner level or that the user has just started learning. Next to this, it shows that the user is learning English and lists the number of words learned, which is 48.

Below the screen, there are several sections reflecting other aspects of learning. One section shows the number of certificates the user has earned, while another displays the number of corrections made by the user, as well as the number of thumbs-up and best corrections received.

At the bottom, there is a "Daily streak" section, where the user's activity throughout the week can be seen. This section shows several icons representing the days of the week, indicating on which days the user was actively learning. Currently, the user has three active days in the week.

This gives the user an overall Figure of their progress on the Busuu platform, providing visual feedback and helping them understand where they stand in the learning process. It motivates the user to continue learning and allows them to see the results of their efforts in terms of the number of words learned, corrections made, and active days achieved.

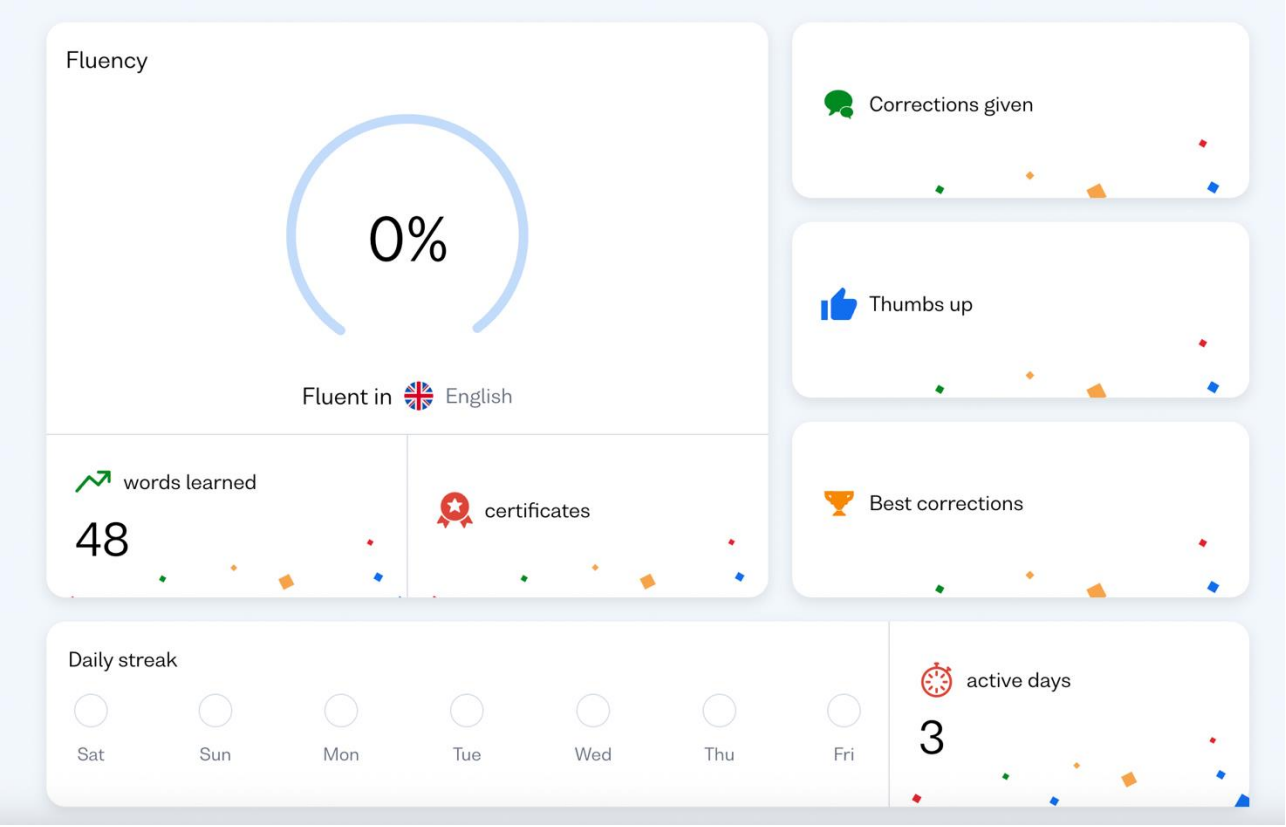

Figure 2.17 – Displaying the user's overall language fluency

Preply

Preply is an online language learning platform that connects students and teachers from all over the world through video lessons. It offers a personalized approach to learning, allowing users to choose instructors based on various criteria such as price, language, experience, and reviews from other students. The platform supports a wide range of languages, including English, Spanish, French, German, and others, enabling users from different countries to learn on their own terms [21].

Preply has an interface that makes it easy to organize lessons and track progress in language learning. Lessons are conducted via an integrated video chat, ensuring high-quality real-time learning. Teachers on the platform use various methods and materials to tailor the learning experience to the individual needs of each student.

The system also allows students to view reviews and ratings of teachers to make the right choice for effective learning. In addition, Preply offers flexibility in scheduling lessons, allowing students to adjust their learning to their own schedule.

All these features make Preply a convenient tool for those who want to learn languages through online lessons with experienced instructors, offering access to personalized lessons at any stage of learning.

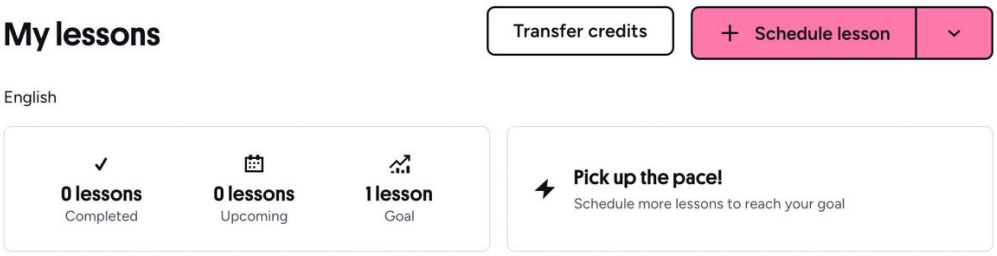

Figure 2.18 - User goal on the Preply platform

On the Preply platform, information is displayed about the lessons the user plans to take as part of their English language learning. It includes a section called "My lessons," which shows the total number of lessons. In this case, the user has not completed any lessons yet, indicated by "0 lessons Completed." However, there is one lesson planned, marked as "1 lesson Goal," which suggests that the user has set a goal to complete at least one lesson. This provides a small analytics snapshot of the number of lessons the user has completed so far.

There are also tests on four topics that the user has completed (Figure 2.19). The exercise presents a text where the user must select the appropriate word options to complete the sentences.

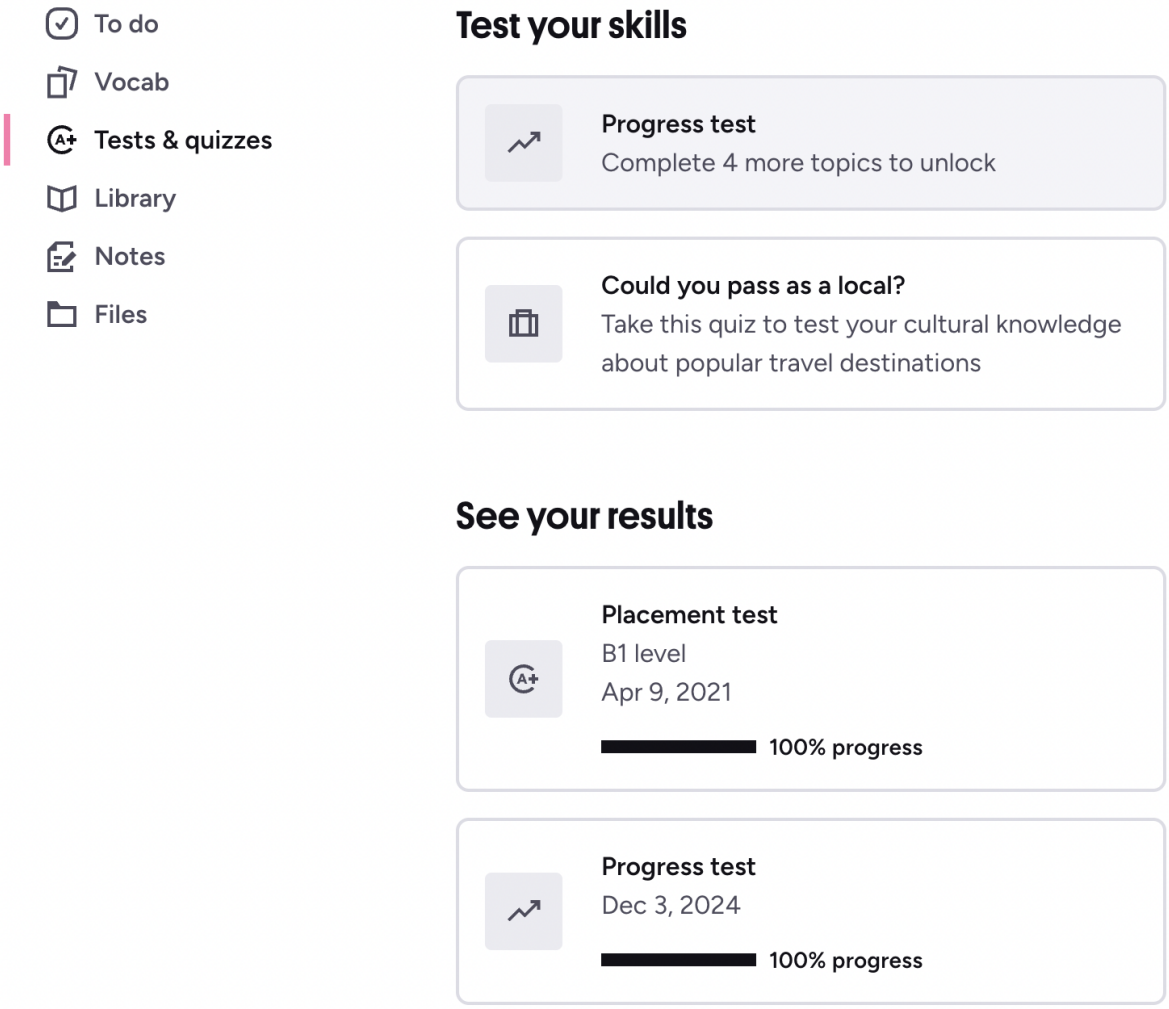

Figure 2.19 - Tests on the Preply platform

These tests require the user to not only know the meaning of words but also understand the context in which these words should be used (Figure 2.20). This exercise helps develop lexical skills, particularly the ability to use words correctly in specific situations.

Thus, the page provides an interactive approach to learning English, allowing the user to study and practice new words in context, which is an essential element of learning.

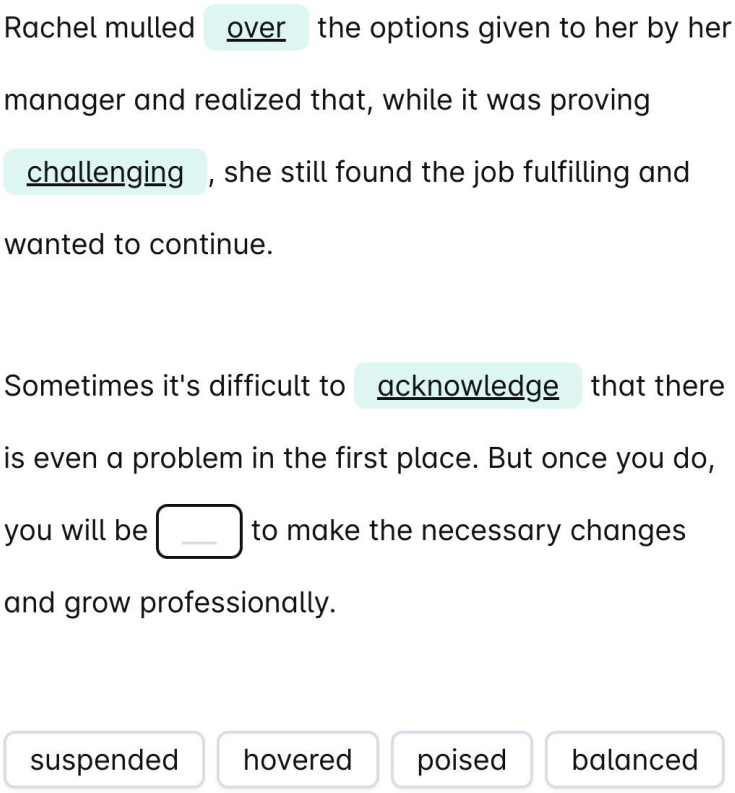

Figure 2.20 - Tests on four topics on the Preply platform

After completing the test, the user is provided with feedback on their progress in the test (Figure 2.21). It shows the percentage of correct answers, divided into categories: 70% correct answers on the first attempt, 22% on the second attempt, and 8% on the third and subsequent attempts. Based on this data, the system offers the user an additional review of specific topics that need more attention; in this case, the topic is "Talk about living and working in another country."

This helps the student track their progress and provides recommendations for improving skills in specific areas.

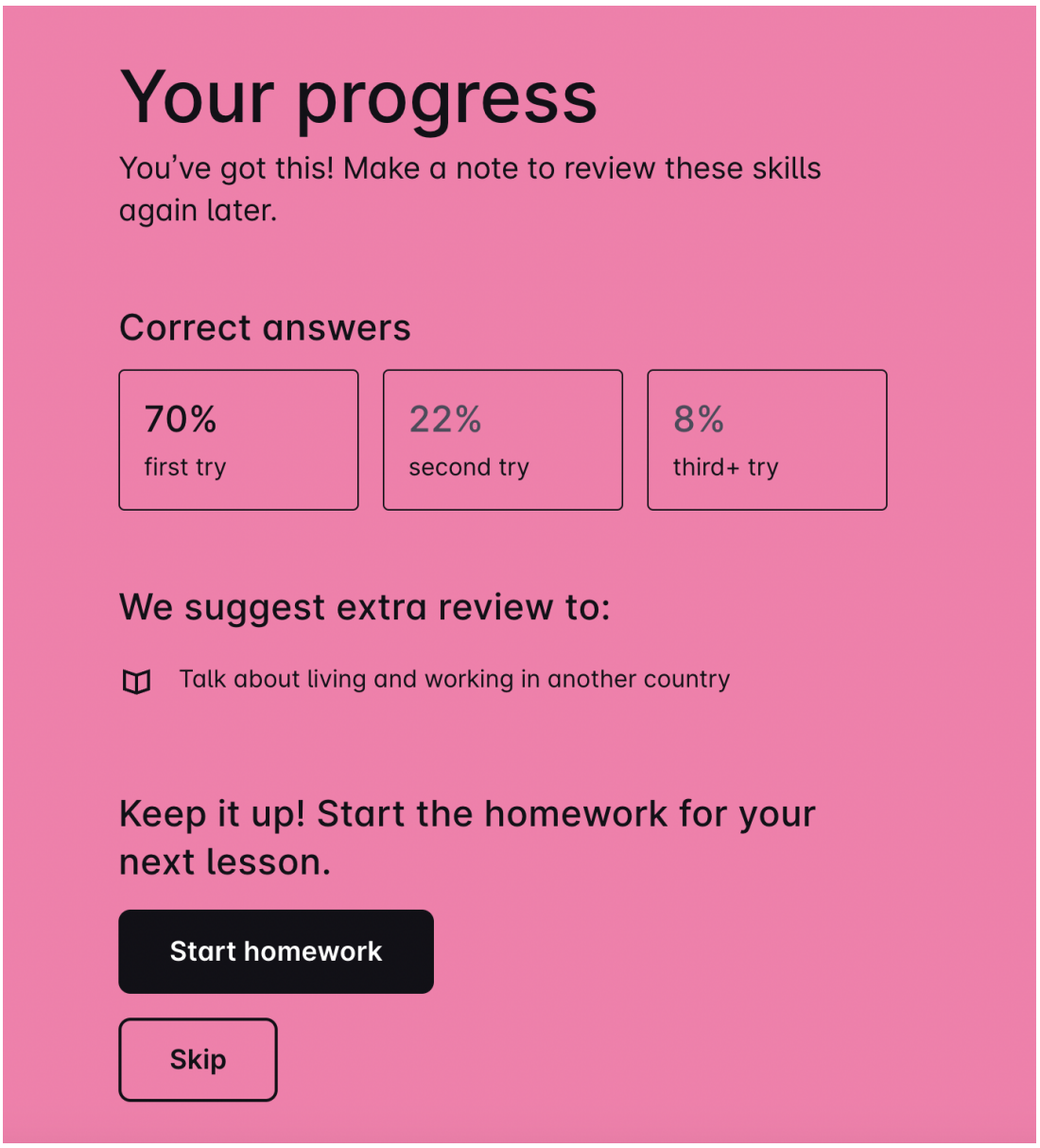

Figure 2.21 – Feedback on your progress in the test

The user also has a test for reviewing and learning words. This test helps the user assess their knowledge by providing feedback and motivating them to continue learning.

