

# Verbally – An AI-Powered Companion for Mastering English



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# FYP Completion Certificate

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# Verbally - An AI-Powered Companion for Mastering English

## Sustainable Development Goals

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9 ✓	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4 ✓	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals



Range of Complex Problem Solving			
	Attribute	Complex Problem	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	✓
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	Complex Activities	

1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	✓
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

## Abstract

In today's digital age, English learning remains a fragmented process, requiring students to rely on a variety of online courses and applications to develop different language skills. However, these solutions often lack clear feedback and structured learning paths, limiting their effectiveness in providing an adaptive learning experience. This project proposes Verbally, an AI-based English learning system designed to transform traditional e-learning platforms from simple content delivery tools into intelligent systems capable of assessment and personalized feedback. The key objective of the project is to create an easy to use, complete, scalable, and self-paced. It should be able to test a learner's skills in all of the core English skills, such as vocabulary, grammar, listening, speaking, writing. The framework is constructed based on a robust three-tier client-server model. React is used to create the front end, which is deployed into Vercel, the backend is constructed using NestJS and run on Railway. Aiven is used to manage PostgreSQL database. In accent based speech assessment module, it uses Deepgram Speech to Text and the Montreal Forced Aligner to provide precise, phoneme level and accent aware feedback. It utilizes the Google Gemini API, which is a generative AI model, to automatically create lesson content, writing prompts and test questions. The common European Framework of Reference of Languages is utilized in the platform to put students to A1-C2 proficiency levels. A Level-Up module allows learners to advance to the next level by taking combined vocabulary, grammar, writing and speech tests. A hybrid python microservice architecture is used for speech scoring pipeline, which uses a lot of processing power. The system also has a real-time messaging feature, and it allows learners to be socially connected. The system aims with response times under a second, 99 percent up-time and capability to service at least 100 number of concurrent users dependent on its beta. This demonstrates that it is a suitable and practical alternative to discontinuous English learning solutions.

**Keywords:** English Language Learning, Artificial Intelligence, Adaptive Learning, CEFR, Speech Analysis, Natural Language Processing, Generative AI, Deepgram, Montreal Forced Aligner, Gemini API, NestJS, React, Microservices Architecture, Adaptive Assessment, E-Learning

## **Dedication**

We would first like to present this project to Almighty God, who is our Creator, the origin of all wisdom, knowledge, and understanding. He is our strong column and our inspiration, without His grace and power we could not have made our way through this.

This work is also dedicated to our favourite parents, siblings and admired teachers. They have to be given a special sense of gratitude due to their unconditional love and sacrifices. Their positive sayings and teachings about persistence are engraved in our minds and that is what provided us with the power to resist all the failures that we met on our way.

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Lastly, this is dedicated to the spirit of endurance; the prayers of our elders never make us surrender no matter the odds and we are ultimately able to achieve our objective.

To our parents for their love and support

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We are also deeply thankful to the Department of Software Engineering at Bahria University. This project is the result of everything we have learned from them.

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# Chapter 1

## Introduction

Verbally is a web and mobile-based e-learning system that educates the English language via artificial intelligence. It provides an all-in-one solution to the English learning problems faced by people around the world. It provides modules aiding persons in enhancing their writing skills, speaking skills, vocabulary, grammar and listening skills. This platform will assist individuals to unlock the world's opportunities and feel confident. Verbally leverages the Common European Framework of Reference of Languages (CEFR) to personalize the content to the learner based on their level of proficiency ranging between A1 and C2. It integrates advanced technologies like Google Gemini API for content generation [7], Google TTS for text to speech [13], Deepgram for speech to text transcription [12] and the Montreal Forced Aligner (MFA) for a detailed phoneme level analysis [6].

This system provides AI feedback in all language skills. One of the most interesting features of Verbally is accent-specific feedback. The platform includes a social feature such as friends connection and real time messaging. Verbally is designed to make high quality, personalized English language education accessible to everyone.

### 1.1 Motivation

English language is the major language of the world. Regrettably, many of the global population cannot get good quality schooling in the English language. This has been caused by financial, geographical and technological constraints. In nations such as Pakistan, people find it difficult to get professional and academic chances due to being incompetent in English language. The reason is that they do not have access to formal learning materials [15].

The drive of Verbally is based on this problem. Most e-learning applications are single purpose. This will make the user alternate between different applications to use grammar, write, vocabulary, speak and listen. This interferes with learning and prevents the learners in keeping track of their progress.

One way of solving these problems was through verbally. It is one platform which encompasses all the fields of English language learning. Through it, we offer a feedback-driven and personalized learning experience with the assistance of AI. English

language mastery was something that could only be obtained by costly personal training in the old days. Luckily to us we have come up with Verbally such that we are providing quality language learning education to everyone.

## 1.2 Objectives

The general idea of the project is to create a comprehensive, AI-powered English language learning platform that serves as a single solution for all English learning needs. In order to do so, more specific objectives have been formulated as follows:

- **Onboarding and Leveling-Up based on CEFR:** To develop an onboarding placement test, which measures the current level of a learner in English and provides him or her with a CEFR level, namely A1, A2, B1, B2, C1 or C2. To also develop Level-Up module whereby learners can upgrade a level as they feel that they have acquired sufficient proficiency in English. They will be tested though and only then will they be able to level up.
- **A Speech Assessment Module:** There will be two types of speech assessment modules. One is to do fluency and one to do accent-specific feedback. The conversion of speech to text and analysis of phonemes at a phoneme level with Gemini and the Montreal Forced Aligner [6] will enable the provision of real-time feedback on pronunciation, fluency, rhythm, prosody, and accent guide (assuming the user want accent-specific feedback).
- **In order to Have an AI-powered Lesson Generation engine:** To use the Google Gemini API [11] to genetically create lesson content, writing prompts, grammar tests and listening activities at levels appropriate to each learner, so that each learner is given a continually differentiated learning experience that is tailored to his or her individual proficiency level.
- **In order to design a multi-skill learning platform:** To create six multi-skill learning modules with vocabulary, grammar, writing, listening, and speaking components, with structured practice and AI-generated feedback to help the learners make consistent improvement in all core English competencies measurable.
- **To design a resilient, low-risk three-tier architecture:** To design a strong client-server application by using React on the frontend, NestJS[8] and FastAPI on the back end, and a PostgreSQL[9] database with Aiven to manage all interactions

between the platforms, making sure that all of these interactions are responsive, scalable, and secure.

- **To Incorporate Social Networking and Community Functionality:** To create a friendship and real-time communication feature based on WebSocket communication [14], thereby allowing learners in the platform to communicate with each other, share their progress, and positively motivate a community of English language learners.
- **To Design an Accessible and Responsive User Interface:** To design a minimalist, user-intuitive, and completely responsive user interface that supports Web Content Accessibility Guidelines, meaning that the platform can be used by all types of devices and screen size and must be accommodating to a user with any physical impairment.

### 1.3 Main contributions

Verbally is an interesting advancement in the area of AI-based language learning. Although there are a number of places already in this area, there is a uniqueness in Verbally, which is both technically rich and broad enough to cover a fairly limited number of competitors can do at the same time..