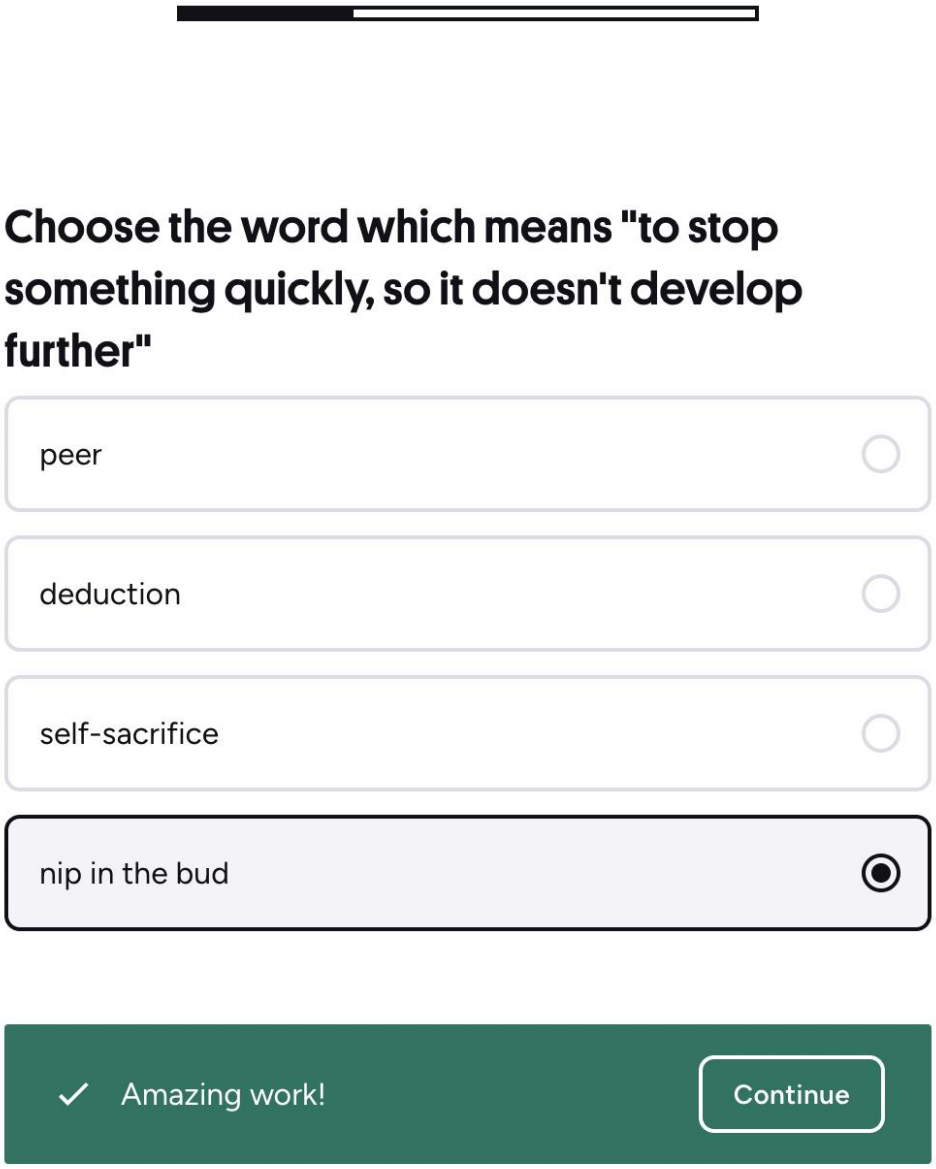

Figure 2.22 – Test to revise and learn words

After the test, the platform displays a pop-up message informing the user that they have practiced 30 words. The list of words includes various expressions, phrases, and terms.

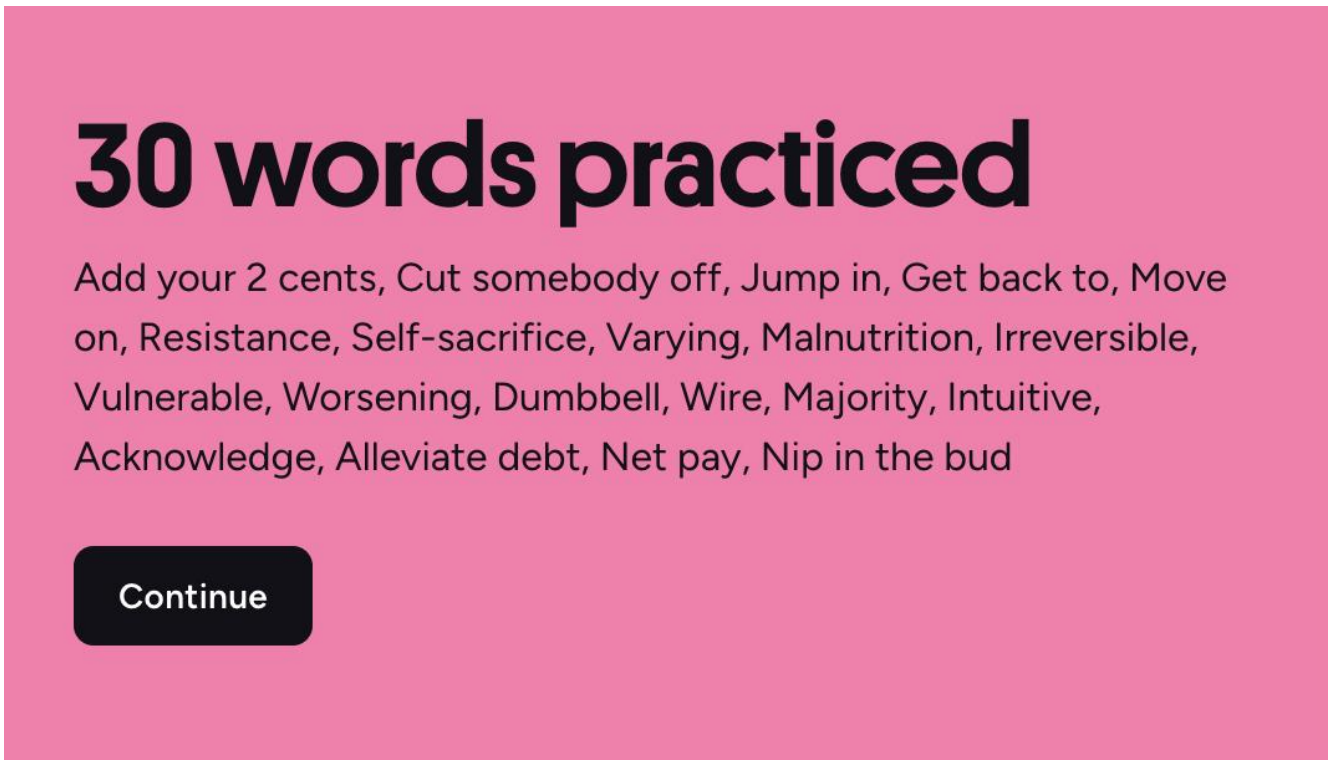

Figure 2.23 – The number of words was practised

Today there are many platforms for learning English that use various methods and technologies for effective learning. The choice between them depends on the user's individual goals: some platforms focus on quickly mastering vocabulary, others on a deep understanding of grammar, while some offer live lessons with instructors. However, despite the significant achievements in the field of online learning, it is important to remember that successful language acquisition requires not only the use of platforms but also continuous practice and motivation.

2.5Main characteristics and functionalities of each analogue and comparison with the developed platform

When comparing the developed platform with other similar platforms, such as Duolingo, Lingoda, Busuu, and Preply, several unique features and advantages of the developed system can be highlighted. The main one is the advanced monitoring of student progress. Unlike most similar platforms, the developed platform provides detailed analytics, including the number of words learned per day and month, tracking student activity on the platform, results of recent tests, and detailed analytics for each topic. These

features allow users to get a comprehensive understanding of their achievements and identify weaknesses in their learning in a timely manner.

Another important aspect is data visualization. The developed platform uses graphs, charts, and special tools like the Radial Gauge to display progress on individual topics. This allows students to better understand which topics they are struggling with and what areas need more focus. Other platforms, such as Duolingo, use gamified achievements, but they do not provide such deep data visualization on learning. Busuu, although offering adaptive lessons, lacks integrated detailed visualization tools.

As for personalized recommendations, the developed platform generates suggestions based on a detailed analysis of test results, allowing for a more individualized approach to learning. This enables students to focus on topics where they need additional practice.

Thus, the developed platform has several important advantages over existing alternatives due to its advanced data analytics, progress visualization, personalized recommendations, and reliable user data protection. These features make your platform more appealing to students who aim to achieve high results in learning English and want a personalized approach to their studies, with the ability to closely monitor their progress.

Table 2.1. Comparison of the developed platform with the reviewed analogues

Criteri	The developed system	Duolingo	Lingoda	Busuu	Preply
Monitoring progress	Detailed analytics by day, month, test, and topic	Basic progress monitoring through levels and achievements	Progress through the levels, details for each lesson	Progress through levels and lessons	Assessment of progress through individual lessons

Words learnt per day/month	Number of words learnt per day and month	No detailed word statistics are available	Learned words are not provided separately	No statistics on the words learnt	No statistics on the words learnt
Activity on the platform	Number of days of activity per month	No activity statistics are available	Statistics on lessons and attendance	No activity statistics are available	No activity statistics are available
Latest tests	Latest tests, saving results	Game achievements, saving test results	Tests after each lesson, saving results	Tests at the end of the lessons	Tests after each lesson (if necessary)
Tests for learning words	After answering correctly 7 times, the words are marked as learnt	Tests to check words, but without automatic marking as ‘learnt’	Learning vocabulary through lessons, but without marking it as ‘learnt’	Vocabulary tests	Tests on request
Analytics by topic	Progress on topics with visualisation via Radial Gauge	Progress through the levels (without detailed analytics by topic)	Progress through the lessons without detail by topic	Progress by level, without visualisation by topic	No detailed statistics are available

Progress on tests by topic	Detailed progress on tests on specific topics	There is no detailed analytics by topic	Progress through lessons, without detailed statistics by topic	Progress by level, without detail by topic	No detailed statistics are available
Number of correct/incorrect answers by topic	Detailed statistics of correct and incorrect answers for each topic	No detailed statistics are available	No detailed statistics are available	Statistics by level, but without detail by topic	No detailed statistics are available
Personalised recommendations	Recommendations based on test results, adaptation of the learning process	Recommendations by level of study	Personalisation through lesson structure	Personalised lessons by level	Personalised lessons with teachers
Data visualisation	Charts, diagrams, Radial Gauge for progress by topic	Gamification, achievements through levels	Graphs to show progress, but without detailed visualisation by topic	Basic progress visualisation	Assessment through individual training, without visualisation
Teaching methods	Interactive tests	Short exercises for every day	Interactive lessons, structured	Interactive exercises, testing	Individual lessons with a teacher via

			tests and activities	and social interaction	video communication
Target audience	Students who want in-depth progress monitoring and personalised recommendations	Beginners and students who want to learn through games	Users who want structured lessons with teachers	Students looking for an interactive experience with native speakers	Students who want individual tuition with a teacher

When comparing the developed system with well-known platforms such as Duolingo, Lingoda, Busuu, and Preply, several key advantages of the developed system can be highlighted.

One of the main differences lies in the expanded progress monitoring. The system allows users to track not only their overall progress but also the number of words learned per day and month, the student's activity level on the platform, and progress on specific tests and topics. This approach provides students with an accurate Figure of their achievements and helps adjust the learning process in a timely manner. While platforms like Duolingo only offer general progress tracking through levels or achievements, your approach is more flexible and detailed, enabling more precise monitoring of the learning process.

As for the analytics of results, the developed system also offers a significant advantage. Thanks to progress visualization through the Radial Gauge and detailed data on correct and incorrect student responses, the system provides a more informative analysis. It allows students and instructors to see which aspects of learning require more

attention. Other platforms, such as Duolingo and Lingoda, offer basic progress information but do not reach the same level of detail and visualization. This can be particularly useful for students who want to understand their strengths and weaknesses more deeply and aim to achieve high results in learning.

A key feature of your platform is personalized recommendations based on test results. You use algorithms that adapt the learning process to the individual needs of each student. This makes learning more effective, as students are offered resources and tasks that address their specific areas of difficulty. While Babbel and Busuu also offer adaptive lessons, the developed system allows for more flexible and precise adjustment of the learning program based on test results, making the approach more individualized.

Regarding data visualization, the developed system offers detailed charts and graphs that help students better understand their progress and identify areas for improvement. For example, thanks to the Radial Gauge, students can visually see how much they have achieved in each specific topic and determine which areas still need work. Compared to other platforms like Duolingo and Lingoda, where visualization is limited to achievements or levels, the developed system provides a deeper understanding of the learning process through detailed visualization of results.

Overall, the developed platform has numerous advantages over its counterparts, thanks to deep progress monitoring, detailed result analytics, personalized recommendations, a variety of learning methods, and convenient data visualization. These features allow students to achieve better results in learning English and provide them with tools for effective self-monitoring and adapting the learning process to their needs.

2.6 Conclusion to the second section

The analysis of modern methods for monitoring student progress shows important improvements in educational technologies, especially with the use of data analytics, machine learning, and visualization tools. These advancements have made it possible to

create personalized learning paths and track progress in more detail, which helps improve the learning experience and meet the individual needs of students. Platforms like Duolingo, Lingoda, Busuu, and Preply offer different ways to monitor progress, but they often do not have the detailed analytics, such as data visualization, personalized recommendations, and the ability to track progress in areas like daily and monthly word learning.

The developed platform stands out because it has full monitoring features, allowing detailed tracking of words learned, student activity, and test results, as well as advanced data visualization tools like Radial Gauge. This helps both students and instructors better understand their learning progress and identify areas for improvement. In addition, personalized recommendations based on test results ensure that the learning process is adjusted to meet each student's specific needs, which improves the platform's effectiveness. Compared to other platforms, the developed system provides a more personalized, data-driven, and flexible learning approach, offering a better and more engaging way for students to learn English.

SECTION 3: IMPLEMENTATION OF THE PLATFORM FOR MONITORING STUDENT PROGRESS

3.1 Technologies and tools of the English language learning platform

Firebase [22]. Firebase is used for storing the dataset for the platform. It allows for storing data on student progress as well as managing test results and user statistics. With Firebase's real-time capabilities, you can ensure quick data updates for users who are taking tests or interacting with learning content. Additionally, Firebase provides APIs for easy access to data and integration with other parts of your system.

React [23]. React is used to build interactive components of the platform. Specifically, this includes test pages, dashboards for visualizing progress, and other elements that require dynamic interaction with users. React enables a component-based development approach, which simplifies code reuse, maintenance, and scaling of the project. For example, the test question page you described is built using React components, providing flexibility and the ability to easily add new features.

SCSS [24]. SCSS is used to style the components and pages of the platform. It is a CSS preprocessor that adds additional features for working with styles, such as nested rules, variables, mixins, and more. SCSS allows for creating more readable and flexible styles, which helps keep the code organized, especially in large projects. SCSS makes it easy to quickly adapt designs and implement new styling changes for individual components.

JavaScript/TypeScript [25]. These languages are used to implement the logic for user interaction with the platform. JavaScript and TypeScript allow for managing the state of components, handling events, interacting with the Firebase API, and executing other business logic. TypeScript adds typing to JavaScript, making the code more reliable and reducing the likelihood of errors. In your project, using TypeScript in React components can ensure better type checking and easier code understanding.

react-google-charts [26]. This library is used to create charts and diagrams that visualize student progress. react-google-charts provides a simple way to integrate Google Charts into your React components, enabling the creation of various types of charts such as bar, line, and pie charts. These charts help students and instructors better understand how well a student has mastered the material and which areas need more attention. Charts are an important tool for displaying large amounts of data in a convenient and understandable format.

3.2 General information about the English language learning platform

Modern platforms provide the opportunity to learn languages at various levels of difficulty and interactively engage with learning materials. However, it is not only important to provide access to learning materials but also to ensure effective monitoring of student progress to help them achieve high results. One of the latest trends in online learning is the integration of data analytics to track student progress. The platform in question combines innovative tools for monitoring student success and provides detailed analytics, significantly enhancing the effectiveness of the learning process.

The English language learning platform includes advanced analytics and is designed not only to provide access to learning materials but also to effectively track the progress of each student. One of the main features of this platform is the integration of analytics, which allows students and instructors to obtain accurate data on their achievements and identify the strengths and weaknesses of the learning process. For example, students can see how many new words they have learned in a day or a month, helping them track their progress in vocabulary acquisition. Such data becomes valuable for students, as they can see the concrete results of their efforts, which boosts their motivation.

Specifically, the platform collects and provides information about the number of words learned over the course of a month. This allows students to clearly see their achievements in terms of vocabulary and adjust their learning strategy in a timely manner.

For example, if a student is learning new words every day but is not achieving the desired results due to insufficient activity on the platform, additional materials or other resources for accelerated vocabulary learning may be suggested to them.

Another important aspect is tracking student activity on the platform, specifically how many days during the month they were active. This metric not only allows for assessing the regularity of their study sessions but also provides insights into the student's level of motivation. Consistency in learning is a key factor for success, so tracking activity helps both the student and the instructor adjust the learning approach accordingly.

One of the most important tools on the platform is the word-learning tests. The platform uses a system where a word is marked as "learned" when the student correctly answers a question about its meaning. This system not only evaluates how well the student has mastered the new vocabulary but also helps them retain the material in memory, as correctly answering several test questions confirms the understanding of the word's meaning. This approach is ideal for students who aim not only to memorize words but also to use them in real language contexts.

Another important tool is the topic analytics. This feature on the platform allows tracking students' progress in specific topics. For example, with the help of a Radial Gauge, a student can see their progress in a particular topic in real-time. This allows them to assess at what stage of learning they are and whether additional effort is needed to master certain material. Such visualization is useful as it provides the student with a clear understanding of their learning progress and what part of the course still needs to be completed.

In addition, test analytics allow tracking students' results for each specific topic, including the number of correct and incorrect answers. This helps to identify which aspects of the topic are causing difficulties and determines which areas students should focus on more. Such detailed information is invaluable for instructors, who can use this data to adjust the learning process or provide additional recommendations to students.

An English language learning platform that includes detailed progress analytics is an important tool for all participants in the learning process. It allows students to see the real results of their efforts, adjust their learning strategy, and stay more motivated to achieve their goals. For instructors, such a platform is a powerful tool for monitoring student success, identifying weaknesses, and responding promptly to issues that arise during the learning process. Therefore, the development of such platforms is an important step towards improving the quality of education and creating personalized learning conditions for each student.

3.3User Instructions

After launching the application, a login form appears on the platform, where the user can log into their personal account (Figure 3.1). The user must enter their email address in the first field and password in the second to access their account. Below the password field, there is a hyperlink "Forgot your password?" which allows the user to recover access to their account in case they forget their password.