- **An All in one English Learning Solution:** The current platforms focus on a specific set of language skills. Duolingo is mainly gamified and rather goal-oriented to vocabulary and basic grammar, which means it does not provide any significant feedback on meaningful writing or speaking. Throughout, Elsa Speak specialises in pronunciation training only, as opposed to grammar, writing and listening. ChatGPT and other generative AI, despite their chat-powered functionality, are an unstructured general-purpose tool where there is no curriculum, no proficiency tracking and no formal evaluation system [1]. Verbally fills all these lapses through the provision of six fully integrated learning modules in a single unified platform that monitors the developments in all the areas of the skills at the same time.
- **Accent-Specific AI Speech Feedback:** One of the most unique technical additions of Verbally is the accent oriented speaking module. Students will be able to choose between an accent in American and British English and will get a detailed instruction on whether their phoneme production can be compared to the native speaker

standards, something that cannot be currently presented by any direct competitor, in combination with more comprehensive language skills testing.

- **CEFR-Aligned Adaptive Learning:** In contrast to Duolingo, which has its own system of progression, Verbally adapts its complete system of learning to the internationally recognized Common European Framework of Reference of Languages. This provides globally recognized proficiency designation to the learners which has real world implications in terms of academic, career, and immigration. The content generation engine, which is Google's Gemini API, dynamically creates all assessments and learning materials up to the current level of the learner in the CEFR.
- **The democratization of access to quality English education:** It may be the biggest thing that Verbally is able to offer to education equity. Quality, individualized learning has always been available only to those who are able to pay private teachers, or to very costly language classes. Verbally enables this aspect of teaching to everyone with an internet connection, though it is especially powerful in such areas as South Asia (e.g. Pakistan) where proficiency in English can act as a social and economic driver and quality teaching is lacking.
- **Social Learning and Peer Connectivity:** Unlike most language learning websites that view learning as individual process, Verbally incorporates a social networking layer that enables learners to meet, make friend requests and interact via a live chat system. This communal aspect brings in a sense of accountability, inspiration and peer involvement, which is predominantly lacking in competitors.

## 1.4 Report organisation

The rest of this thesis is structured in the following way:

- **Chapter 2:** Background Study/Literature Review is a summary of currently available language learning technological solutions such as Duolingo and Elsa Speak, and a discussion of current-state AI speech recognition and natural language processing methods.
- **Chapter 3:** System Requirements describes both the functional and non functional requirements of Verbally with a detailed use case on the requirements of the learner and administrator and CEFR compatible assessment criteria.

- **Chapter 4:** System Design describes the hybrid modular monolith-microservice design, the MVC architecture method and the logical data models to be applied to support the multi-skill learning and real-time feedback domains.
- **Chapter 5:** System Implementation explains the development plan and how specific tools, such as the Gemini API, Montreal Forced Aligner and Deepgram are integrated into the AI pipeline.
- **Chapter 6:** System Testing and Evaluation presents the testing strategy and results for each learning module, verifying the accuracy of AI evaluations and system performance under various scenarios.
- **Chapter 7:** Conclusion summarizes the project's contributions toward democratizing English education and proposes future work for further latency optimization and expanded skill modules.

## **Chapter 2**

### **Background Study/Literature Review**

The increasing need of a quick and efficient device to learn languages has fueled business and research innovations in the sphere of AI-education. This chapter summarizes the existent platforms, technologies, and academic literature that were the most applicable to the design and development of Verbally and where the existing solutions cannot be found and how Verbally will fill those gaps.

#### **2.1 Current Solutions and Platforms**

##### **2.1.1 Duolingo**

Duolingo is certainly the most popular language learning app in the world, and has more than 500 million registered users. Its system is based on gamification as a language learning program, with streaks, points earned, and levels achieved to keep the user interested. Its advantage is that it is easy to use and that it can be used in order to develop the habits of basic vocabulary and grammar with the help of repetition. Nonetheless, in the scholarly literature on L2 learning, Duolingo has frequently been criticized as being too superficial. There is no constructive form of feedback on spoken output provided by the platform, and the writing activities are mostly of a fill-in-the-blank, as opposed to free-form writing. Duolingo is not of much help to learners who are going to advance their conversation levels.

##### **2.1.2 Elsa Speak**

Elsa Speak is a pronunciation training application, a specialized AI-powered application where deep-learning models analyze the speech of the learners and give them feedback concerning the type of phonemes, stress, and intonation. It is among the most technologically advanced pronunciation aids to consumers and is a formidable reference point to speech evaluation. Nonetheless, it is very limited in its scope. Elsa Speak will offer no grammar, vocabulary, writing, listening, or reading comprehension curriculum, but instead, it only covers the speaking aspect of learning language. This implies that students have to use other platforms to fill the other areas of skills contributing to the same issue of fragmentation which Verbally attempts to address. Moreover, Elsa Speak does not position its

material or development according to any globally established framework like the CEFR, which makes it hard to differentiate the developments of learners in a meaningfully global concept.

### **2.1.3 Babbel**

Babbel is a subscription-based language study program, which provides expertly created courses by professional linguists. It deals with grammar, vocabulary, and conversational practice, and is typically considered a more pedagogically rigorous course of study than Duolingo. Nevertheless, Babbel is more or less a static pre-authored content, i.e., it does not dynamically alter in response to the performance of an individual learner. Its speech recognition is a simplistic tool in comparison with specific apps such as Elsa Speak and there is limited free form writing evaluation along with no AI-based writing feedback. Similar to the majority of its competitors it is also not equipped with a social networking feature which would enable the learners to interact and communicate between each other.

### **2.1.5 Rosetta Stone**

Rosetta Stone is a one of the oldest and the most established language learning software brand. It is an image-driven, immersion based language learning tool that has speech recognition on pronunciation training. It is however a lot more costly than most of the options and to some extent might be confusing to those learners who do not like to be immersed in the methodology as the explicit grammar instruction provided under this approach may prove confusing. Although it has speech recognition technology, it lacks the phoneme level details of what the modern AI-based tools can offer.

## **2.2 Current AI-based Language Learning Methods.**

### **2.2.1 Speech Recognition and Pronunciation Test**

Development of deep learning architectures has seen progress in automatic Speech Recognition. Initial ASR systems were based on Hidden Markov Models with Gaussian Mixture Models to decode the acoustic features to sequences of phonemes. Although these systems worked well then, they lacked resilience to accent change and noisy background. These methods have been mostly supplanted by modern deep learning-based ASR systems, which can achieve significantly lower word error rates and much more flexibility to a variety

of speech patterns, as reported by Radford et al. (2022) [2] when training the Whisper model of OpenAI.

Verbally use Google speech-to-text and text-to-speech [13] features to support audio conversion in its speaking and listening feature. The multimodal architecture of Gemini enables it to take the form of spoken input and naturalistic audio output at the same API, complexifying the system architecture, but producing high-quality products. In the case of pronunciation assessment, Verbally uses the Montreal Forced Aligner [6], which graphs the speech to desired phoneme combinations by applying forced alignment between the spoken sound and the text. It allows the system to accurately tell the phonemes a learner mirrors, the way his stress patterns are rather different than that of the target accent, and the areas of his prosody and rhythmic mismatch. This phoneme-quality diagnostics, coupled with AI-created corrective feedback via the Gemini API [11], is the technical base of the speaking module of Verbally, and a considerably more advanced technique than the bare accept/reject pronunciation scoring applied by other apps such as Duolingo.

### **2.2.2 Writing Assessment Natural Language Processing.**

The subject of automated writing evaluation is not a new one, and has been actively studied over a few decades. Earlier models, including e-rater, created at Educational Testing Service, employed feature-based methods to evaluate predictive grammatical correctness, vocabulary coverage and discourse coherence. More recent research has shown that the large language models can provide full writing feedback using human consistency and accuracy. Mizumoto and Eguchi (2023) demonstrated that GPT-based models can produce detailed, criterion-referenced feedback on the writing of learners that is both pedagogical and linguistically appropriate [3]. Leverages this potential verbally using the Gemini API which analyzes writing entries by learners and provides structured feedback on grammar, sentence structure, vocabulary use and coherence.

### **2.2.3 CEFR-based Proficiency Frameworks and Adaptive Learning.**

The most popular foreign standard of describing language proficiency is the Common European Framework of Reference of Languages. A study conducted by North (2014) showed that the settings of assessment that are CEFR [4] aligned yield more stable and transferable measurements of proficiency than platform specific systems. The efficacy of

adaptive learning systems, which can modify the difficulty of the content following shown performance, has also been selected as suitable to confirm by several studies. The use of intelligent tutoring systems by Corbett and Anderson brought about the fact that adaptive feedback and difficulty adjustment has a tremendous impact on enhancing learning outcomes as opposed to the fixed-curriculum approach. Verbally implements these concepts by having the levels of CEFR central to any content production and evaluation and ensuring that learners are treated to always access material that is matched to their current level of capabilities.

#### **2.2.4 Social Learning and Gamification in E-Learning**

The beneficial influence on learner motivation and retention in online learning is constantly shown to be supported by the use of gamification and social aspects (Sooko et al., 2020). In an extensive review of gamification in education, Dichev and Dicheva (2017) discovered that factors like tracking of progress and achievement badges, as well as streaks, play a crucial role in enhancing the engagement and persistence level among learners [5]. On the same note, the research studies done on the social learning theory which were based on the research conducted by Vygotsky argue the significance of peer contact and group work when learning a language. Bradyotically takes into account each of the two dimensions with its achievement and streak system and its live social messaging and friend connection that it recognizes that the challenge of sustained language learning is not only a cognitive one.

## Chapter 3

### System Requirements

#### 3.1 System Level Use Case Diagram

Figure 3.1 depicts the use case diagram of Verbally system, an AI-based device to learn a foreign language, which outlines the main interaction points between the system and the two major user jobs, i.e., Learner and Admin. The Learner starts with signing up or logging in and then proceeds to an onboarding validation to make the learning process personalized. The main functionalities would be practicing listening, writing, vocabulary, grammar, and speaking (fluency and accent) as well as other options, such as real-time chat, word of the day, grammar lessons, and tips. The system also allows learners to monitor progress, maintain vocabulary and unlock accomplishments, encouraging further improvement.

Admin takes care of running the systems with the use of the Admin dashboard, where users are managed, roles or status are updated accordingly, and the system is properly managed. Speech processing, vocabulary support and content generation are further facilitated with other AI services and APIs, which is integrated with the platform to make it more intelligent and interactive. Relationships like <<include> and <|human|>The relationships like, include and extend are meant to denote the functional dependence and optionality of the system emphasizing its modular and adapting design.

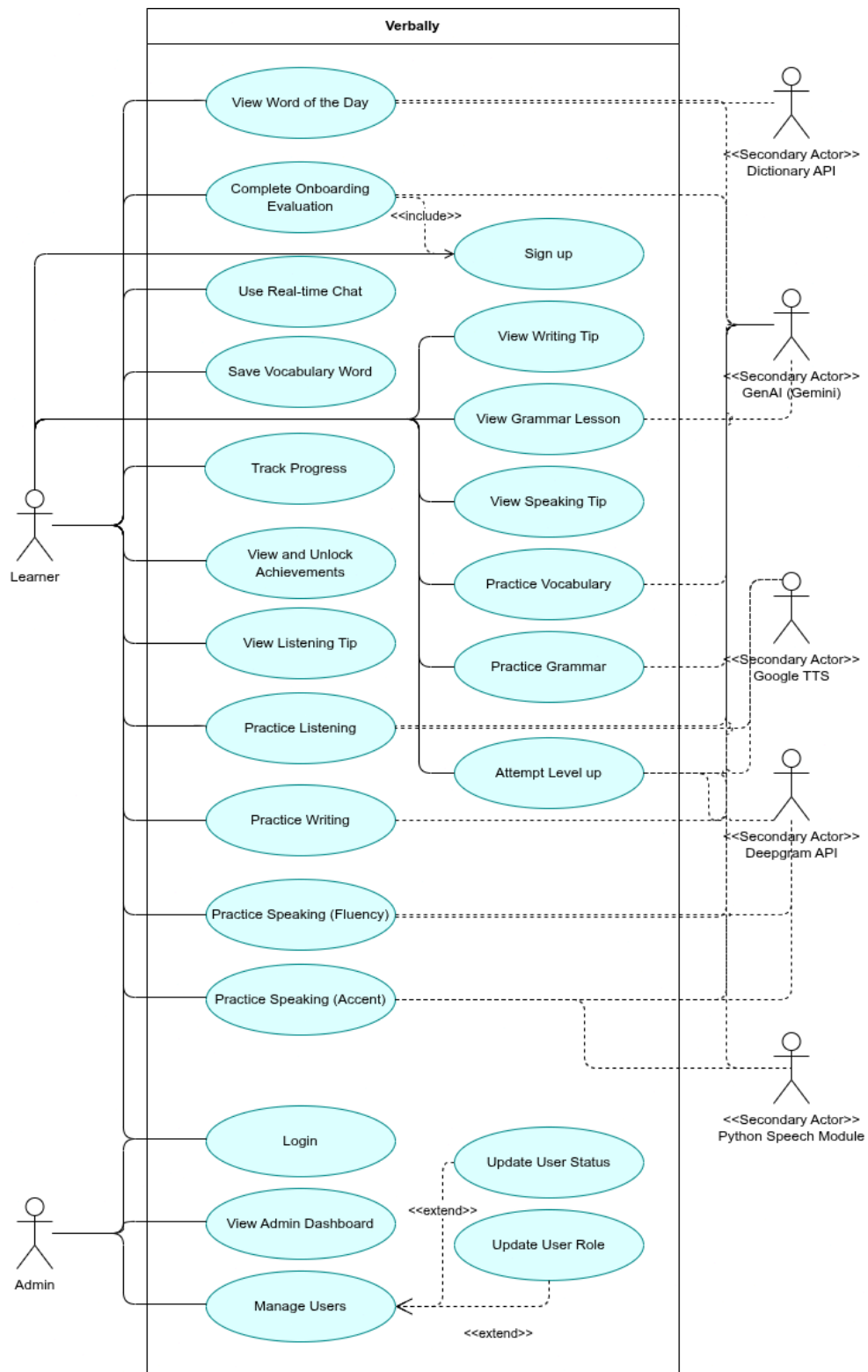


Figure 3.1: A High Level Use Case Diagram of Verbally

## 3.2 Detailed Use Cases

### 3.2.1 Learner Management

#### 3.2.1.1 Login

The login use-case in the table below defines the steps to authenticate a user.