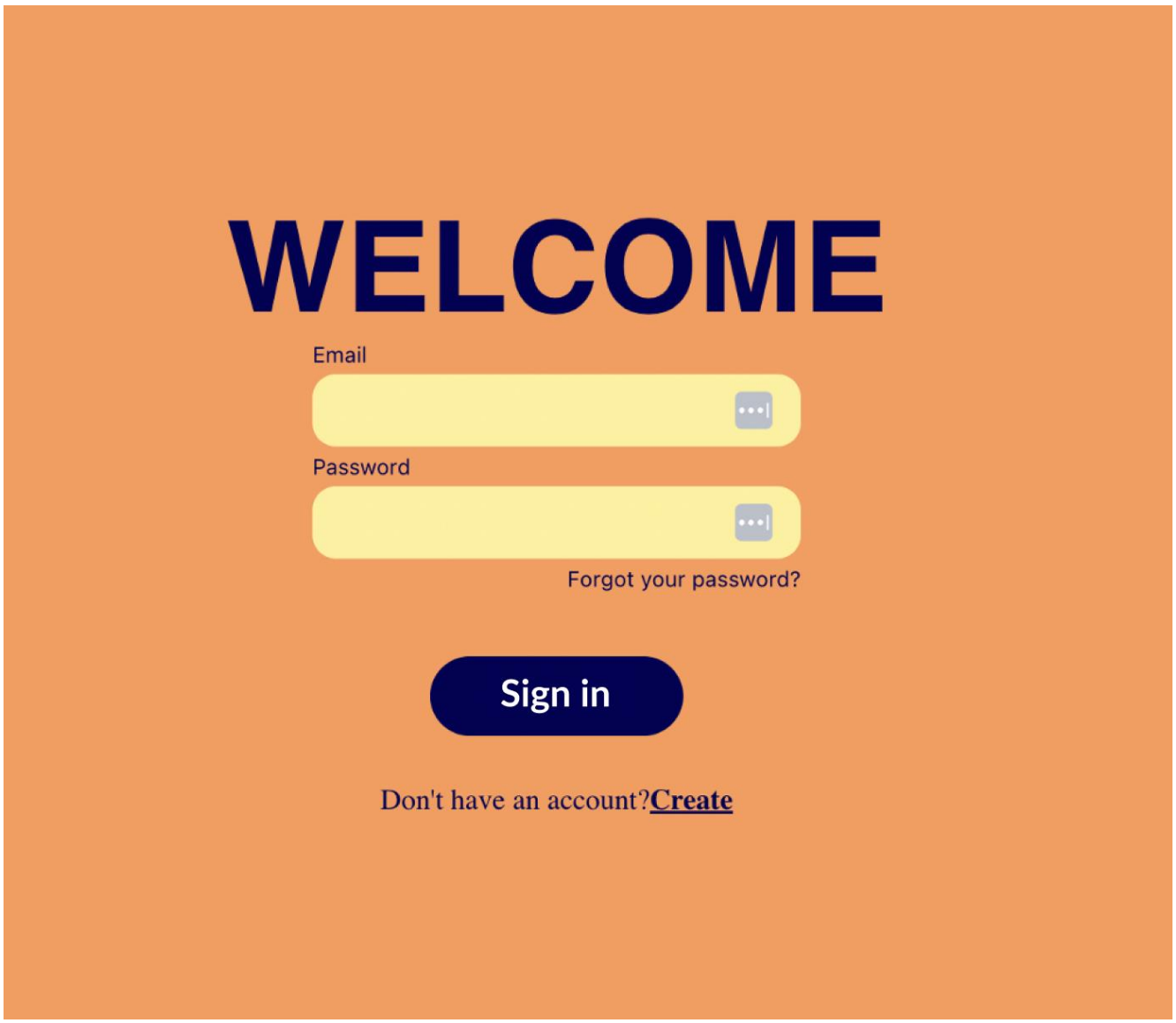

Figure 3.1 - Login form to the platform

If the user is not registered in the system, they can click the "Create" button, which will redirect them to the page for registering a new account (Figure 3.2).

On this page, there are fields to enter the necessary data. After entering this information, the user can click the "Create" button to complete the registration and create an account. Next to this button, there is a link "Already have an account?" which provides the option to go to the login page if the user is already registered.

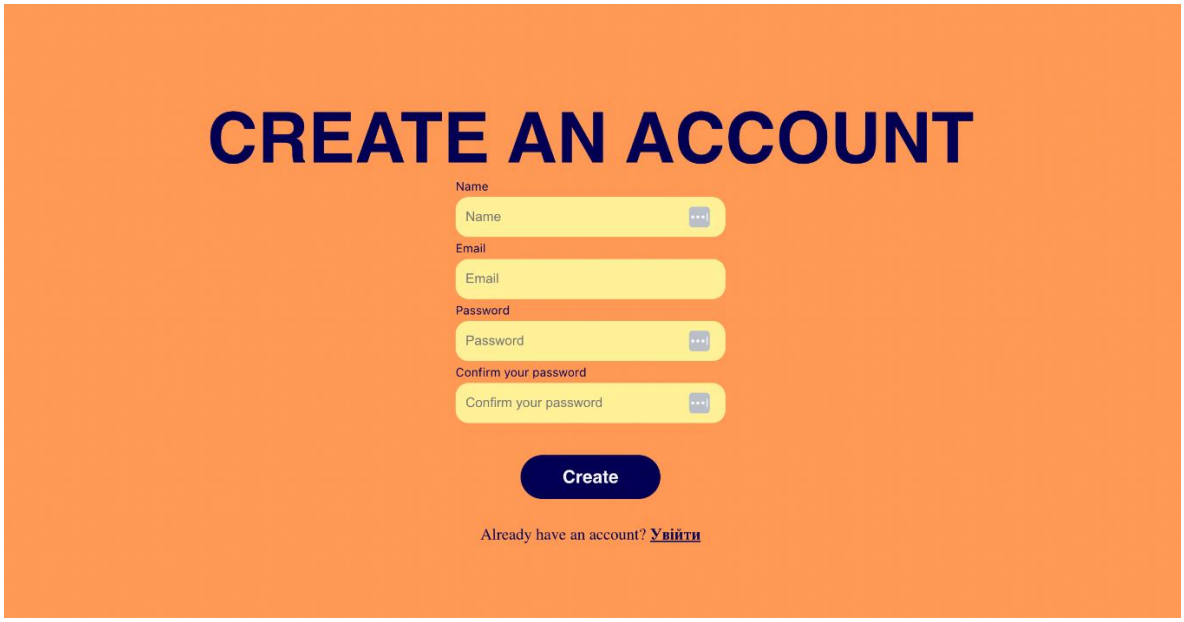

Figure 3.2 - New user registration page on the platform

Next, we move to the homepage, which serves to track the user's progress in language learning. It provides convenient tools for viewing results and maintaining motivation. At the top of the page, the user sees a personalized greeting message, as well as a motivational message.

This page is designed to help the user easily track their progress, receive recommendations, and stay motivated for continued learning.

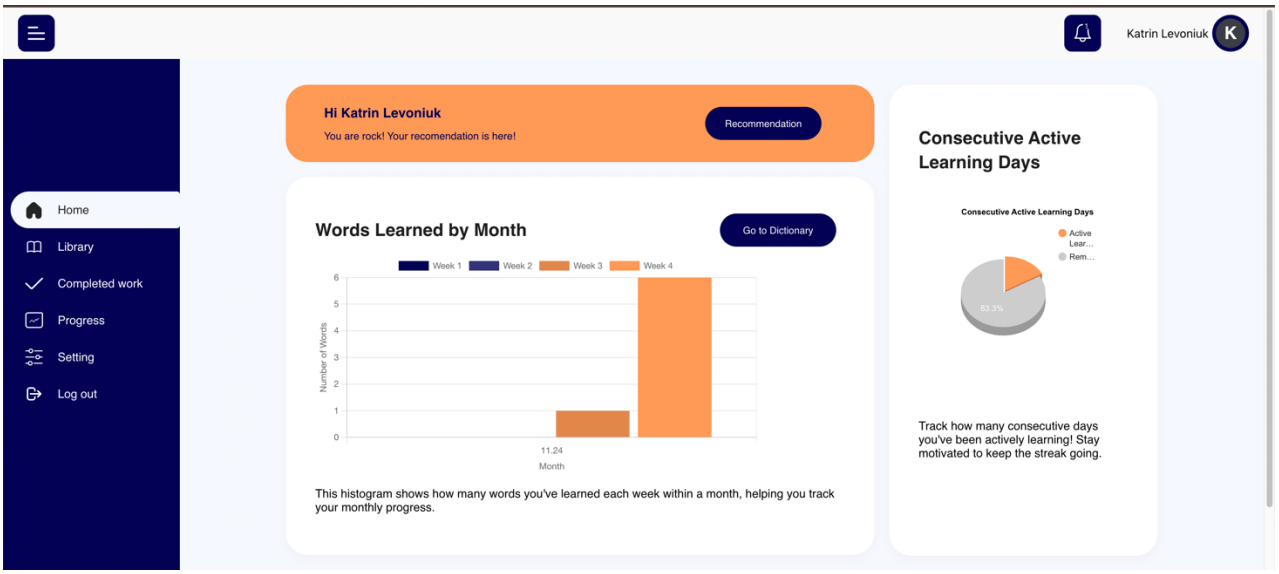

Figure 3.3 - Home page of the English language learning platform

On the homepage, there are several important elements for analyzing progress. One of the main elements is the "Words Learned by Month" chart, which displays a histogram. This histogram shows how many words the user has learned each week throughout the month.

Figure 3.4 - Graphical representation of the user's progress in learning words for a certain month

Each bar on the chart corresponds to a specific week (week 1, week 2, week 3, week 4), allowing the user to visually track their weekly progress in learning words. This helps the user monitor their growth in learning and motivates them to achieve further progress (Figure 3.5).

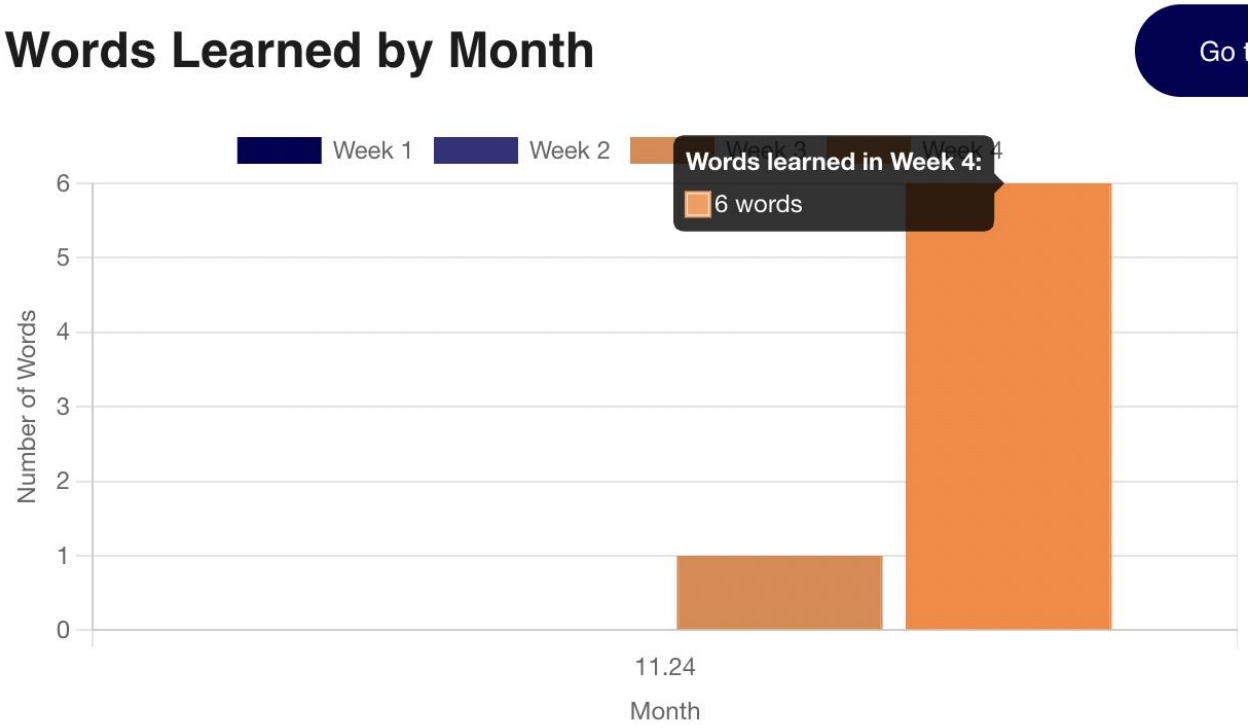

Figure 3.5 - Histogram with the number of words learnt each week

To the right of the chart is the "Consecutive Active Learning Days" panel, where the user can see how many days in a row they have been engaged in learning. A pie chart is displayed, illustrating the percentage of active days throughout the month compared to the days without learning. This helps the user track their discipline, maintain motivation, and keep a continuous streak of learning days.

The chart is divided into two sections: an orange part, representing active learning days, and a gray part, representing days when no learning took place.

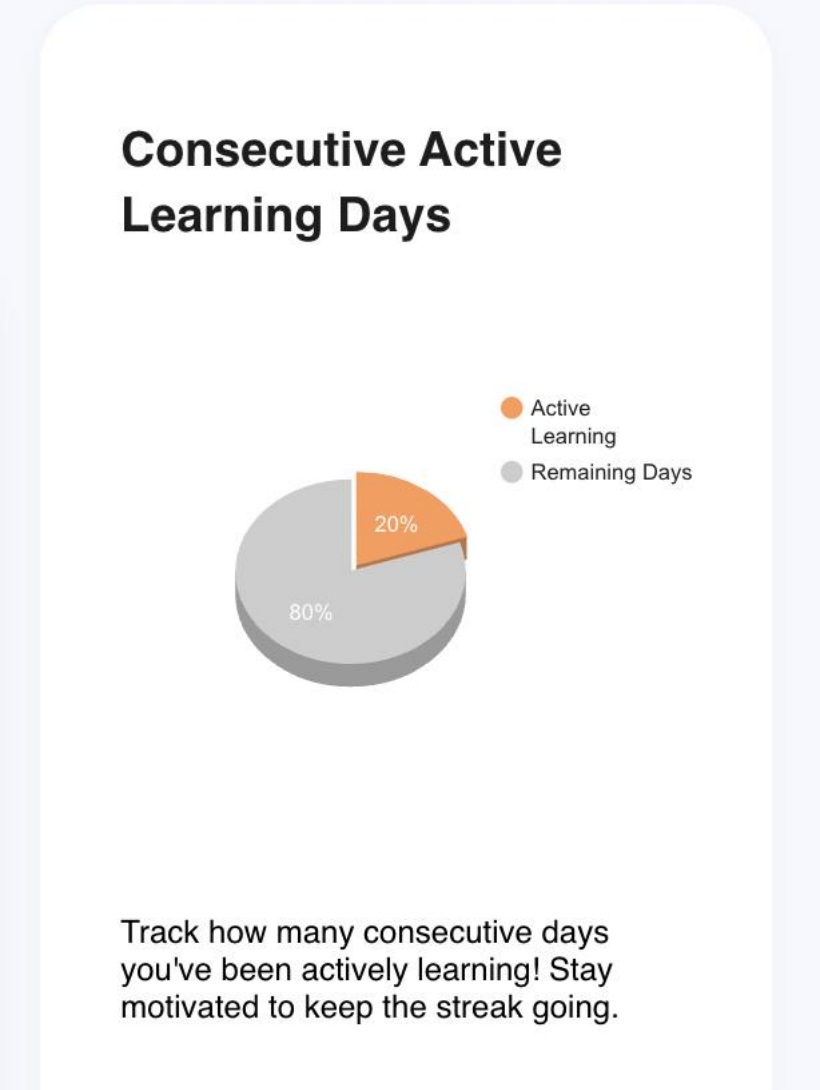

Figure 3.6 - Pie chart illustrating the percentage of active days during the month

There is also a table at the bottom with detailed information about the tests recently taken by the user (Figure 3.7).

The user can filter the results by selecting between all tests, successful tests, or unsuccessful tests using the corresponding tabs: "All," "Successful," "Not successful."

The table contains several columns. The first column, "Topic," indicates the general topic of the test; in this case, all tests are related to the topic "Parts of Speech." The second column, "Subtopic," specifies the particular part of speech that was tested; in this case, it's "Nouns." The third column, "Date & Time," displays the exact time the test was taken. The fourth column, "Correct answers," shows the number of correct answers in the test.

The last column, "Progress in %," displays the percentage result, indicating the success rate of each test.

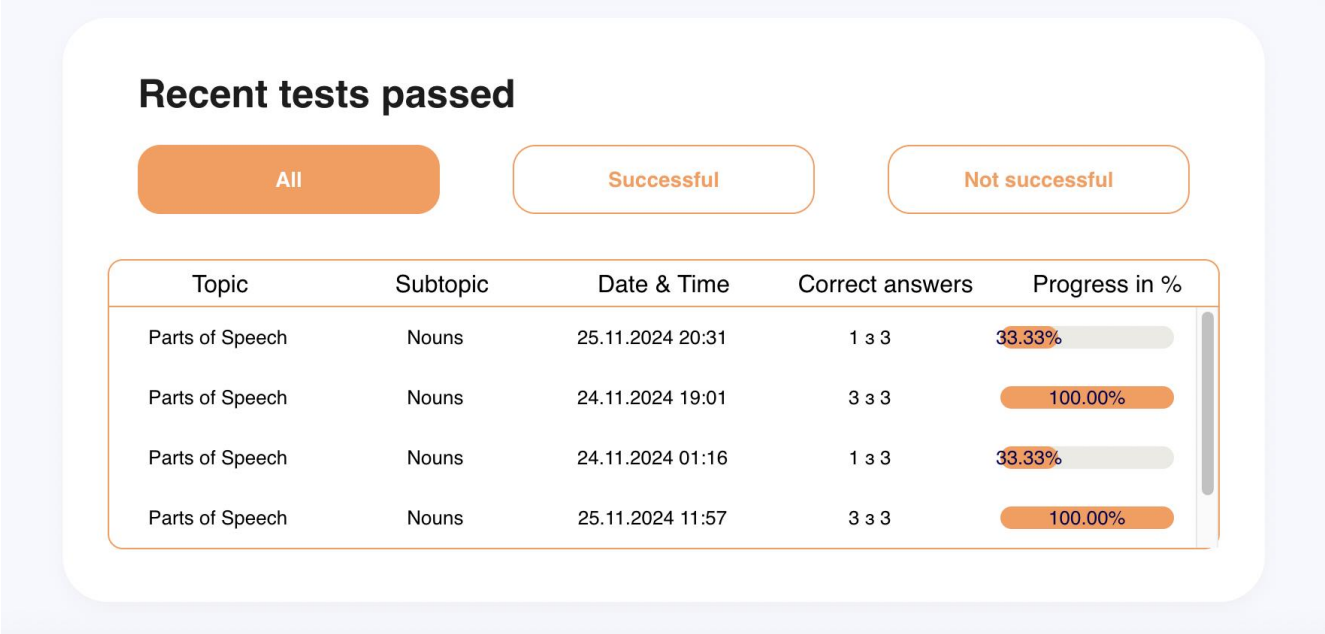

Figure 3.7 - Table with detailed information about recently passed tests by the user

The next page (Figure 3.8) presents grammar and language structure learning materials. It contains topics along with a navigation panel for moving between them. Each topic has a title and a brief description with an example.