**Table 3.1: Use-Case Description of Learner Login**

<b>Use Case ID:</b>	UM - 001	
<b>Use Case Name:</b>	Authenticate User	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be registered.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"><li>1. The User enters their credentials.</li><li>2. The system sends the credentials to the system. If the credentials are valid, the User is successfully logged in.</li></ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User enters their username and password in the relevant fields. The User clicks on the 'Login' button.	The system verifies the credentials. If the credentials are valid, the User is redirected to the Home Page.
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>

1.a	The User enters invalid credentials.	2.a If the User's credentials are invalid, a clear error message is displayed.
1.b	The User tries to login without entering any credentials.	2.b If the user doesn't enter any credentials, they will be asked to fill the form fields.

### 3.2.1.2 Signup

The signup use-case in the table below defines the steps to register a user.

**Table 3.2: Use-Case Description of Learner Signup**

<b>Use Case ID:</b>	UM - 002	
<b>Use Case Name:</b>	Signup	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must not have an account with the same email.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User enters their credentials.</li> <li>2. If the email is not already taken, the User will get a confirmation email.</li> <li>3. If the User confirms, they will be given access to their new account.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User enters valid 'Full Name', 'Email', 'Password', and 'Confirm Password' into	The system first validates the inputs in the form fields and then performs validation checks on the credentials.

	the form fields and clicks on 'Signup'.	If they are valid, the user is shown a message indicating a successful signup.
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User enters credentials which do not satisfy input field constraints (e.g., empty fields, very short password, incorrect email format etc.)	2.a If the User enters credentials which do not satisfy input field constraints, the User will be displayed messages under input fields (e.g., Username field is empty). The User won't be able to sign up until they enter the proper credentials.
1.b	The User enters an email address which has already been taken.	2.b The user will be displayed a message showing that the email already exists.

### 3.2.1.3 Complete Onboarding Evaluation

The use-case in the table below defines the steps to onboard a new user and determine their CEFR level.

**Table 3.3: Use-Case Description of Complete Onboarding Evaluation**

<b>Use Case ID:</b>	UM - 003
<b>Use Case Name:</b>	Complete Onboarding Evaluation
<b>Actor(s):</b>	Learner
<b>Pre-Conditions:</b>	The User must be authenticated and using their account for the first time.

<b>Priority:</b>		High
<b>Basic Flow:</b>		<ol style="list-style-type: none"> <li>1. The User logs in for the first time.</li> <li>2. The User is greeted and given a written assessment to complete to determine their current English level.</li> <li>3. The User is assigned their English level.</li> </ol>
<b>Actor Actions</b>		<b>System Response</b>
1	The User logs in successfully for the first time.	The system redirects the User to a written assessment page.
2	The User completes the written assessment and clicks on 'Submit Assessment'.	The system determines the CEFR level (e.g., A1, A2, B1, B2 etc.) and assigns it to the user. The User is then shown their level.
3	The User clicks on 'Start Learning'.	The User is redirected to the home page.
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User does not meet the word limit of the written assessment.	2.a The system will ask the user to write more.
1.b	The User writes what does not meet the criteria of the written assessment.	2.b The system will assign the User a CEFR level of A1.

1.c	The user writes in a different language	2.c The user will be shown an error and asked to rewrite the assessment in English.
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### 3.2.1.4 View Word of the Day

The use-case in the table below defines the steps to view the word of the day.

**Table 3.4: Use-Case Description of View Word of the Day**

<b>Use Case ID:</b>	UM - 004	
<b>Use Case Name:</b>	View Word of the Day	
<b>Actor(s):</b>	Learner and Dictionary API	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User must be on the modules page.</li> <li>2. The Dictionary API will fetch a word to display to the user.</li> <li>3. The User will be able to view the word of the day.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User logs in successfully or visits the module page.	The system will use the Dictionary API to fetch a word with its details (e.g. meaning, pronunciation, etc.) to display to the user.
2	The User will be able to view the word of the day	

### 3.2.1.5 Save Vocabulary Word

The use-case in the table below defines the steps to save a word.

**Table 3.5: Use-Case Description of Save Vocabulary Word**

<b>Use Case ID:</b>	UM - 005	
<b>Use Case Name:</b>	Save Vocabulary Word	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	<ol style="list-style-type: none"><li>1. The user must be on the modules page.</li><li>2. The user must click on the save icon in the 'word of the day card'</li><li>3. The user will be shown that the word is saved.</li></ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User logins successfully or visits the module page.	The system will display the user the 'word of the day' along with the save icon button.
2	The User will click on the save icon button.	The system will display a message to show that the word has been saved successfully.

### 3.2.1.6 Practice Vocabulary

The use-case in the table below defines the steps to practice vocabulary by taking a vocabulary quiz.

**Table 3.6: Use-Case Description of Practice Vocabulary**

<b>Use Case ID:</b>	UM - 006	
<b>Use Case Name:</b>	Practice Vocabulary	
<b>Actor(s):</b>	Learner and GenAI (Gemini)	
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User clicks on the ‘Start Quiz’.</li> <li>2. The GenAI generates a quiz for the User.</li> <li>3. The User solves and completes the multiple choice questions quiz.</li> <li>4. The User gets their result and feedback.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on the ‘Start Quiz’ button under the Vocabulary Section.	The system then redirects the User to the multiple choice quiz page. GenAI generates a quiz based on the ‘word of the day’.
2	The User completes the five multiple choice questions.	The system gives the result and feedback from GenAI.
<b>Alternative Course of Action (if any)</b>		

<b>Actor Action</b>		<b>System Response</b>
1.a	The User leaves the quiz without completing it.	2.a The quiz will not be completed and no feedback will be generated.

### 3.2.1.7 View Grammar Lesson

The use-case in the table below defines the steps to view a grammar lesson.

**Table 3.7: Use-Case Description of View Grammar Lesson**

<b>Use Case ID:</b>	UM - 007	
<b>Use Case Name:</b>	View Grammar Lesson	
<b>Actor(s):</b>	Learner and GenAI (Gemini)	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User must be on the modules page.</li> <li>2. The GenAI will generate a grammar lesson.</li> <li>3. The User must click on the grammar lesson card to see the complete lesson.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User logins successfully or visits the module page.	The system will use the Gemini API to fetch a grammar lesson to display to the user. Only a part of the lesson will be displayed to the User on the modules page.

2	The User can click ‘see more’ to see the complete grammar lesson.	The system will show the complete grammar lesson in a modal dialog box.
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### 3.2.1.8 Practice Grammar

The use-case in the table below defines the steps to practice grammar by taking a grammar quiz.

**Table 3.8: Use-Case Description of Practice Grammar**

<b>Use Case ID:</b>	UM - 008	
<b>Use Case Name:</b>	Practice Grammar	
<b>Actor(s):</b>	Learner and GenAI (Gemini)	
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User clicks on the ‘Start Quiz’.</li> <li>2. The GenAI generates a quiz for the User.</li> <li>3. The User solves and completes the multiple choice questions quiz.</li> <li>4. The User gets their result and feedback.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on the ‘Start Quiz’ button under the Grammar Section.	The system then redirects the User to the multiple choice quiz page. GenAI generates a quiz based on the ‘Grammar Lesson’.