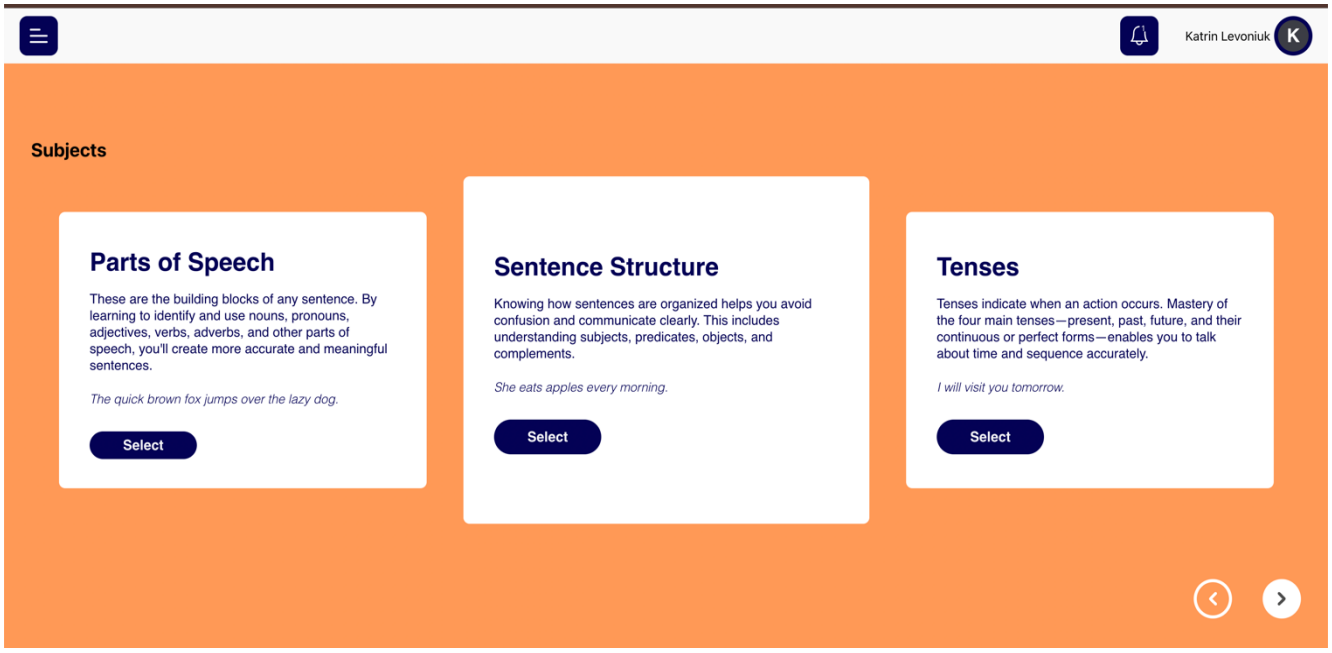

Figure 3.8 - Learning materials/topics on the platform

By clicking the "Select" button, we are redirected to the subcategory page for the topic (Figure 3.9). Instead of one large block of information, the user can dive into individual aspects, which helps to better understand the material.

The page also contains a button to navigate to the next screen, providing easy navigation between subcategories.

By clicking the "Select" button, we move to a new page, which is the test page (Figure 3.10).

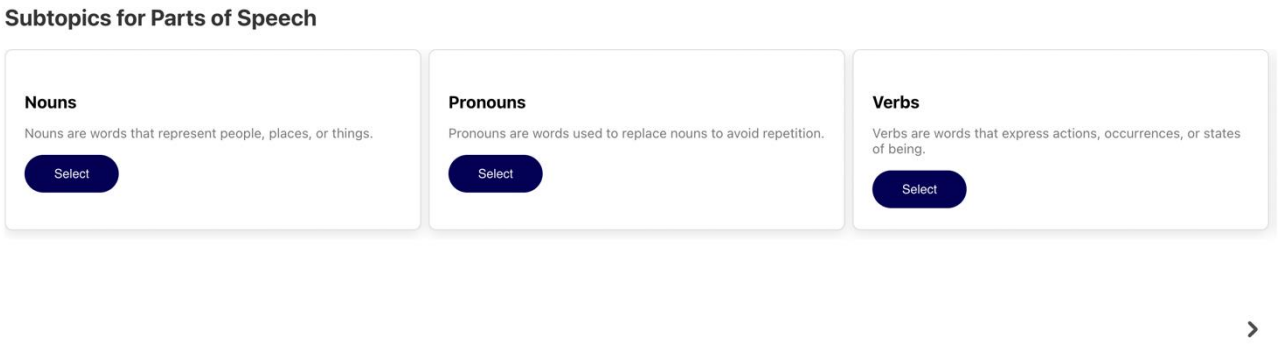

Figure 3.9 - Subcategories for the topic

This page includes questions, each aimed at studying the key aspects of nouns in grammar. Below, there is a "Save Answers" button, which allows the user to save their answers and continue working on the test. The test helps to assess the user's basic knowledge of nouns and is part of the curriculum for improving grammar.

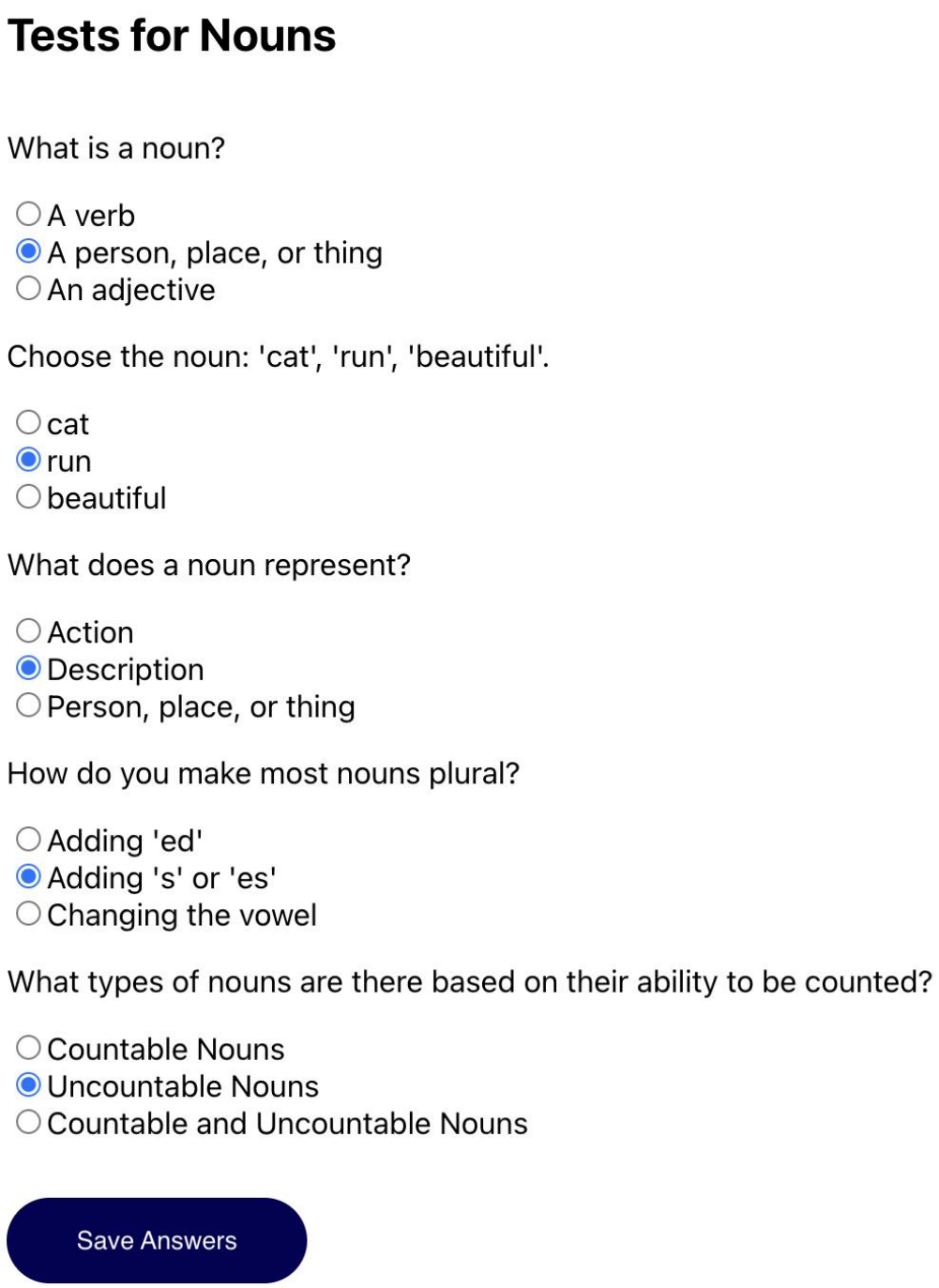

Figure 3.10 - User knowledge test

After the user clicks the "Save Answers" button, the platform immediately provides the test results and shows how many questions the user answered correctly and incorrectly (Figure 3.11). It also offers recommendations for the user (Figure 3.12).

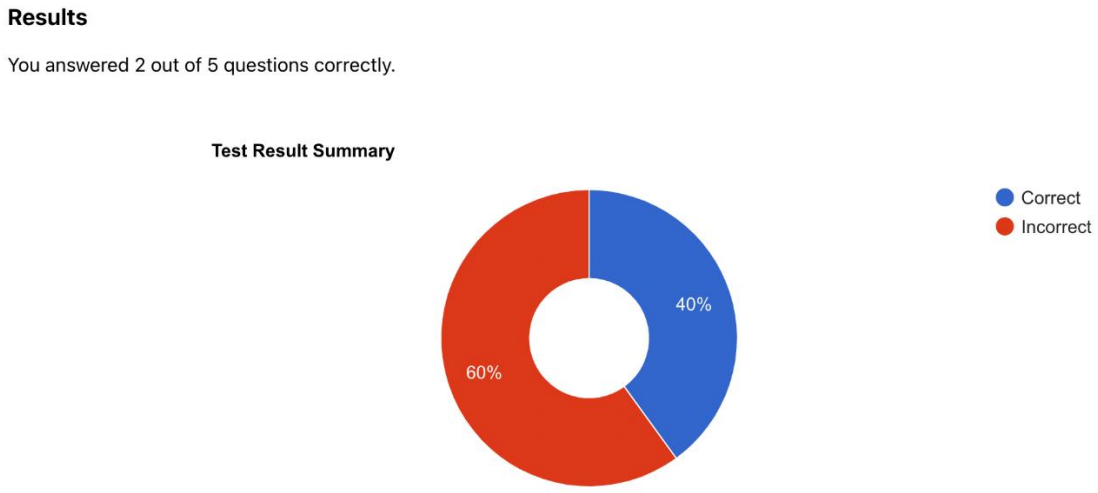

Figure 3.11 - Pie chart of correct and incorrect answers

At the top, there is a message saying "You answered 2 out of 5 questions correctly," which informs the user of their overall result. Below this message, the test result is displayed in the form of a pie chart.

The chart shows two sections: one blue, representing correct answers, and one red, representing incorrect answers. The blue section occupies 40% of the total chart, indicating 2 correct answers, while the red section occupies 60%, reflecting 3 incorrect answers. This allows the user to visually assess how well they performed on the test.

Such a result is useful for evaluating the user's knowledge level and helps identify where mistakes were made. The user can use this information to further improve their knowledge by focusing on errors and completing additional exercises or reviews to enhance their results.

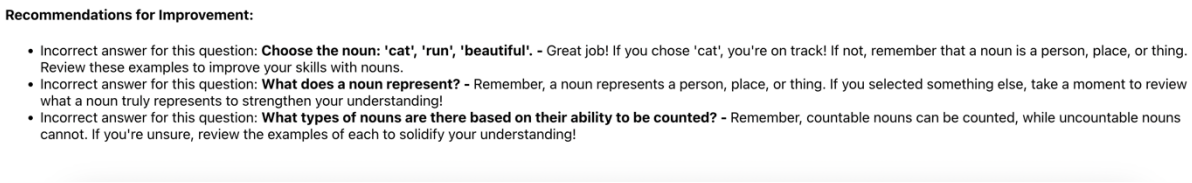

Figure 3.12 - Recommendations for improving user knowledge

This section contains three recommendations for the three incorrect questions where the user provided wrong answers. These recommendations help the user understand where they made mistakes and provide specific advice for improving their knowledge and skills in grammar.

The progress page for all topics (Figure 3.13) gives the user the ability to view their progress across different language topics. It is divided into several cards. Each card contains the topic title, the number of lessons and hours, as well as a "Continue" button, which allows the user to move to the next page and preview the progress of the topic (Figure 3.14).

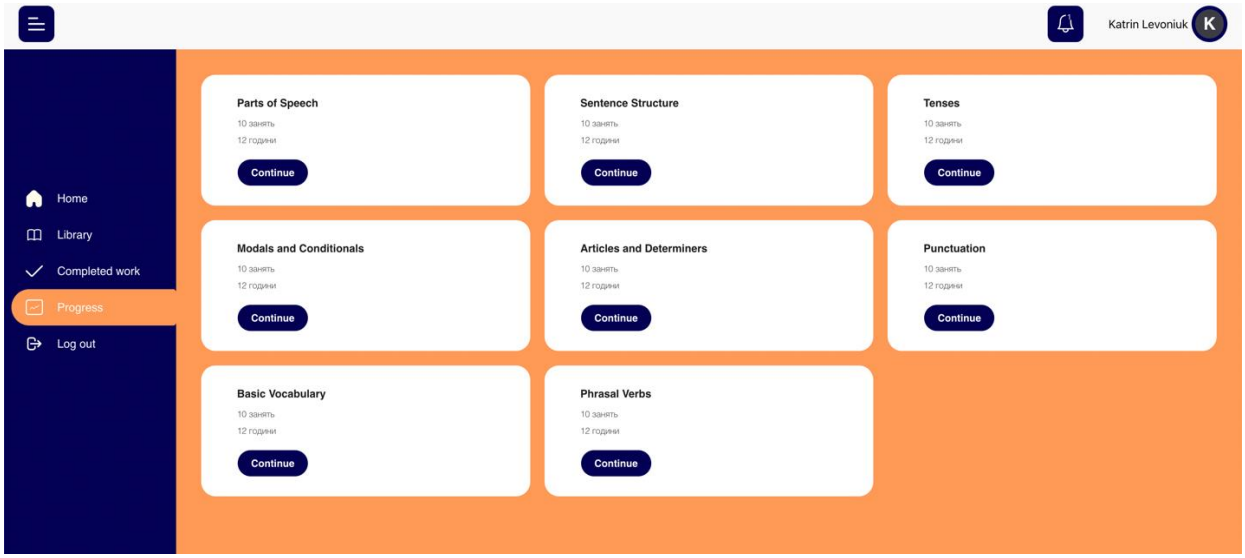

Figure 3.13 - Progress page for all topics

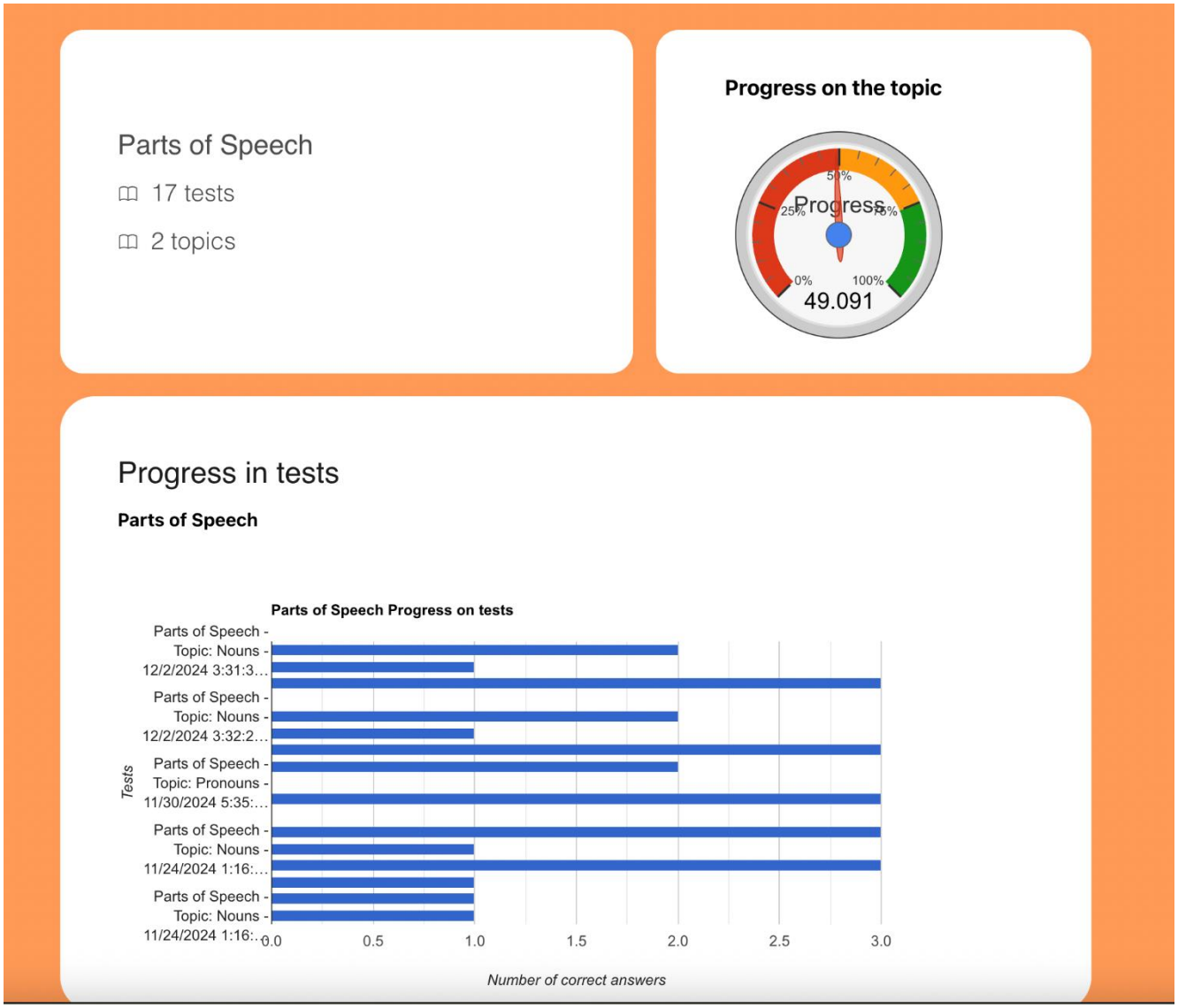

Figure 3.14 - Preview of the topic progress

This page provides the user with a detailed overview of their progress in learning the topic "Parts of Speech." At the top, there is a title indicating that the user has completed 17 tests on this topic and two subcategories. Additionally, there is a "Progress on the topic" indicator showing that the user's progress in this topic is 49.09%. The indicator is displayed as a scale with color-coded zones representing success levels: the red zone indicates low progress, the yellow zone indicates medium progress, and the green zone indicates high progress.