2	The User completes the five multiple choice questions.	The system gives the result and feedback from GenAI.
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User leaves the quiz without completing it.	2.a The quiz will not be completed and no feedback will be generated.

### 3.2.1.9 View Speaking Tip

The use-case in the table below defines the steps to view a speaking tip.

**Table 3.9: Use-Case Description of View Speaking Tip**

<b>Use Case ID:</b>	UM - 009
<b>Use Case Name:</b>	View Speaking Tip
<b>Actor(s):</b>	Learner
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.
<b>Priority:</b>	Medium
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User must be on the modules pages.</li> <li>2. The system will generate a speaking tip for the user.</li> <li>3. The User will be able to view the tip.</li> </ol>

Actor Actions		System Response
1	The User logs in successfully or visits the module page.	The system will generate a random speaking tip based on the current CEFR level of the user.
2	The User will be able to see the speaking tip in the speaking section inside the 'speaking tip' card.	

### 3.2.1.10 Practice Speaking (Fluency)

The use-case in the table below defines the steps to practice English fluency using the impromptu speaking module.

**Table 3.10: Use-Case Description of Practice Speaking (Fluency)**

<b>Use Case ID:</b>	UM - 010
<b>Use Case Name:</b>	Practice Speaking (Fluency)
<b>Actor(s):</b>	Learner, GenAI (Gemini), and Deepgram
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.
<b>Priority:</b>	High
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User clicks on 'Practice Now'.</li> <li>2. The system gives the User a prompt to speak about.</li> <li>3. The User speaks about the topic given by the prompt.</li> <li>4. The System gives the User feedback on their speaking.</li> </ol>

<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on the 'Practice Now' button inside the 'Daily Speaking' card under the Speech section.	The system then redirects the User to the 'Daily Speaking' page. The system uses GenAI (Gemini) and provides the user with a prompt to speak about.
2	The User clicks on 'Start Speaking' and speaks about the topic (< 1 min). The User then clicks on 'Finish Recording'.	The system takes the User's audio using Deepgram transcription (speech-to-text) and gives feedback on fluency using GenAI (Gemini).
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User leaves the recording without submitting it.	2.a If the User leaves before submitting, their progress will be removed. The User will not be given any feedback.
1.b	The User tries to speak for longer than the time constraints (> 1 minute).	2.b The system will stop recording further when the time limit is exceeded.
1.c	The user speaks things unrelated to the given prompt.	2.c The system will display an error message indicating that what the user said was unrelated to what the user was asked.

### 3.2.1.11 Practice Speaking (Accent)

The use-case in the table below defines the steps to practice a user’s preferred accent (e.g. British or English) using the recitation module.

**Table 3.11: Use-Case Description of Practice Speaking (Accent)**

<b>Use Case ID:</b>	UM - 011	
<b>Use Case Name:</b>	Practice Speaking (Accent)	
<b>Actor(s):</b>	Learner, GenAI (Gemini), Deepgram, and Python Service.	
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User selects their preferred English accent and clicks on ‘Practice Now’.</li> <li>2. The system gives the User a text to recite.</li> <li>3. The User records their audio reciting the text.</li> <li>4. The System gives the User feedback on their accent.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User selects their goal English accent from a dropdown (e.g., American English or British English) and clicks on the ‘Practice Now’ button inside the ‘Accent Focus’ card under the Speech section.	The system then redirects the User to the ‘Accent focus’ page. The system provides the user a text to recite using GenAI (Gemini).

2	The User clicks on ‘Start Speaking’ and recites the text. The User then clicks on ‘Finish Recording’.	The system takes the User’s audio and gives feedback on their current accent and their preferred accent using Deepgram, Python Service and GenAI (Gemini).
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User leaves the recording without submitting it.	2.a If the User leaves before submitting, their progress will be removed.
1.b	The User tries to speak for longer than the time constraints (> 1 minute).	2.b The system will stop recording further when the time limit is exceeded.
1.c	The User recites things unrelated to the given prompt.	2.c The system will display an error message to inform the user that their recitation was unrelated to the given text.

### 3.2.1.12 View Writing Tip

The use-case in the table below defines the steps to view a writing tip.

**Table 3.12: Use-Case Description of View Writing Tip**

<b>Use Case ID:</b>	UM - 012
<b>Use Case Name:</b>	View Writing Tip
<b>Actor(s):</b>	Learner

<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User must be on the modules pages.</li> <li>2. The system will generate a writing tip for the user.</li> <li>3. The User will be able to view the tip.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User logins successfully or visits the module page.	The system will generate a random writing tip based on the current CEFR level of the user.
2	The User will be able to see the writing tip in the writing section inside the 'writing tip' card.	

### 3.2.1.13 Practice Writing

The use-case in the table below defines the steps to practice writing using the writing assessment module.

**Table 3.13: Use-Case Description of Practice Writing**

<b>Use Case ID:</b>	UM - 013
<b>Use Case Name:</b>	Practice Writing
<b>Actor(s):</b>	Learner and GenAI (Gemini)
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.

<b>Priority:</b>		High
<b>Basic Flow:</b>		<ol style="list-style-type: none"> <li>1. The User clicks on the ‘Start Practice’.</li> <li>2. The system gives the User a writing prompt.</li> <li>3. The User completes the writing practice.</li> <li>4. The system gives the User feedback on their writing.</li> </ol>
<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on the ‘Start Practice’ button under the Writing Section.	The system then redirects the User to a writing assessment page. The system gives a writing prompt using GenAI (Gemini).
2	The User completes the writing assessment and clicks on ‘Submit’.	The system gives a result and feedback using GenAI (Gemini).
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>
1.a	The User does not meet the word limit of the written assessment.	2.a The system will not allow the User to submit the writing assessment until they meet the word limit.
1.b	The User writes things unrelated to the writing prompt	2.b The system will give the user an error message that their writing does not match the given prompt.

### 3.2.1.14 View Listening Tip

The use-case in the table below defines the steps to view a listening tip.

**Table 3.14: Use-Case Description of View Listening Tip**

<b>Use Case ID:</b>	UM - 014	
<b>Use Case Name:</b>	View Listening Tip	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>4. The User must be on the modules pages.</li> <li>5. The system will generate a listening tip for the user.</li> <li>6. The User will be able to view the tip.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User logs in successfully or visits the module page.	The system will generate a random listening tip based on the current CEFR level of the user.
2	The User will be able to see the listening tip in the listening section inside the 'listening tip' card.	

### 3.2.1.15 Practice Listening

The use-case in the table below defines the steps to practice listening skills by listening to an audio recording and answering a question.

**Table 3.15: Use-Case Description of Practice Listening**

<b>Use Case ID:</b>	UM - 015	
<b>Use Case Name:</b>	Practice Listening	
<b>Actor(s):</b>	Learner, GenAI (Gemini), and Google TTS.	
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User clicks on the ‘Start Practice’.</li> <li>2. The system gives the user an audio to listen to.</li> <li>3. The User answers a question.</li> <li>4. The system gives the User the result.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on the ‘Start Practice’ button under the Listening Section.	The system then redirects the User to the listening assessment page. The system gives the user an audio to listen to (using GenAI and Google TTS) and a question to answer (generated using GenAI).
2	The User listens to the audio clip and answers the question.	The system gives a result and feedback (using GenAI)
<b>Alternative Course of Action (if any)</b>		

<b>Actor Action</b>		<b>System Response</b>
1.a	The User leaves the quiz without completing it.	2.a If the User leaves the quiz, their progress will be removed.
1.b	The User answers something unrelated to the listening prompt.	2.b The user will be shown an error message indicating that their answer is unrelated to the given audio.

### 3.2.1.16 Attempt Level-Up Module

The use-case in the table below defines the steps to take the CEFR level-up assessment to update a user's CEFR level (e.g. A2 to B1).

**Table 3.16: Use-Case Description of Attempt Level-Up Module**

<b>Use Case ID:</b>	UM - 016
<b>Use Case Name:</b>	Attempt Level-Up Module
<b>Actor(s):</b>	Learner, Deepgram, Google TTS, and Gemini API.
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.
<b>Priority:</b>	High
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User clicks on 'Level-Up'.</li> <li>2. The system redirects the User to the level-up page.</li> <li>3. The User solves the assessments.</li> <li>4. The system evaluates user performance. If the performance is good, the CEFR level is upgraded.</li> </ol>
<b>Actor Actions</b>	<b>System Response</b>

1	The User clicks on the 'Level-Up' in the navigation bar.	The system then redirects the User to the level-up page.
2	The User clicks on 'Start Assessment'.	The system gives a vocabulary assessment generated using GenAI to solve.
3	The User solves the vocabulary assessment and clicks on 'Next Section'.	The system gives a grammar assessment generated using GenAI to solve.
4	The User solves the grammar assessment and clicks on 'Next Section'.	The system gives a writing generated using GenAI assessment.
5	The User solves the writing assessment and clicks on 'Next Section'.	The system gives a listening test generated using GenAI and Google TTS assessment.
6	The User solves the listening assessment and clicks on 'Next Section'.	The system gives a speaking (fluency) assessment generated using GenAI and evaluated using Deepgram.
7	The User solves the speaking (fluency) assessment and clicks on 'Complete Assessment'.	The system will then give the user feedback and their final result using GenAI (upgrade CEFR level or not).
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>

1.a	The User leaves the assessment without completing it.	2.a The system will ask the User for confirmation before leaving. If the User leaves the assessment, their progress will be removed and their level won't be upgraded.
1.b	The User gives incorrect answers to certain modules.	2.b The System will not allow the user to level-up if they fail in certain modules.

### 3.2.1.17 Track Progress

The use-case in the table below defines the steps to track a user's progress.

**Table 3.17: Use-Case Description of Track Progress**

<b>Use Case ID:</b>	UM - 017	
<b>Use Case Name:</b>	Track Progress	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The User must navigate to the progress page.</li> <li>2. The system will show the user their progress in various modules.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User visits the progress page by clicking on 'progress' in the navbar.	The system will display to the User their progress in various modules (e.g. vocabulary, grammar, writing, etc.).

### 3.2.1.18 View and Unlock Achievements

The use-case in the table below defines the steps to view and unlock a user's achievements (e.g. badges).

**Table 3.18: Use-Case Description of View and Unlock Achievements**

<b>Use Case ID:</b>	UM - 018	
<b>Use Case Name:</b>	View and Unlock Achievements	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be authenticated and using their account.	
<b>Priority:</b>	Medium	
<b>Basic Flow:</b>	1. The User must navigate to the progress page and scroll down to view their locked and unlocked achievement badges.	
<b>Actor Actions</b>		<b>System Response</b>
1	The User visits the progress page by clicking on 'progress' in the navbar and scrolls down towards the achievements section.	The system will display to the User the badges that are unlocked (e.g. Completed Onboarding Badge) and that are locked (blurred out).

### 3.2.1.19 Use Real-Time Chat

The use-case in the table below defines the steps for users to connect with other users and use real-time chat.

**Table 3.19: Use-Case Description of Use Real-Time Chat**

<b>Use Case ID:</b>	UM - 019	
<b>Use Case Name:</b>	Use Real-Time Chat	
<b>Actor(s):</b>	Learner	
<b>Pre-Conditions:</b>	The User must be authenticated and have an initial CEFR level.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	<ol style="list-style-type: none"> <li>1. The user clicks on 'Friends' in the navbar.</li> <li>2. The system will suggest the User friends.</li> <li>3. The User will send a request.</li> <li>4. If the other User accepts, they can start chatting in real-time.</li> </ol>	
<b>Actor Actions</b>		<b>System Response</b>
1	The User clicks on 'Friends' in the navigation bar.	The system then redirects the User to the 'Friends' page.
2	The User clicks on 'Add' on one of the suggested users.	The system will send a request to that User. If that User accepts the friend request, chatting will be activated.
3	The User can send messages to their friend now.	

## 3.2.2 Admin Management

### 3.2.2.1 View Admin Dashboard

The use-case in the table below defines the steps to view the admin dashboard.

**Table 3.20: Use-Case Description of View Admin Dashboard**

<b>Use Case ID:</b>	UM - 020	
<b>Use Case Name:</b>	Authenticate User	
<b>Actor(s):</b>	Admin	
<b>Pre-Conditions:</b>	The User must be registered as an Admin in the system.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	1. The User will login and be redirected to the Admin Dashboard if the credentials are valid.	
<b>Actor Actions</b>		<b>System Response</b>
1	The User enters their username and password in the relevant fields. The User clicks on the 'Login' button.	The system verifies the credentials. If the credentials are valid, the User is redirected to Admin Dashboard.
<b>Alternative Course of Action (if any)</b>		
<b>Actor Action</b>		<b>System Response</b>

1.a	The User enters invalid credentials.	2.a If the User's credentials are invalid, a clear error message is displayed and the User won't be able to access the Admin Dashboard.
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### 3.2.2.2 Update User Status

The use-case in the table below defines the steps to update user status (by admin).

**Table 3.21: Use-Case Description of Update User Status**

<b>Use Case ID:</b>	UM - 021	
<b>Use Case Name:</b>	Update User Status	
<b>Actor(s):</b>	Admin	
<b>Pre-Conditions:</b>	The User must be registered as an Admin in the system.	
<b>Priority:</b>	High	
<b>Basic Flow:</b>	1. The Admin changes the status of a User from Activate to Deactivate and Vice Versa.	
<b>Actor Actions</b>		<b>System Response</b>
1	The Admin can toggle the status of Users from Activate to Deactivate and Vice Versa.	The system will activate (allow User access to the system) or deactivate (disallow User access to the system) the User.

### 3.2.2.3 Update User Role

The use-case in the table below defines the steps to update user status (by admin).

**Table 3.22: Use-Case Description of Update User Status**

<b>Use Case ID:</b>	UM - 022	
<b>Use Case Name:</b>	Update User Role	
<b>Actor(s):</b>	Admin	
<b>Pre-Conditions:</b>	The User must be registered as an Admin in the system.	
<b>Priority:</b>	medium	
<b>Basic Flow:</b>	1. The Admin changes the status of a User from Learner to Admin and vice versa.	
<b>Actor Actions</b>		<b>System Response</b>
1	The Admin can toggle the status of Users from Learner to Admin and Vice Versa.	The system will convert the User from Learner to Admin and Vice Versa.