Below, there is a "Progress in tests" chart, which shows detailed results for each test the user has taken on the "Parts of Speech" topic. The chart consists of horizontal bars

representing the number of correct answers the user achieved in each test. The X-axis shows the number of correct answers, and the Y-axis displays the test names. Each bar represents one test, and its length shows the number of correct answers, allowing the user to quickly see which tests they performed best on.

The page also contains a pie chart showing the ratio of correct to incorrect answers. The answers are divided into two categories: correct answers are marked in blue, and incorrect answers are marked in red (Figure 3.15).

This page provides a clear visual representation of progress and helps the user understand which aspects of the topic they have mastered to a sufficient level, and where there is still room for improvement. It also motivates the user to continue learning and provides detailed feedback on their achievements.

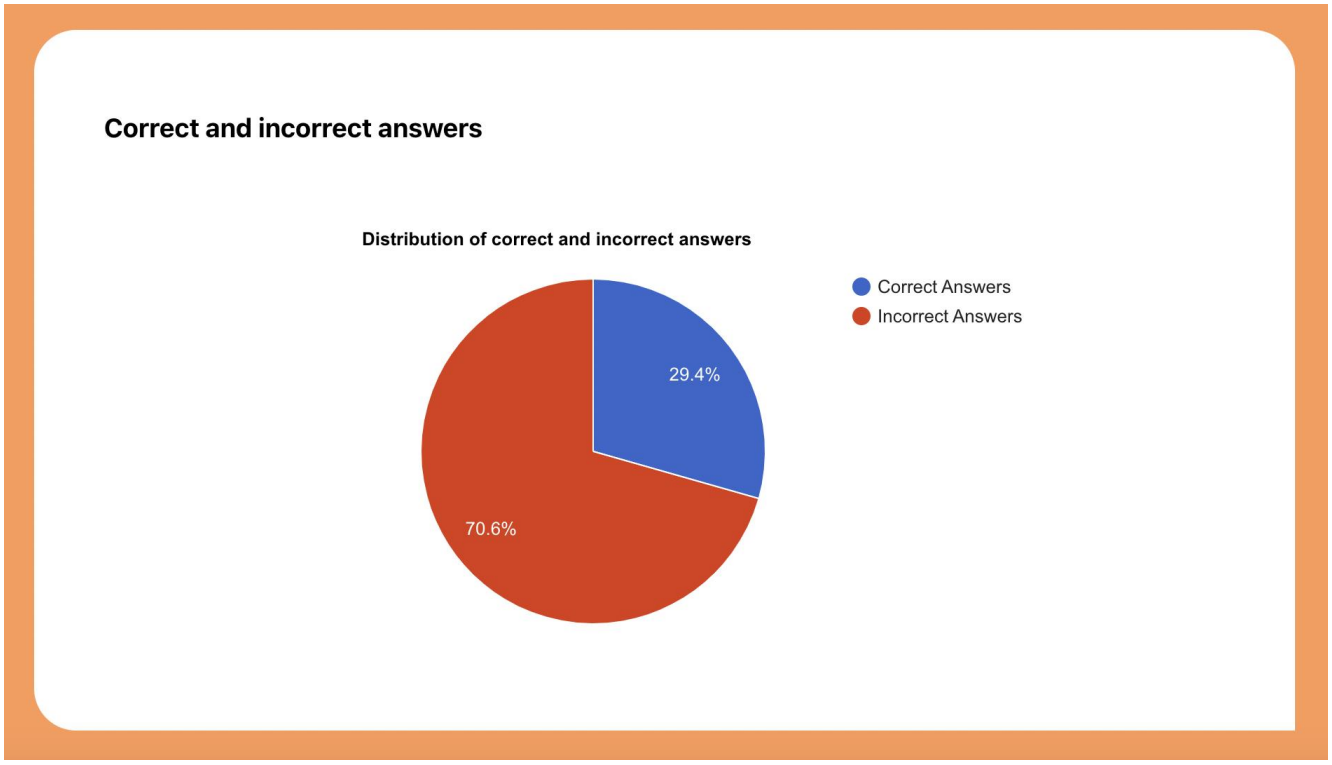

Figure 3.15 - Pie chart showing the ratio of correct to incorrect answers

The next page is the vocabulary page (Figure 3.16). On this page, statistics are displayed for the words, allowing the user to track the number of learned and reviewed words through a chart that shows the distribution of learned and reviewed words in the

form of a pie chart. This helps the user not only monitor their progress but also motivates further word learning through visual statistics and the ability to test their knowledge.

Figure 3.16 - A graph showing the distribution of learnt and repeated words in the form of a pie chart.

There is also a "Take the Quiz" button, which provides the user with the opportunity to test their knowledge, memorize new words, or practice reviewing previously learned words (Figure 3.17). This test page includes a process for evaluating the user's knowledge, based on selecting the correct word for a given definition.

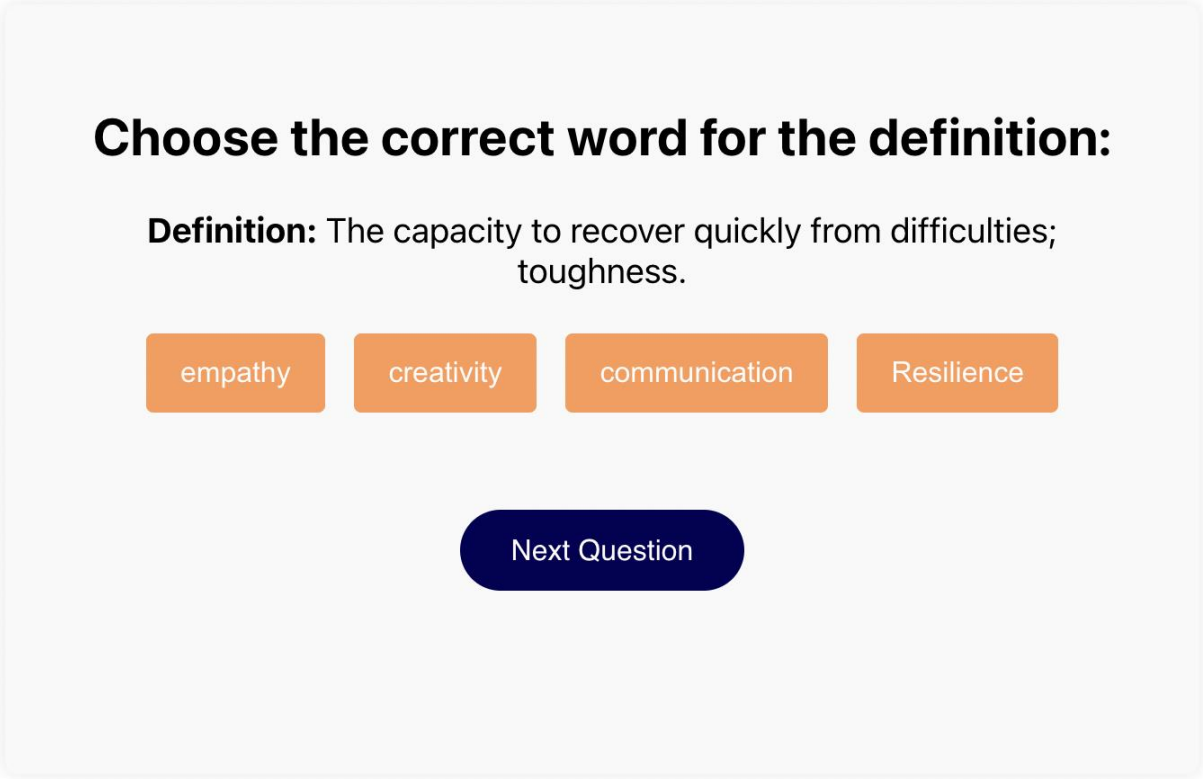

Figure 3.17 - Test of the user's knowledge of words

When the user selects an incorrect answer, a message appears on the screen saying "Incorrect," and the word is highlighted in red (Figure 3.18).

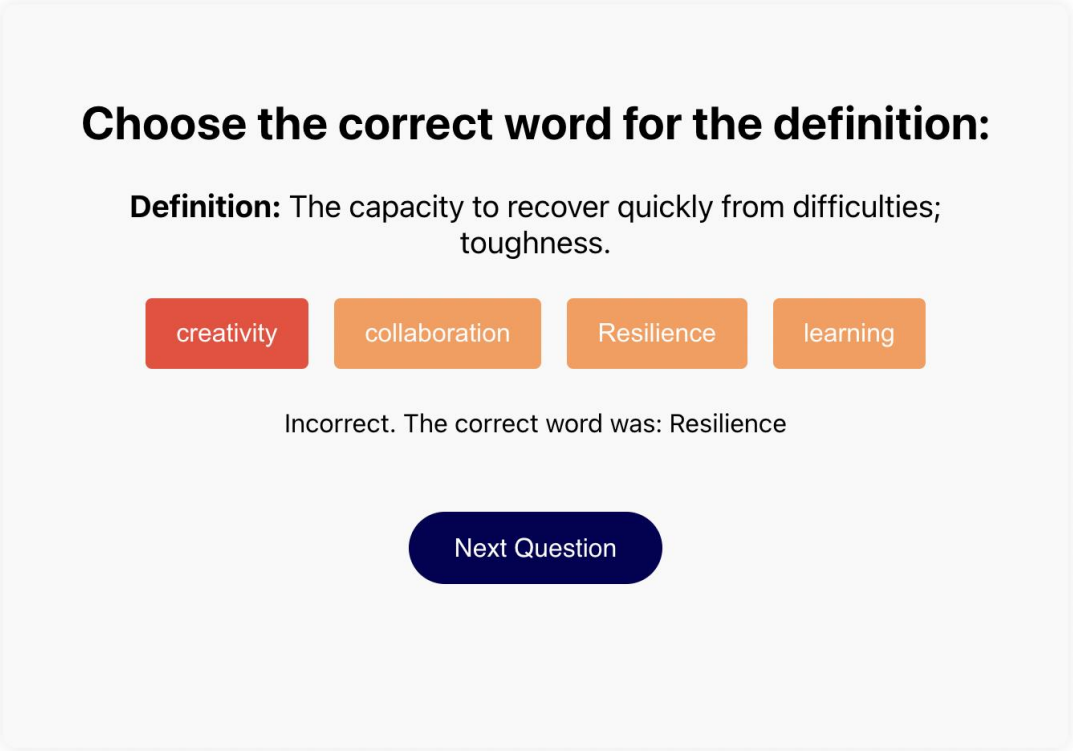

Figure 3.18 - Test of user's knowledge of words with incorrect answers

When the correct word is selected, it is highlighted in green, and a message saying "Correct!" appears, along with the final test result: "Quiz Finished! Your score: 7/9" (**Figure 3.19**). After completing the test, there is a "Save Progress" button, which allows the user to save the test results. This enables the user to receive feedback and assess their knowledge in the context of word definitions, as well as track their progress in learning.

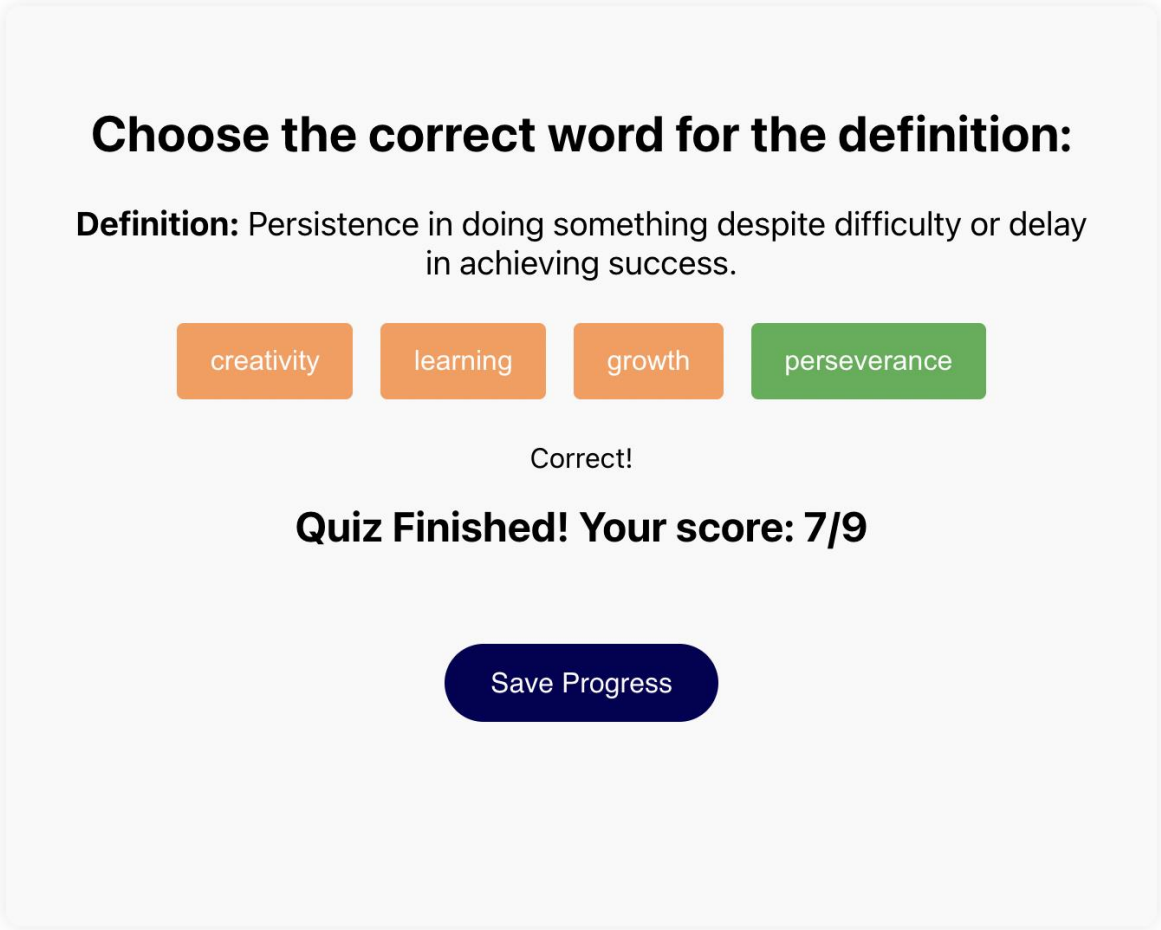

Figure 3.19 - Word test with correct answer and test result

Also, on the vocabulary page, below the chart, we can see information about the words, their definitions, and synonyms, as well as the number of times each word has been correctly selected in tests (Figure 3.20). At the top of the page, there is an "Add New Word" button, which allows the user to add new words to their vocabulary (Figure 3.21). When a word has been correctly selected 7 times, it is considered "Learned."

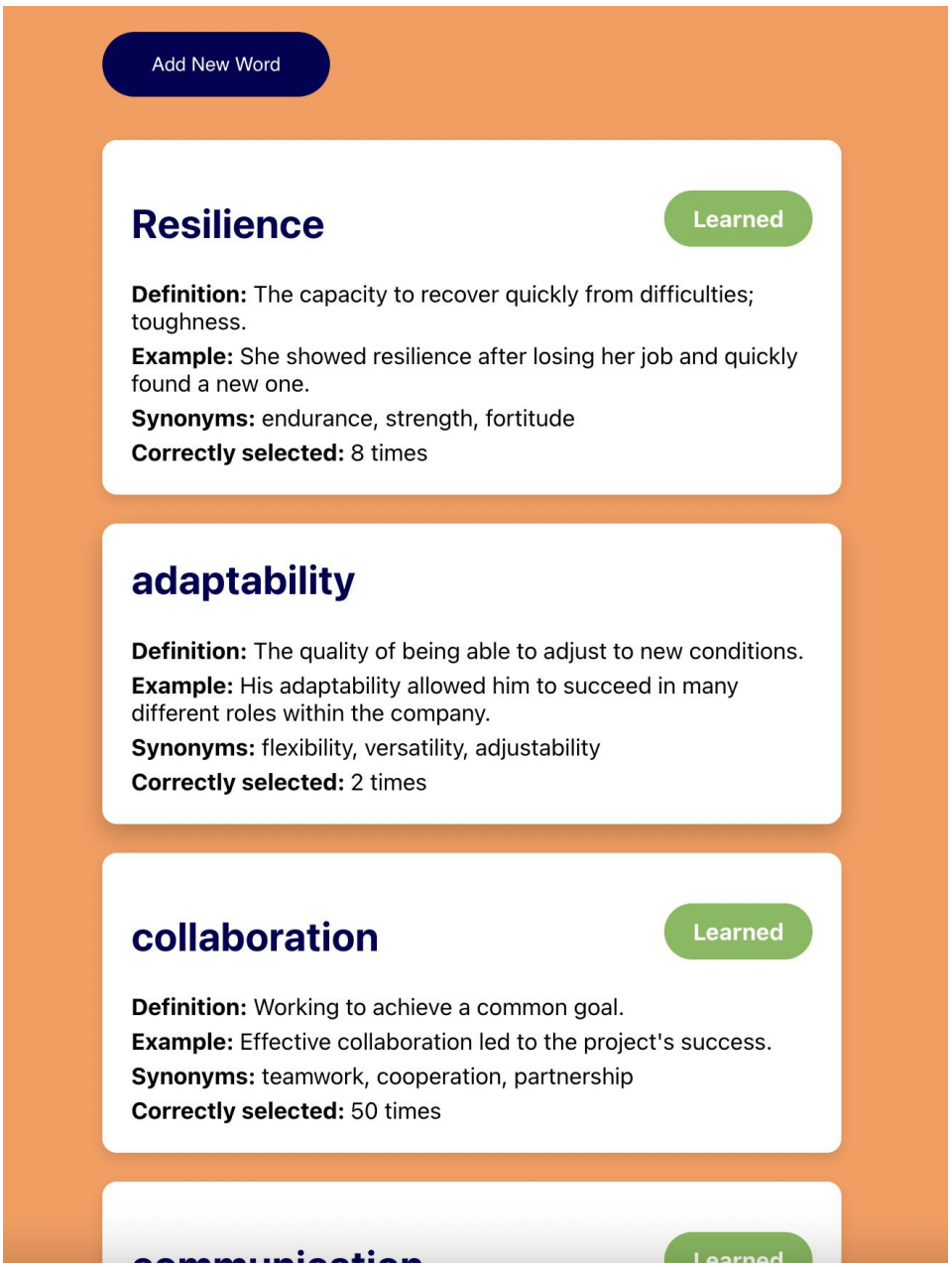

Figure 3.20 - Words in the dictionary

Next to the word field, there are fields for entering the definition of the word, an example of its usage in a sentence, and synonyms.