### 3.3 Functional Requirements

#### 3.3.1 Learner Management

##### 3.3.1.1 Login

The table below defines the functional requirement for the login use-case.

**Table 3.23: Functional Requirement of Login**

<b>Identifier</b>	FR1
<b>Title</b>	Login
<b>Requirement</b>	The user will be able to log into their account after successfully signing up with Verbally.
<b>Source</b>	Web application
<b>Rationale</b>	To protect user data from unwanted access.
<b>Restrictions and Risk</b>	Login should only be allowed if all fields are filled and valid.
<b>Dependencies</b>	FR2
<b>Priority</b>	High

##### 3.3.1.2 Signup

The table below defines the functional requirement for the signup use-case.

**Table 3.24: Functional Requirement of Signup**

<b>Identifier</b>	FR2
<b>Title</b>	Signup
<b>Requirement</b>	The user should be allowed to register an account with Verbally using their full name, email, and chosen password
<b>Source</b>	Web Application
<b>Rationale</b>	Allow every user to have their own private and personalized account.
<b>Restrictions and Risk</b>	Duplicated emails must be rejected during the registration process and passwords must be strong.
<b>Dependencies</b>	N/A
<b>Priority</b>	High

### 3.3.1.3 Complete Onboarding Evaluation

The table below defines the functional requirement for the onboarding use-case.

**Table 3. 25: Functional Requirement of Complete Onboarding Evaluation**

<b>Identifier</b>	FR3
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<b>Title</b>	User onboarding and CEFR level assessment
<b>Requirement</b>	A new user must be welcomed to Verbally and their CEFR level must be assessed through a writing assessment.
<b>Source</b>	Onboarding Module
<b>Rationale</b>	The goal is to assess a user's CEFR level through a writing assessment to personalize their learning experience.
<b>Restrictions and Risk</b>	Only a first-time user will receive an onboarding assessment, otherwise they will be directed to the dashboard.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.4 View Word of the Day

The table below defines the functional requirement for the 'view word of the day' use-case.

**Table 3.26: Functional Requirement of View Word of the Day**

<b>Identifier</b>	FR4
<b>Title</b>	Word of the Day Lesson

<b>Requirement</b>	The user will be able to see a new word everyday on their homepage.
<b>Source</b>	Vocabulary module
<b>Rationale</b>	A new word to learn everyday will help the user improve their vocabulary
<b>Restrictions and Risk</b>	Word of the day will change after completing a vocabulary quiz.
<b>Dependencies</b>	FR1
<b>Priority</b>	Medium

### 3.3.1.5 Save Vocabulary Word

The table below defines the functional requirement for the ‘save vocabulary word’ use-case.

**Table 3.27: Functional Requirement of Save Vocabulary Word**

<b>Identifier</b>	FR5
<b>Title</b>	Save the vocabulary word
<b>Requirement</b>	Users should be allowed to save a word from word of the day.

<b>Source</b>	Vocabulary module
<b>Rationale</b>	Users can save words so that they can revisit them later to revise.
<b>Restrictions and Risk</b>	A word cannot be saved multiple times.
<b>Dependencies</b>	FR1, FR4
<b>Priority</b>	Medium

### 3.3.1.6 Practice Vocabulary

The table below defines the functional requirement for the ‘practice vocabulary’ use-case.

**Table 3.28: Functional Requirement of Practice Vocabulary**

<b>Identifier</b>	FR6
<b>Title</b>	Practice vocabulary quizzes
<b>Requirement</b>	A user should be allowed to practice the words they learned in different scenarios through a multiple-choice quiz.
<b>Source</b>	Vocabulary module
<b>Rationale</b>	Practicing through a quiz and receiving feedback helps retain

	learning. It also provides the user feedback on their learning.
<b>Restrictions and Risk</b>	The quiz must be from the same word which is shown in the ‘word of the day’.
<b>Dependencies</b>	FR1, FR4
<b>Priority</b>	High

### 3.3.1.7 View Grammar Lesson

The table below defines the functional requirement for the ‘view grammar lesson’ use-case.

**Table 3.29: Functional Requirement of View Grammar Lesson**

<b>Identifier</b>	FR7
<b>Title</b>	View daily grammar lesson
<b>Requirement</b>	The user will be given a grammar lesson daily.
<b>Source</b>	Grammar module
<b>Rationale</b>	The grammar lesson will help the user improve their grammar skills.
<b>Restrictions and Risk</b>	The grammar lesson will change after completing a grammar

	quiz.
<b>Dependencies</b>	FR1
<b>Priority</b>	Medium

### 3.3.1.8 Practice Grammar

The table below defines the functional requirement for the ‘practice grammar’ use-case.

**Table 3.30: Functional Requirement of Practice Grammar**

<b>Identifier</b>	FR8
<b>Title</b>	Practice grammar quizzes
<b>Requirement</b>	A user should be allowed to practice the words they learned in different scenarios through a multiple-choice quiz.
<b>Source</b>	Grammar module
<b>Rationale</b>	Practicing through a quiz and receiving feedback helps retain learning. It also provides the user feedback on their learning.
<b>Restrictions and Risk</b>	The quiz must be from the grammar lesson.
<b>Dependencies</b>	FR1, FR7

<b>Priority</b>	High
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### 3.3.1.9 View Speaking Tip

The table below defines the functional requirement for ‘view speaking tip’.

**Table 3.31: Functional Requirement of Speaking Tip**

<b>Identifier</b>	FR9
<b>Title</b>	View speaking tip
<b>Requirement</b>	The user should be able to see tips about speaking/speech.
<b>Source</b>	Speech Module
<b>Rationale</b>	Such speaking tips will help the user in improving their speaking skills.
<b>Restrictions and Risk</b>	Speaking tips must be according to the CEFR level of the user.
<b>Dependencies</b>	FR1
<b>Priority</b>	Medium

### 3.3.1.10 Practice Speaking (Fluency)

The table below defines the functional requirement for the ‘practice speaking (fluency)’ use-case.

**Table 3.32: Functional Requirement of Practice Speaking (Fluency)**

<b>Identifier</b>	FR10
<b>Title</b>	Practice regular speaking (fluency)
<b>Requirement</b>	The user should be able to practice impromptu speaking about a given topic.
<b>Source</b>	Speech Module
<b>Rationale</b>	This will help the user improve their conversational speaking and determine their fluency without focusing on the accent.
<b>Restrictions and Risk</b>	The user must allow access to their mic for recording their audio. The audio recording of the user must be limited to less than 1-2 minutes.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.11 Practice Speaking (Accent)

The table below defines the functional requirement for the ‘practice speaking (accent)’ use-case.

**Table 3.33: Functional Requirement of Practice Speaking (Accent)**

<b>Identifier</b>	<b>FR11</b>
<b>Title</b>	Practice regular speaking (accent)
<b>Requirement</b>	The user should be able to choose a preferred accent, recite a prompt, and get feedback on how to adapt to their preferred accent.
<b>Source</b>	Speech Module
<b>Rationale</b>	This will help the user adapt to their preferred accent (e.g. British, English) by providing phoneme-level feedback.
<b>Restrictions and Risk</b>	The user must allow access to their mic for recording their audio. The audio recording of the user must be limited to less than 1-2 minutes.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.12 View Writing Tip

The table below defines the functional requirement for the ‘view writing tip’ use-case.