This allows the user to maintain a personal vocabulary list, adding new words, which enhances learning effectiveness and helps organize new vocabulary systematically.

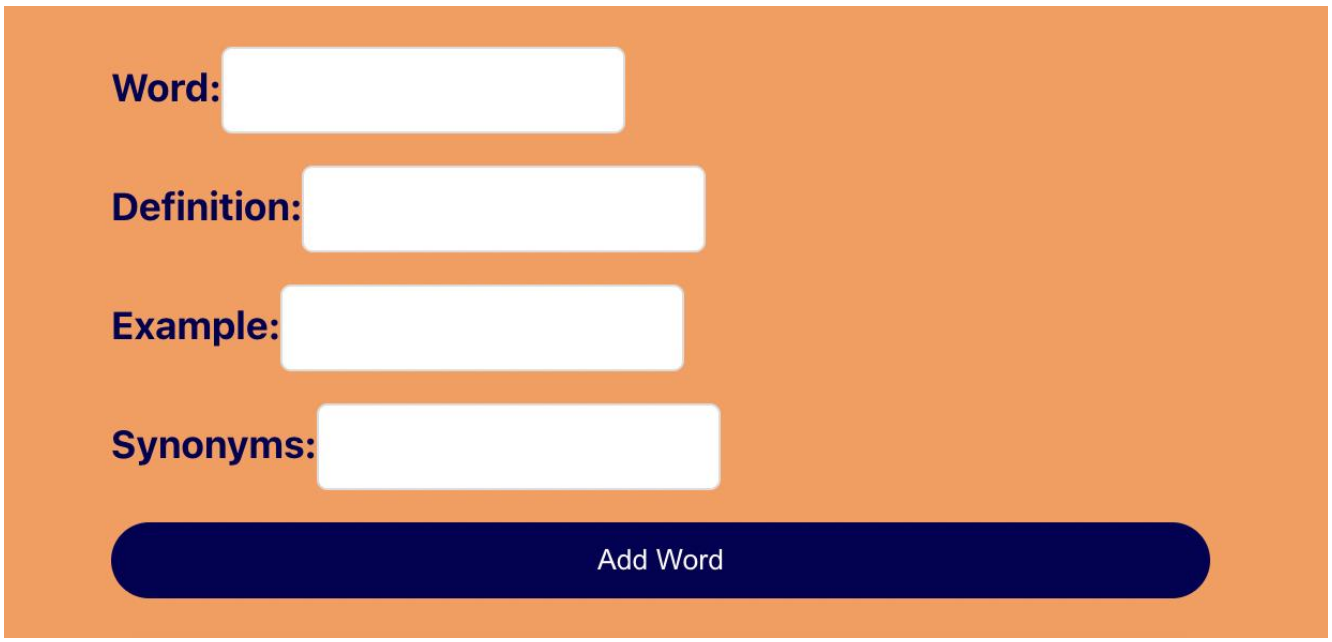

Figure 3.21 - Adding a new word to the dictionary

In Figure 3.22 there is a user role selection where the user has the option to choose between two options: "I AM TEACHER" and "I AM STUDENT." Each of these options is represented as a separate block with corresponding labels that clearly indicate the role the user selects.

The "I AM TEACHER" option is highlighted in orange and is accompanied by a message encouraging teachers to join the platform, emphasizing that they will be given the opportunity to help students explore the world.

Figure 3.22 – Introduction page to choose the role

After selecting the teacher role, the user is directed to the main page, which provides an overview of the students' progress for the instructor. It contains personalized welcome information for the teacher, including their name, and highlights the students' progress. The heading "Your students' progress" indicates that the information displayed is about the students.

Below, there are cards for each student with their information, including their name, total number of tests taken, progress level, and the topics they have studied. For each student, there is a "View Progress" button that allows the instructor to view more detailed information about that specific student.

Below the students, there is a section called "The latest tests students have passed," which shows the recently completed tests by the students. Each test displays the topic title, subcategory, date and time of completion, as well as the percentage of successfully completed tasks in the test.

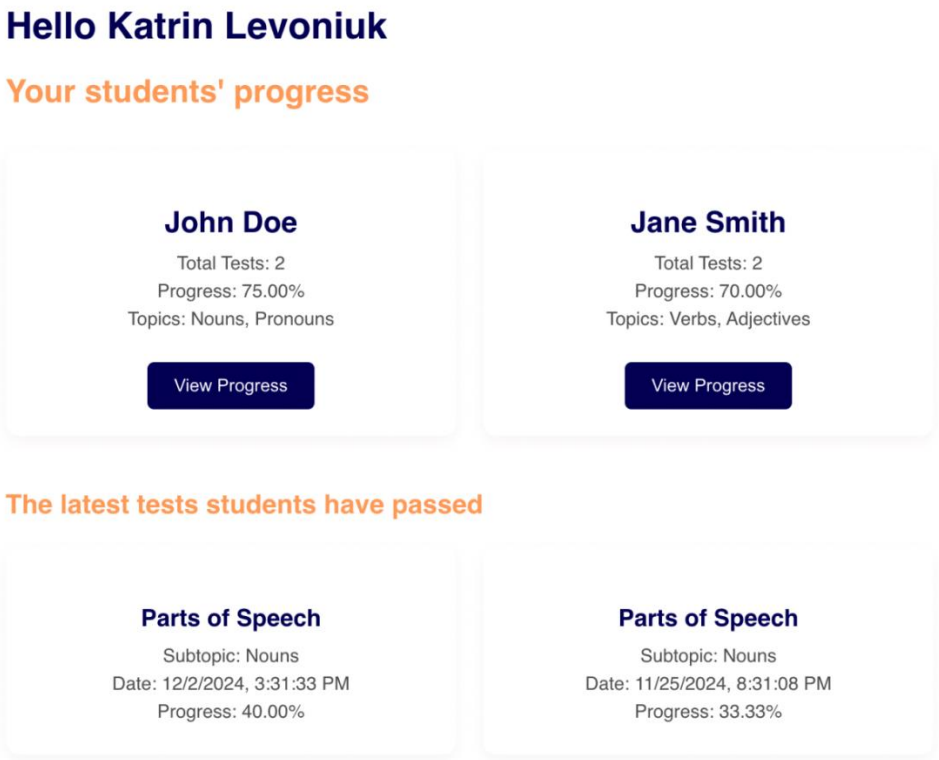

Figure 3.23 – Home page for teacher

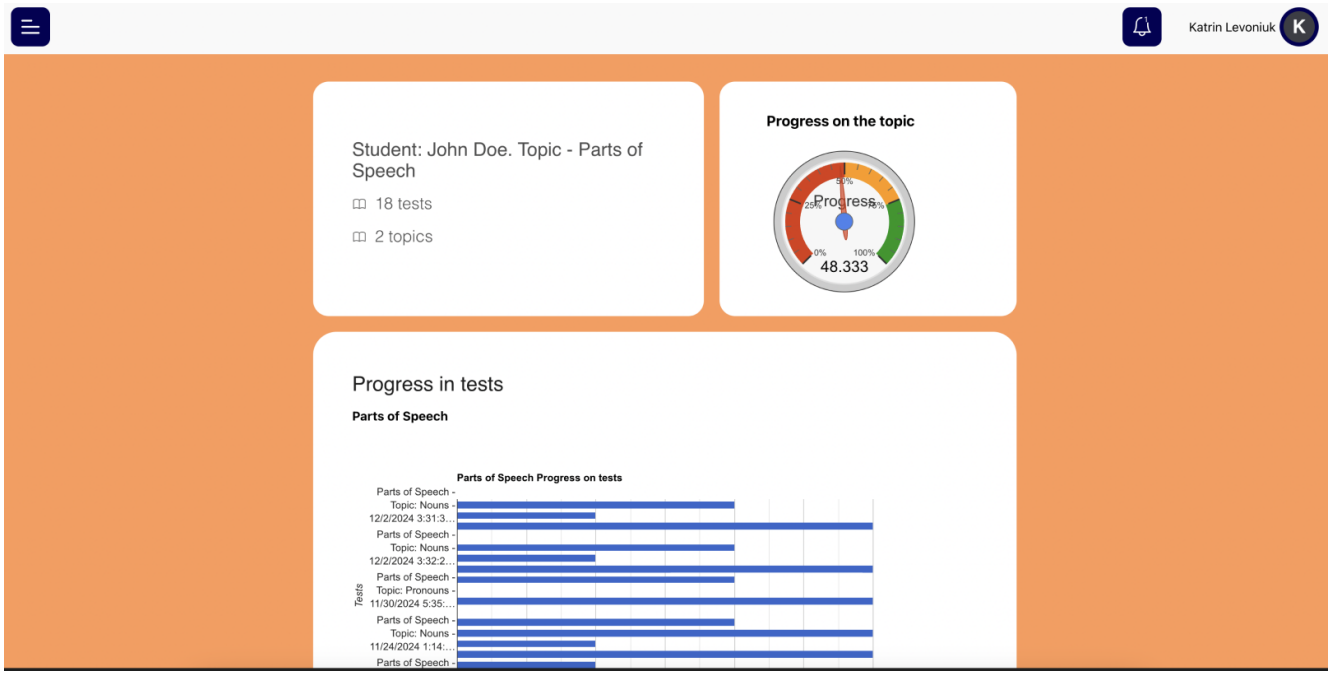

Figure 3.23 – Detailed information about a specific student's progress

On the Figure 3.24 image provides detailed information about a specific student's progress within the selected topic. It includes three main sections:

The first section shows the student's name, the number of tests completed, and the number of topics the student is studying. For example, for the student John Doe, it shows that he has completed 18 tests and is studying 2 topics, including the topic "Parts of Speech."

The second section contains a circular progress indicator that demonstrates the student's progress in the topic. This indicator has a color scale with different shades to indicate the level of progress: red for low progress, yellow for medium, and green for high progress. John's progress is displayed at 48.33%.

The third section shows the student's progress in tests for each subcategory. This is a table where all the tests the student has taken within the "Parts of Speech" topic are displayed. For each test, the subcategory name, test date, and number of correct answers are shown.

This page allows the instructor to clearly see the student's achievements and the effectiveness of their learning in a particular topic, using both general indicators (progress percentage) and detailed information for each test.

3.4 Conclusion to the third section

The third chapter focuses on the integration of important technologies and tools in the English language learning platform, including Firebase for real-time data storage, React for dynamic user interfaces, and react-google-charts for progress visualization. These technologies allow the platform to provide detailed analytics on student progress, such as statistics on word learning and feedback on specific topics, helping both students and instructors track achievements and identify areas for improvement. The platform also offers personalized recommendations based on test results, creating a more individualized learning experience. With its user-friendly interfaces and clear progress tracking, the platform improves the effectiveness of language learning and provides valuable tools for both students and instructors.

CONCLUSIONS

As a result of completing the master's thesis, significant scientific and practical results have been achieved, which greatly improve the process of monitoring student progress on English language learning platforms. A system has been developed that allows tracking not only the overall progress of students but also provides detailed analysis of their achievements in real-time, significantly enhancing the effectiveness of learning.

One of the key scientific results is the integration of data analytics and visualization for evaluating learning outcomes. Including personalized recommendations based on student test results allows for more accurate adjustment of the learning process, ensuring an individualized approach for each student. This creates conditions for more effective and faster language acquisition, as it helps students focus on their weak areas while also motivating them to improve their results.

The practical value of the results lies in the fact that the developed system provides both teachers and students with convenient tools for real-time progress monitoring. Students can independently adjust their learning strategies based on the data, and instructors are able to respond quickly to issues and provide necessary support. This increased transparency in the learning process makes it more adaptive and focused on the needs of each student.

In conclusion, it can be stated that the developed system is an important tool for modern English language learning platforms. It allows for accurate assessment of student results, enables the creation of personalized learning paths, and greatly improves the effectiveness of the educational process.

Recommendations for the scientific and practical use of the results include further adapting the developed system to other educational platforms that use interactive learning methods. The proposed methods of analytics and visualization can be used not only for learning English but also for other subjects where tracking student progress is important.

It is also recommended to further improve the algorithms for forming personalized recommendations, which will allow even more precise adjustment of the learning process to individual student needs.

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APPENDICES

APPENDIX A. Platform pages

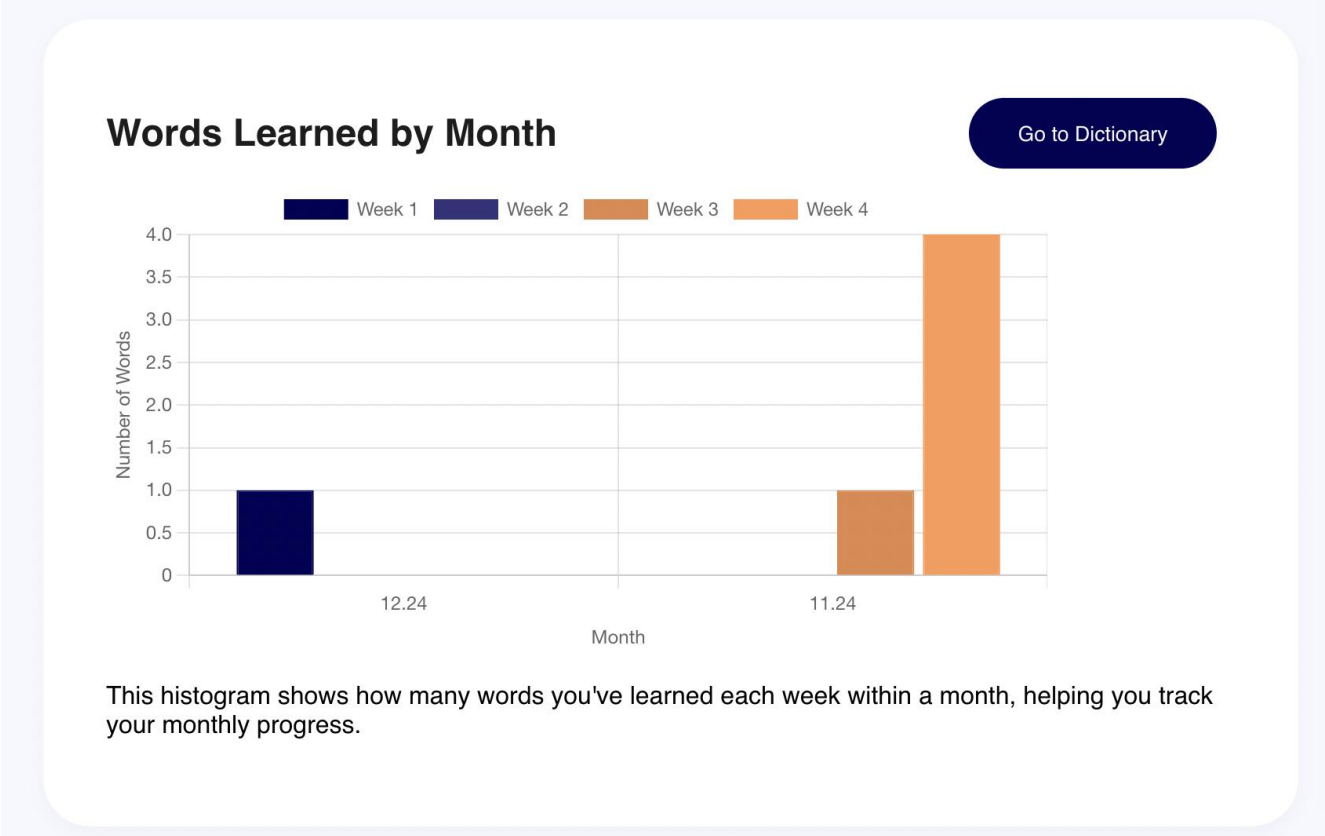

Figure A.1 - A bar chart showing the number of words you have learnt in each week of the month

Figure A.2 - Diagram showing the number of remaining days of study per month

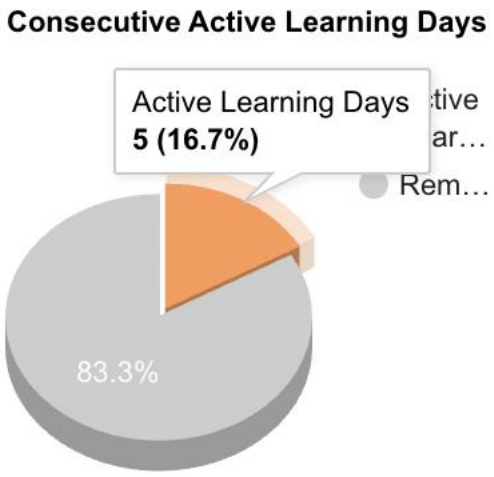

Figure A.3 - Diagram showing the number of active learning days per month

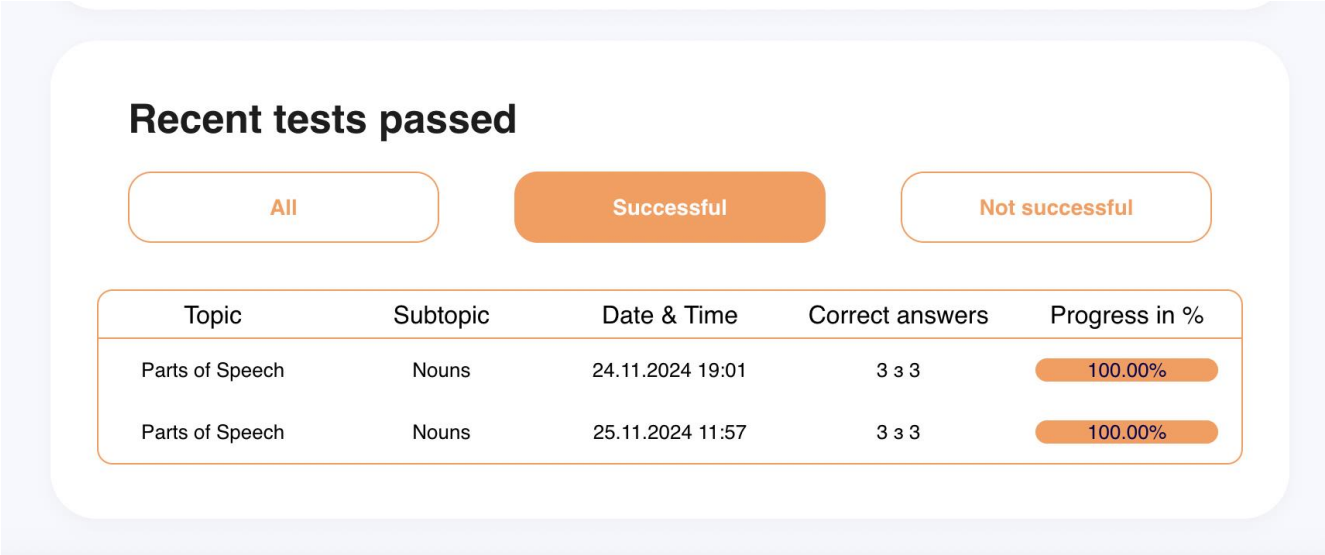

Figure A.4 - History of recent tests that have passed with date, subcategory and percentage progress

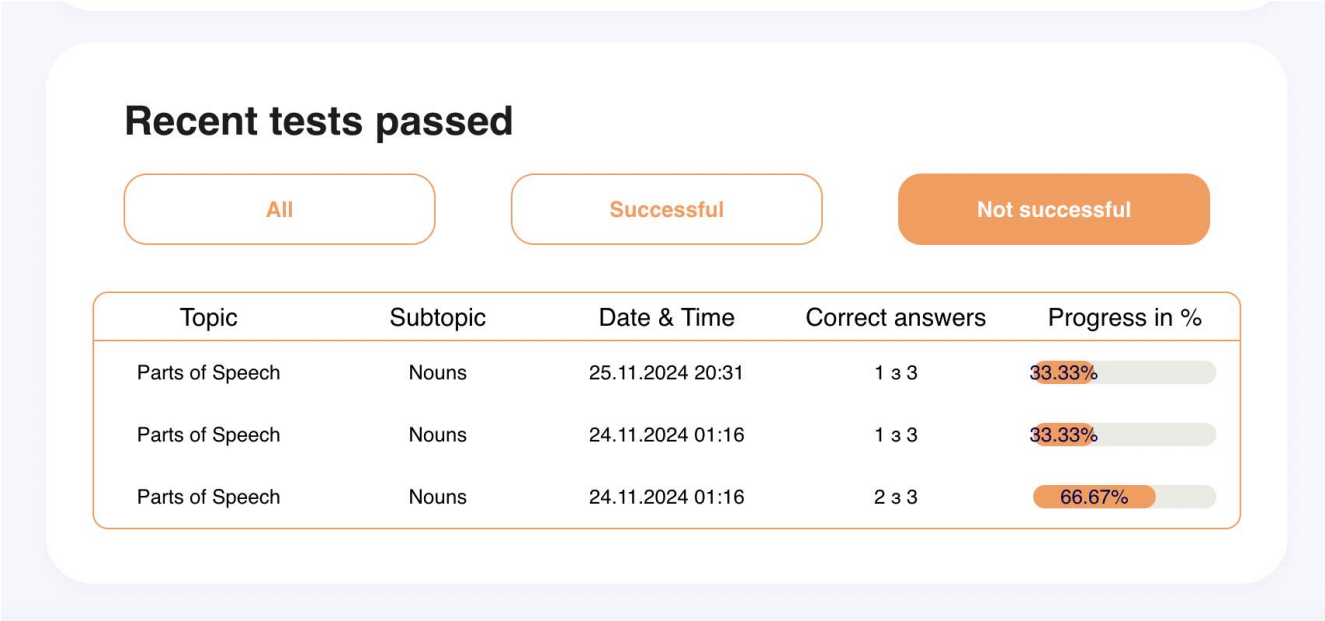

Figure A.5 - History of the last failed tests with information on date, subcategory and percentage progress

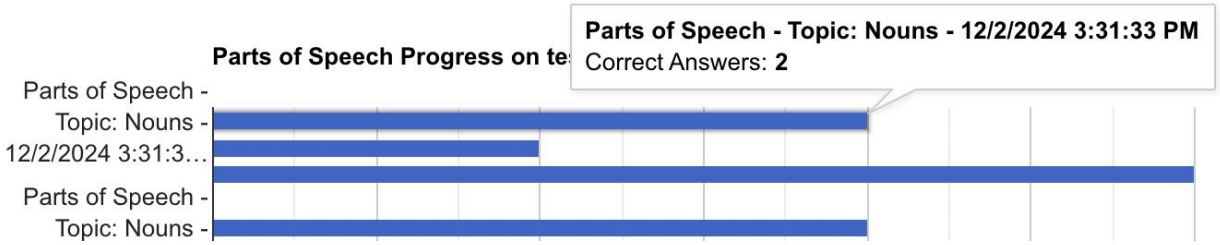

Figure A.6 - Progress on the ‘Parts of Speech’ test with the ‘Nouns’ subcategory, including the number of correct answers for each test

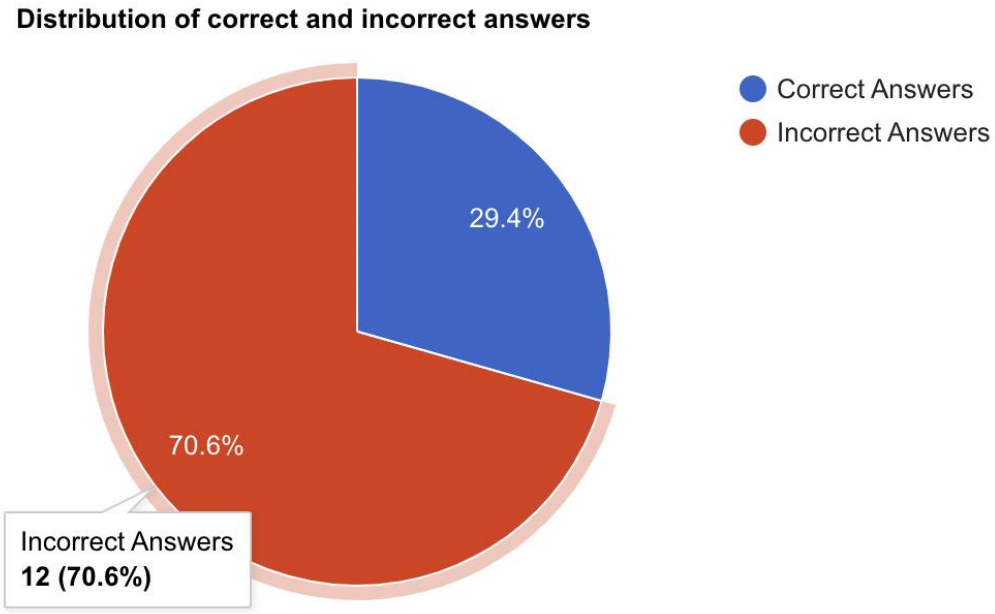

Figure A.7 - Distribution of correct and incorrect answers by test results

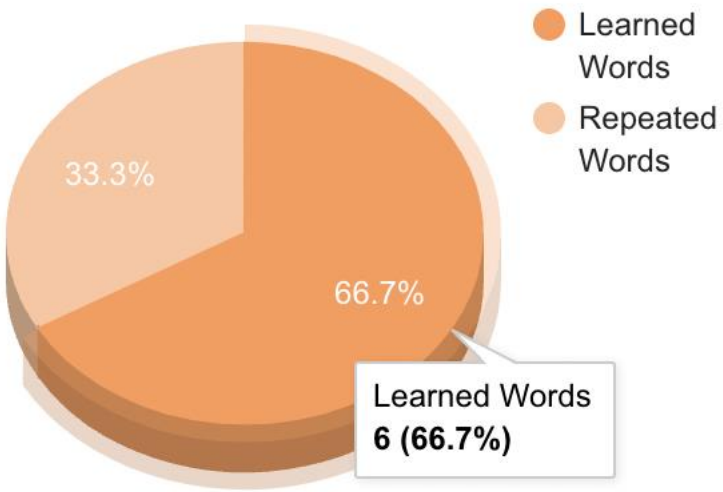

Figure A.8 - Statistics of learnt words

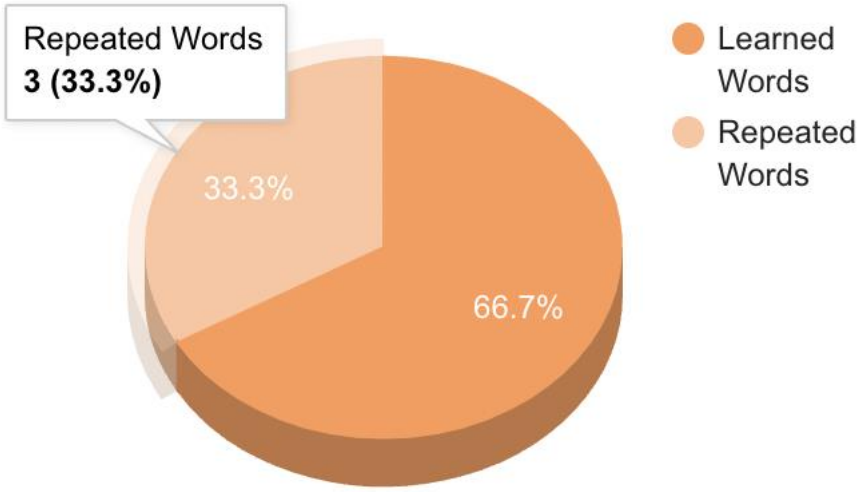

Figure A.9 - Statistics of repeated words

B.1. Home page code

```
import React, { useEffect, useMemo, useState, useCallback } from 'react';
import { collection, collectionGroup, getDocs, query } from 'firebase/firestore';
import { Bar } from 'react-chartjs-2'; // Importing Bar chart
import { Chart as ChartJS, CategoryScale, LinearScale, Title, Tooltip, Legend,
BarElement } from 'chart.js'; // Register necessary components for Bar chart
import 'react-calendar/dist/Calendar.css';
import './Calendar.scss';
import './Home.scss';
import { useSelector } from 'react-redux';
import { getUser } from '../../store/selectors/auth';
import moment from 'moment';
import pathNames from '../../routes/pathes';
import { Chart } from "react-google-charts"; // Import Google Charts

// Registering Chart.js components for Bar chart
ChartJS.register(CategoryScale, LinearScale, Title, Tooltip, Legend, BarElement);

const HomePage: React.FC<any> = ({ db }) => {
    const user = useSelector(getUser);
    const [filter, setFilter] = useState<string>('All');
    const [completedTests, setCompletedTests] = useState<any[]>([]);
    const [consecutiveDays, setConsecutiveDays] = useState<number>(0); // Track
consecutive active days
    const [wordsLearned, setWordsLearned] = useState<any[]>([]); // Store words
learned data

    // Fetch completed tests
    const fetchCompletedWorks = useCallback(async () => {
        const testTopic = query(collectionGroup(db, 'CompletedTests'));
        const querySnapshot = await getDocs(testTopic);
        let newData = querySnapshot.docs.map(doc => doc.data());

        // Log data for debugging
        console.log("Completed Tests Data:", newData);
        setCompletedTests(newData); // Store the completed tests for the user
    }, [db]);

    // Fetch words learned
```

```
    const fetchWordsLearned = useCallback(async () => {
        const wordsCollection = query(collection(db, 'Dictionary'));
        const querySnapshot = await getDocs(wordsCollection);
        let wordsData = querySnapshot.docs.map(doc => doc.data());

        // Log data for debugging
        console.log("Fetched Words Data:", wordsData);

        let userWords = wordsData.filter((data: any) => data?.correctSelections >=
7); // Only words that have been learned
        setWordsLearned(userWords);  // Store the words learned for the user
    }, [db]);

    useEffect(() => {
        fetchCompletedWorks().catch(error => console.error(error));
        fetchWordsLearned().catch(error => console.error(error));
    }, [fetchCompletedWorks, fetchWordsLearned]);

    // Calculate the dates for the Pie Chart
    const calculateConsecutiveActiveDays = () => {
        const completedTestDates = completedTests.map((test: any) =>
            moment(test.date.toDate()).format('YYYY-MM-DD') // Format date to
YYYY-MM-DD
        );
        console.log("Completed Test Dates:", completedTestDates); // Log dates for
debugging

        // Count unique dates
        const uniqueDates = [...new Set(completedTestDates)];
        console.log("Unique Dates:", uniqueDates); // Log unique dates for
debugging

        setConsecutiveDays(uniqueDates.length); // Set the number of unique dates
(consecutive days)
    };

    useEffect(() => {
        if (completedTests.length > 0) {
            calculateConsecutiveActiveDays(); // Recalculate when completedTests
is updated
        }
    }, [completedTests]);
```

```
    // Memoize the displayed tests (limit to 5)
    const recentlyCompletedTests = useMemo(() => {
        if (completedTests?.length > 4) return completedTests.slice(0, 5);
        return completedTests;
    }, [completedTests]);

    // Filter tests based on the current filter
    const filteredTests = useMemo(() => {
        if (filter === 'Successful') {
            return recentlyCompletedTests?.filter((test: any) =>
test.count_right_answers === test.totalQuestions);
        } else if (filter === 'Unsuccessful') {
            return recentlyCompletedTests?.filter((test: any) =>
test.count_right_answers < test.totalQuestions);
        }
        return recentlyCompletedTests;
    }, [recentlyCompletedTests, filter]);

    // Header labels for the table
    const headers = ['Topic', 'Subtopic', 'Date & Time', 'Correct answers',
'Progress in %'];

    // Calculate progress
    const calculateProgress = (count_right_answers: number, totalQuestions:
number) => {
        if (totalQuestions && count_right_answers >= 0) {
            return ((count_right_answers / totalQuestions) * 100).toFixed(2); //
Return progress in percentage
        }
        return '0';
    };

    // Handle the date and time display
    const formatDateTime = (date: any) => {
        if (date && date.toDate) {
            return moment(date.toDate()).format("DD.MM.YYYY HH:mm"); // Include
time (HH:mm)
        }
        return 'Invalid date';
    };

    // Calculate words learned per month and week
    const calculateWordsPerMonth = () => {
```

```
        const wordsByMonth: Record<string, Record<string, number>> = {}; // Store
words by week

        wordsLearned.forEach((word: any) => {
            if (word.correctSelections >= 7) {  // Only count words that have been
learned
                const learnedDate = moment(word.lastLearned.toDate()); // Assuming
'lastLearned' is a timestamp
                if (!learnedDate.isValid()) {
                    console.warn("Invalid date:", word.lastLearned);
                    return; // Skip invalid date
                }
                const monthYear = learnedDate.format('MM.YY'); // Format as MM.YY
for month-year grouping
                const weekOfMonth = learnedDate.week() % 4 || 4; // Determine
which week in the month (1-4)

                // Initialize week object if it doesn't exist
                if (!wordsByMonth[monthYear]) {
                    wordsByMonth[monthYear] = { week1: 0, week2: 0, week3: 0,
week4: 0 };
                }

                // Increment the count for the corresponding week
                wordsByMonth[monthYear][`week${weekOfMonth}`] += 1;
            }
        });

        // Convert the object to an array for charting
        return Object.entries(wordsByMonth).map(([monthYear, weeks]) => ({
            monthYear,
            week1: weeks.week1,
            week2: weeks.week2,
            week3: weeks.week3,
            week4: weeks.week4
        }));
    };

    // Prepare the chart data for words learned by month and week
    const wordsChartData = {
        labels: calculateWordsPerMonth().map((entry: any) => entry.monthYear), //
X-axis as month-year
        datasets: [
```

```
            {
                label: 'Week 1',
                data: calculateWordsPerMonth().map((entry: any) => entry.week1),
// Week 1 data
                backgroundColor: '#030155', // Bar color for week 1
                borderColor: '#030155',
                borderWidth: 1,
            },
            {
                label: 'Week 2',
                data: calculateWordsPerMonth().map((entry: any) => entry.week2),
// Week 2 data
                backgroundColor: '#33327B', // Bar color for week 2
                borderColor: '#33327B',
                borderWidth: 1,
            },
            {
                label: 'Week 3',
                data: calculateWordsPerMonth().map((entry: any) => entry.week3),
// Week 3 data
                backgroundColor: '#E2874B', // Bar color for week 3
                borderColor: '#E2874B',
                borderWidth: 1,
            },
            {
                label: 'Week 4',
                data: calculateWordsPerMonth().map((entry: any) => entry.week4),
// Week 4 data
                backgroundColor: '#FF9956', // Bar color for week 4
                borderColor: '#FF9956',
                borderWidth: 1,
            }
        ]
    };

    const chartOptions = {
        responsive: true,
        plugins: {
            tooltip: {
                callbacks: {
                    // Customizing tooltip to show the number of words learned
                    title: (tooltipItem: any) => {
                        const weekIndex = tooltipItem[0]?.datasetIndex; // Get the
```

```
week index (0 = Week 1, 1 = Week 2, etc.)
                        const weekNumber = `Week ${weekIndex + 1}`; // Calculate
which week it is (Week 1, Week 2, etc.)
                        return `Words learned in ${weekNumber}:`; // Display the
month-year and the week
                    },
                    label: (tooltipItem: any) => {
                        const wordsCount = tooltipItem.raw; // Get the number of
words for the hovered week
                        return `${wordsCount} words`; // Display the count
                    }
                }
            }
        },
        scales: {
            x: {
                title: {
                    display: true,
                    text: 'Month',
                }
            },
            y: {
                title: {
                    display: true,
                    text: 'Number of Words',
                }
            }
        }
    };

    // Google Chart data for Consecutive Active Learning Days (Donut chart)
    const googleChartData = [
        ['Label', 'Value'],
        ['Active Learning Days', consecutiveDays],
        ['Remaining Days', 30 - consecutiveDays] // Assuming 30 days as the goal
    ];

    return (
        <div className='Home'>
            <div className='LeftHomeWrapper'>
                <div className='TitleWrapper'>
                    <div className='TitleWrapper--firstRow'>
                        <div className='text1'>
```

```
                            <p>{`Hi ${user?.first_name}`}</p>
                            <p className='TitleWrapper--secondRow'>You are rock!
Your recomendation is here!</p>
                        </div>
                        <button className='TitleWrapper--thirdRow'
type={"button"}>
                            Recommendation
                        </button>
                    </div>

                </div>

                {/* Words Learned by Month and Week */}
                <div className='WordsLearnedComponent'>
                    <div className='WordsLearnedComponentflex'>
                    <h1 className='WordsLearnedComponent--title'>Words Learned by
Month</h1>
                    <button className="TitleWrapper--thirdRow"
                            onClick={() => window.location.href =
pathNames.dictionary}>
                        Go to Dictionary
                    </button>
                    </div>
                    <div className='WordsLearnedComponent--chart'>
                        <Bar data={wordsChartData} options={chartOptions}/>
                    </div>
                    <p>This histogram shows how many words you've learned each
week within a month, helping you track
                        your monthly progress.</p>
                </div>


                <div className='RecentlyComponent'>
                    <h1 className='table-wrapper--title'>Recent tests passed</h1>
                    <div className='filters-wrapper'>
                    <div className={`${filter === 'All' ? 'active' : ''}`}
onClick={() => setFilter('All')}>All
                        </div>
                        <div className={`${filter === 'Successful' ? 'active' :
''}`}
                             onClick={() => setFilter('Successful')}>Successful
                        </div>
                        <div className={`${filter === 'Unsuccessful' ? 'active' :
```

```
''}`}
                            onClick={() => setFilter('Unsuccessful')}>Not
successful
                        </div>
                    </div>
                    {filteredTests?.length ? (
                        <div className='subject-progress-list'>
                            <div className='subject-progress-list--header'>
                                {headers.map((header, index) => <div
key={index}>{header}</div>)}
                            </div>
                            <div className='subject-progress-list--body'>
                                {filteredTests.map((topicItem: any) => (
                                    <div key={topicItem?.id} className='subject-
progress-list--body--row'>
                                        <div
                                            className='subject-progress-list--
body--row--item'>{topicItem?.subject_title}</div>
                                        <div
                                            className='subject-progress-list--
body--row--item'>{topicItem?.topic_title}</div>
                                        <div
                                            className='subject-progress-list--
body--row--item'>{formatDateTime(topicItem.date)}</div>
                                        {/* Show date and time */}
                                        <div className='subject-progress-list--
body--row--item'>
                                            {/* Ensure the values exist and
calculate correctly */}
                                            {`${topicItem.count_right_answers ||
0} ɜ ${topicItem.totalQuestions || 0}`}
                                        </div>
                                        <div className='subject-progress-list--
body--row--item'>
                                            <div className='progress'>
                                                <div className='progress--
indicate' style={{
                                                    width:
`${calculateProgress(topicItem.count_right_answers || 0, topicItem.totalQuestions
|| 0)}%`,
                                                    color: '#030155',
                                                    backgroundColor: '#FF9956'
                                                }}>
```

```
{`${calculateProgress(topicItem.count_right_answers || 0, topicItem.totalQuestions
|| 0)}%`}
                                                    </div>
                                                </div>
                                            </div>
                                        </div>
                                    ))}
                                </div>
                            </div>
                        ) : (
                            <div className={'RecentlyComponent--not-result'}>
                                <h1>No tests have been passed yet!</h1>
                            </div>
                        )}
                    </div>
                </div>
                <div className='RightHomeWrapper'>
                    <div className={'account-card'}>

                        <div className="ConsecutiveDaysComponent">
                            <h1 className="ConsecutiveDaysComponent--
title">Consecutive Active Learning Days</h1>
                            <div className="google-chart-wrapper">
                                <Chart
                                    chartType="PieChart"
                                    data={googleChartData}
                                    options={{
                                        title: `Consecutive Active Learning Days`,
                                        is3D: true,
                                        slices: {
                                            0: {offset: 0.1, color: '#FF9956'},
                                            1: {color: '#cdcdcd'}
                                        },
                                        pieSliceText: 'percentage'
                                    }}
                                    width={'300px'}
                                    height={'300px'}
                                />
                            </div>
                            <p>Track how many consecutive days you've been actively
learning! Stay motivated to keep the
                                streak
```

```
                            going.</p>
                    </div>
                </div>
            </div>
        </div>
    );
};

export default React.memo(HomePage);
```

B.2. Dictionary page code

```
import React, { useEffect, useState, useCallback } from "react";
import { collection, getDocs, doc, setDoc } from "firebase/firestore";
import { useNavigate } from "react-router-dom";
import { Chart } from "react-google-charts"; // Import Google Charts
import "./dictionaty.scss";

const DictionaryPage: React.FC<{ db: any }> = ({ db }) => {
    const [dictionary, setDictionary] = useState<any[]>([]);
    const [loading, setLoading] = useState<boolean>(true);
    const [newWord, setNewWord] = useState({
        id: "",
        definition: "",
        example: "",
        synonyms: "",
    });
    const [showForm, setShowForm] = useState(false);
    const [wordsStatistics, setWordsStatistics] = useState({
        newWords: 0,
        learnedWords: 0,
        repeatedWords: 0,
    });
    const navigate = useNavigate();

    // Fetch dictionary data from Firebase
    const fetchDictionary = useCallback(async () => {
        try {
            setLoading(true);
            const querySnapshot = await getDocs(collection(db, "Dictionary"));
            const data = querySnapshot.docs.map((doc) => ({
                id: doc.id,
                ...doc.data(),
```

```
            }));
            setDictionary(data); // Store the fetched data in the state
        } catch (error) {
            console.error("Error fetching dictionary data: ", error);
        } finally {
            setLoading(false);
        }
    }, [db]);

    // Process the data to calculate words added, learned, and repeated per day
    const fetchWordsStatistics = () => {
        const newWords = dictionary.filter(word => word.correctSelections ===
0).length;
        const learnedWords = dictionary.filter(word => word.correctSelections >=
7).length;
        const repeatedWords = dictionary.filter(word => word.correctSelections > 0
&& word.correctSelections < 7).length;

        setWordsStatistics({
            newWords,
            learnedWords,
            repeatedWords,
        });
    };

    useEffect(() => {
        fetchDictionary(); // Fetch data on mount
    }, [fetchDictionary]);

    useEffect(() => {
        if (dictionary.length > 0) {
            fetchWordsStatistics(); // Calculate statistics when dictionary is
updated
        }
    }, [dictionary]);

    // Google Chart data for Word Statistics (Pie chart)
    const googleChartData = [
        ['Label', 'Value'],
        ['New Words', wordsStatistics.newWords],
        ['Learned Words', wordsStatistics.learnedWords],
        ['Repeated Words', wordsStatistics.repeatedWords]
    ];
```

```
    // Add a new word to the dictionary using the word as the document ID
    const addWordToDictionary = async (e: React.FormEvent) => {
        e.preventDefault();
        try {
            if (!newWord.id.trim()) {
                alert("Word cannot be empty.");
                return;
            }

            const wordDoc = {
                definition: newWord.definition,
                example: newWord.example,
                synonyms: newWord.synonyms,
                correctSelections: 0,  // Initialize the correctSelections field
to 0
            };

            // Add the new word to Firestore
            await setDoc(doc(db, "Dictionary", newWord.id.trim()), wordDoc); //
Use the word as the document ID
            fetchDictionary(); // Refresh the dictionary list
            setNewWord({ id: "", definition: "", example: "", synonyms: "" }); //
Clear the form
            setShowForm(false); // Hide the form
        } catch (error) {
            console.error("Error adding word to dictionary: ", error);
        }
    };

    return (
        <div className="DictionaryPage">
            <h1>Dictionary</h1>
            <div className="words-statistics">
                <h2>Word Statistics</h2>
                <Chart className="testChartword"
                       chartType="PieChart"
                       data={googleChartData}
                       options={{

                           is3D: true,
                           slices: {
                               0: {offset: 0.1, color: '#8D5CF6'},
```

```
                            1: {color: '#FF9956'},
                            2: {color: '#FFC59F'}
                        },
                        pieSliceText: 'percentage'
                    }}
                    width={'470px'}
                    height={'300px'}
                />
                <p>Track the number of new, learned, and repeated words.</p>
                <button className="buttonblue1" onClick={() =>
navigate("/quiz")}>Take the Quiz</button>
            </div>


            <button
                className="buttonblue1"
                onClick={() => setShowForm(!showForm)}
            >
                {showForm ? "Cancel" : "Add New Word"}
            </button>

            {showForm && (
                <form className="add-word-form" onSubmit={addWordToDictionary}>
                    <label>
                        <strong>Word:</strong>
                        <input
                            type="text"
                            value={newWord.id}
                            onChange={(e) =>
                                setNewWord({...newWord, id: e.target.value})
                            }
                            required
                        />
                    </label>
                    <label>
                        <strong>Definition:</strong>
                        <input
                            type="text"
                            value={newWord.definition}
                            onChange={(e) =>
                                setNewWord({...newWord, definition:
e.target.value})
                            }
```

```
                            required
                        />
                    </label>
                    <label>
                        <strong>Example:</strong>
                        <input
                            type="text"
                            value={newWord.example}
                            onChange={(e) =>
                                setNewWord({...newWord, example: e.target.value})
                            }
                        />
                    </label>
                    <label>
                        <strong>Synonyms:</strong>
                        <input
                            type="text"
                            value={newWord.synonyms}
                            onChange={(e) =>
                                setNewWord({...newWord, synonyms: e.target.value})
                            }
                        />
                    </label>
                    <button  type="submit">Add Word</button>
                </form>
            )}

            {loading ? (
                <div>Loading...</div>
            ) : dictionary.length > 0 ? (
                <div className="dictionary-list">
                    {dictionary.map((entry) => (
                        <div key={entry.id} className="dictionary-item">
                            {/* Show "Learned" label after 7 correct selections
*/}
                            {entry.correctSelections >= 7 && (
                                <span className="learned-label">Learned</span>
                            )}
                            <h2>{entry.id}</h2>
                            <p><strong>Definition:</strong> {entry.definition ||
"N/A"}</p>
                            <p><strong>Example:</strong> {entry.example ||
"N/A"}</p>
```

```
                            <p><strong>Synonyms:</strong> {entry.synonyms ||
"N/A"}</p>

                            {/* Show the correct selections count */}
                            {entry.correctSelections !== undefined && (
                                <div>
                                    <strong>Correctly selected: </strong>
                                    {entry.correctSelections} times
                                </div>
                            )}


                        </div>
                    ))}
                </div>
            ) : (
                <div>No words found in the dictionary!</div>
            )}


        </div>
    );
};

export default DictionaryPage;
```

B.3. Code of the progress page by topic

```
import React, { useEffect, useState, useCallback } from 'react';
import { collection, getDocs, query } from 'firebase/firestore';
import { useSelector } from 'react-redux';
import { getUser } from '../../store/selectors/auth';
import { Chart } from 'react-google-charts';
import './style.scss';

const SubjectProgressPage = ({ db, subjectId }: { db: any, subjectId: string }) =>
{
    const user = useSelector(getUser);
    const [completedTests, setCompletedTests] = useState<any[]>([]);
    const [subjectData, setSubjectData] = useState<any>(null);
    const [subjectProgress, setSubjectProgress] = useState<any>({});

    useEffect(() => {
```

```
        // Fetch subject details dynamically from Firebase
        fetchSubjectData();
        fetchCompletedWorks();
    }, [subjectId]);

    const fetchSubjectData = async () => {
        try {
            const subjectRef = query(collection(db, 'Subjects'));
            const querySnapshot = await getDocs(subjectRef);
            const subjects = querySnapshot.docs.map(doc => doc.data());

            const subject = subjects.find(subj => subj.id === subjectId); // Find
the subject by subjectId
            setSubjectData(subject); // Set subject data dynamically
        } catch (error) {
            console.error("Error fetching subject data:", error);
        }
    };

    // Fetch all completed tests for the current user
    const fetchCompletedWorks = async () => {
        try {
            const testTopic = query(collection(db, 'CompletedTests'));
            const querySnapshot = await getDocs(testTopic);
            const newData = querySnapshot.docs.map(doc => doc.data());

            // Filter the tests for the current user
            const userCompletedTests = newData.filter((data: any) => data?.uid ===
user?.uid);
            setCompletedTests(userCompletedTests);

            // Process data to include the topic_title
            await processTestsData(userCompletedTests);
        } catch (error) {
            console.error("Error fetching completed tests:", error);
        }
    };

    // Process the tests to organize by subject and topic
    const processTestsData = async (tests: any[]) => {
        const updatedTests = [...tests];

        updatedTests.forEach((test) => {
```

```
            const topicTitle = test.topic_title;  // 'topic_title' represents the
subtopic title directly

            if (!topicTitle) {
                test.topicData = { title: 'No Subtopic' };  // If no topic_title,
mark as "No Subtopic"
            } else {
                test.topicData = { title: topicTitle };  // Assign the topic title
directly
            }
        });

        setCompletedTests(updatedTests);  // Update the completed tests state with
topic title
    };

    const calculateSubjectProgress = useCallback(() => {
        const progressData: any = {};
        const topicsSet = new Set();  // To track unique topics

        completedTests.forEach((test: any) => {
            const subject = test.subject_title;
            const correctAnswers = test.count_right_answers;
            const date = test.date.toDate(); // Get the test date
            const formattedDate = `${date.toLocaleDateString()}
${date.toLocaleTimeString()}`; // Format date and time
            const topic = test.topicData?.title || 'No Subtopic';  // Ensure the
topic is not undefined

            // Add topic to the set to count unique topics
            topicsSet.add(topic);

            if (!progressData[subject]) {
                progressData[subject] = [];
            }

            progressData[subject].push({
                correctAnswers: correctAnswers,
                date: formattedDate, // Add date and time
                topic: topic,   // Add topic (subtopic title)
            });
        });
```

```
        // Add the number of unique topics
        setSubjectProgress({ progressData, uniqueTopicsCount: topicsSet.size });
    }, [completedTests]);

    useEffect(() => {
        if (completedTests.length) {
            calculateSubjectProgress();
        }
    }, [completedTests, calculateSubjectProgress]);

    // Calculate the percentage of correct answers for the Radial Gauge
    const calculateProgressPercentage = () => {
        let totalCorrectAnswers = 0;
        let totalQuestions = 0;

        completedTests.forEach((test: any) => {
            totalCorrectAnswers += test.count_right_answers;
            totalQuestions += test.totalQuestions;
        });

        if (totalQuestions === 0) return 0;  // Avoid division by zero

        return (totalCorrectAnswers / totalQuestions) * 100;  // Calculate
percentage
    };

    const progressPercentage = calculateProgressPercentage();

    // Prepare data for the Bar Chart (Topic Comparison)
    const prepareBarChartData = () => {
        const chartData: { subject: string, data: [string, number][] }[] = [];

        Object.keys(subjectProgress.progressData || {}).forEach((subject) => {
            const subjectData = subjectProgress.progressData[subject];

            if (subjectData.length > 0) {
                const correctAnswers = subjectData
                    .map((item: { correctAnswers: number }) =>
item.correctAnswers)
                    .filter((correctAnswer: number) => correctAnswer !== 0.5); //
Remove 0.5 values

                chartData.push({
```

```
                    subject,
                    data: [
                        ['Date and Time', 'Correct Answers'],
                        ...subjectData.filter((item: any) => item.correctAnswers
!== 0.5).map((item: any) => [
                            `${subject} - Topic: ${item.topic} - ${item.date}`, //
Concatenate Subject, Topic (Subtopic), and Date
                            item.correctAnswers,
                        ]),
                    ],
                });
            }
        });

        return chartData;
    };

    // Prepare data for the Pie Chart (Correct vs Incorrect Answers)
    const preparePieChartData = () => {
        let correctCount = 0;
        let incorrectCount = 0;

        completedTests.forEach((test: any) => {
            const correctAnswers = test.count_right_answers;
            const totalQuestions = test.totalQuestions;

            if (correctAnswers === totalQuestions) correctCount++;
            else incorrectCount++;
        });

        return [
            ['Performance', 'Count'],
            ['Correct Answers', correctCount],
            ['Incorrect Answers', incorrectCount],
        ];
    };

    const barChartData = prepareBarChartData();
    const pieChartData = preparePieChartData();

    return (
        <div className="subject-progress-page">
            <div className="subject-progress-wrapper">
```

```
                <div className="subject-progress-wrapper--upper-side">
                    <div className="subject-progress-information-wrapper">
                        <h1>{subjectData?.title}</h1>
                        <div>
                            <img src={process.env.PUBLIC_URL +
'/images/lessonsIcon.svg'} alt="Lessons icon"/>
                            <p>{`${completedTests.length} tests`}</p>
                        </div>
                        <div>
                            <img src={process.env.PUBLIC_URL +
'/images/lessonsIcon.svg'} alt="Lessons icon"/>
                            <p>{`${subjectProgress.uniqueTopicsCount || 0}
topics`}</p>
                        </div>

                    </div>
                    <div className="subject-progress-information-wrapper1">

                        <div className="gauge-container">
                            <h3>Progress on the topic</h3>
                            <Chart
                                chartType="Gauge"
                                data={[
                                    ['Label', 'Value'],
                                    ['Progress', progressPercentage],  // Use
calculated percentage
                                ]}
                                options={{
                                    width: 200,
                                    height: 200,  // Set height for better
visibility
                                    redFrom: 0, redTo: 50,
                                    yellowFrom: 50, yellowTo: 75,
                                    greenFrom: 75, greenTo: 100,
                                    minorTicks: 5,
                                    max: 100,
                                    majorTicks: ['0%', '25%', '50%', '75%',
'100%'],
                                    colors: ['#FF0000', '#FF6600', '#FFCC00',
'#99CC00', '#00FF00'], // Color gradient for different levels
                                    angleStart: 0, // Set the start angle for the
half circle
                                    angleEnd: 450, // Set the end angle for the
```

```
half circle (180 degrees)
                                }}
                            />
                        </div>
                    </div>

                </div>
                <div className="subject-progress-wrapper--down-side">
                    <h1>Progress in tests</h1>

                    {/* Bar Chart for Topic Comparison */}
                    {barChartData.length > 0 && barChartData.map((chart) => (
                        <div key={chart.subject}>
                            <h4 className="subjectheading">{chart.subject}</h4>
                            <Chart className="testChart"
                                chartType="BarChart"
                                data={chart.data}
                                options={{
                                    title: `${chart.subject} Progress on tests`,
                                    legend: { position: 'none' },
                                    hAxis: { title: 'Number of correct answers' },
                                    vAxis: { title: 'Tests' },
                                    height: 400,
                                    width: 800,
                                }}

                            />
                        </div>
                    ))}
                </div>

                    <div className="subject-progress-wrapper--down-side">
    {pieChartData.length > 0 && (
        <div className="rightwrongasnwers">
            <h3>Correct and incorrect answers</h3>
            <Chart className="testChart"
                   chartType="PieChart"
                   data={pieChartData}
                   options={{
                       title: 'Distribution of correct and incorrect answers',
                       height: 400,
                       width: 800,
                   }}
```

```
            />
        </div>
    )}



                </div>
            </div>
        </div>
    );
};

export default SubjectProgressPage;dot
```