**Table 3.34: Functional Requirement of View Writing Tip**

<b>Identifier</b>	<b>FR12</b>
<b>Title</b>	View writing tip
<b>Requirement</b>	The user should be able to see tips about writing.
<b>Source</b>	Writing Module
<b>Rationale</b>	Such speaking tips will help the user in improving their writing skills.
<b>Restrictions and Risk</b>	Writing tips must be according to the CEFR level of the user.
<b>Dependencies</b>	FR1
<b>Priority</b>	Medium

### 3.3.1.13 Practice Writing

The table below defines the functional requirement for the ‘practice writing’ use-case.

**Table 3.35: Functional Requirement of Practice Writing**

<b>Identifier</b>	FR13
<b>Title</b>	Practice writing skills
<b>Requirement</b>	The user should be able to practice writing to writing prompts.
<b>Source</b>	Writing module
<b>Rationale</b>	Writing on given prompts and receiving feedback will improve writing skills.
<b>Restrictions and Risk</b>	Writing tasks will have a word limit requirement which has to be met.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.14 View Listening Tip

The table below defines the functional requirement for the ‘view listening tip’ use-case.

**Table 3.36: Functional Requirement of View Listening Tip**

<b>Identifier</b>	<b>FR14</b>
<b>Title</b>	View listening tip
<b>Requirement</b>	The user should be able to see tips about listening.
<b>Source</b>	Listening Module
<b>Rationale</b>	Such tips will help the user in improving their listening skills.
<b>Restrictions and Risk</b>	listening tips must be according to the CEFR level of the user.
<b>Dependencies</b>	FR1
<b>Priority</b>	Medium

### 3.3.1.15 Practice Listening

The table below defines the functional requirement for the ‘practice listening’ use-case.

**Table 3.37: Functional Requirement of Practice Listening**

<b>Identifier</b>	<b>FR15</b>
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<b>Title</b>	Practice listening
<b>Requirement</b>	The user should be able to practice their listening by listening to an audio and answering a question.
<b>Source</b>	Listening module
<b>Rationale</b>	This will help users to improve their listening skills in a real-life conversational setting.
<b>Restrictions and Risk</b>	The audio and the question must be according to the user's CEFR level.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.16 Attempt Level-Up Module

The table below defines the functional requirement for the 'attempt level-up module' use-case.

**Table 3.38: Functional Requirement of Attempt Level-Up Module**

<b>Identifier</b>	FR16
<b>Title</b>	Level-up module to upgrade CEFR level

<b>Requirement</b>	The user must be able to take a level-up assessment to change their CEFR level (e.g. A2 to B1).
<b>Source</b>	Level-up module
<b>Rationale</b>	This will allow the user to change their CEFR level when they feel ready to study higher levels of English.
<b>Restrictions and Risk</b>	The user cannot level up until they pass all the modules (e.g. speaking, writing, listening, etc.) in the level-up module.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.1.17 Track Progress

The table below shows the functional requirement for the ‘track progress’ use-case.

**Table 3.39: Functional Requirement of Track Progress**

<b>Identifier</b>	FR17
<b>Title</b>	Track modules progress
<b>Requirement</b>	The users should be able to see their progress in various English learning modules (e.g. Vocabulary, Speaking, etc.).

<b>Source</b>	Achievements and progress module
<b>Rationale</b>	The user will be able to see their learning progress which can act as a motivator.
<b>Restrictions and Risk</b>	N/A
<b>Dependencies</b>	FR1, FR6, FR8, FR10, FR11, FR13 and FR15.
<b>Priority</b>	High

### 3.3.1.18 View and Unlock Achievements

The table below shows the functional requirement for the ‘view and unlock achievements’ use-case.

**Table 3.40: Functional Requirement of View and Unlock Achievements**

<b>Identifier</b>	FR18
<b>Title</b>	View and Unlock Achievements
<b>Requirement</b>	The users should be able to receive badges (e.g. 7 vocabulary quizzes completed).
<b>Source</b>	Achievements and progress module

<b>Rationale</b>	This will motivate the users as they will see themselves receive more badges the more they learn from Verbally.
<b>Restrictions and Risk</b>	N/A
<b>Dependencies</b>	Depends on all FRs
<b>Priority</b>	Medium

### 3.3.1.19 Use Real-Time Chat

The table below shows the functional requirement for the ‘use real-time chat’ use-case.

**Table 3.41: Functional Requirement of Use Real-Time Chat**

<b>Identifier</b>	FR19
<b>Title</b>	Use Real-Time Chat
<b>Requirement</b>	Users should be able to chat and connect with other users.
<b>Source</b>	Chatting and friendship module
<b>Rationale</b>	This will allow users to connect with other English learners and help in gaining knowledge from others.
<b>Restrictions and Risk</b>	Users can only chat with users who have accepted their friend

	requests.
<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.2 Admin Management

#### 3.3.2.1 View Admin dashboard

The table below defines the functional requirement for the ‘view admin dashboard’ use-case.

**Table 3.42: Functional Requirement of View Admin Dashboard**

<b>Identifier</b>	FR20
<b>Title</b>	View admin dashboard
<b>Requirement</b>	The admin should be able to access a separate dashboard where they can manage all users.
<b>Source</b>	Admin portal
<b>Rationale</b>	The admin will be able to see all users (e.g. username, CEFR level), activate/deactivate accounts, change user roles etc.
<b>Restrictions and Risk</b>	To view the admin dashboard, the admin must be registered as an admin.

<b>Dependencies</b>	FR1
<b>Priority</b>	High

### 3.3.2.2 Update User Status

The table below defines the functional requirement for the ‘update user status’ use-case.

**Table 3.43: Functional Requirement of Update User Status**

<b>Identifier</b>	FR21
<b>Title</b>	Update user status
<b>Requirement</b>	The admin must be able to update the user status from activate to deactivate and vice versa.
<b>Source</b>	Admin portal
<b>Rationale</b>	Admin should be able to deactivate users with suspicious activity to prevent harm to the system.
<b>Restrictions and Risk</b>	To update user status, the user must be registered as an admin in the system.
<b>Dependencies</b>	FR1

<b>Priority</b>	High
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### 3.3.2.3 Update User Role

The table below defines the functional requirement for the ‘update user role’ use-case.

**Table 3.44: Functional Requirement of Update User Role**

<b>Identifier</b>	FR22
<b>Title</b>	Update user role
<b>Requirement</b>	The admin must be able to change the user role from learner to admin and vice versa.
<b>Source</b>	Admin portal
<b>Rationale</b>	This will allow some users to be upgraded to the Admin role.
<b>Restrictions and Risk</b>	To update a user role, the user must be registered as an admin in the system.
<b>Dependencies</b>	FR1
<b>Priority</b>	Low

## 3.4 Interface Requirements

### 3.4.1 User Interfaces

The frontend of Verbally will be developed using React and styled using TailwindCSS and Shadcn/ui. This will ensure a responsive and minimalist user experience across all device types including desktops, laptops, tablets, and smartphones. The user interface design will follow standard GUI and HCI principles including visual feedback, consistent color schemes, accessible layouts, and intuitive navigation. Key actions such as Start Quiz, Practice Now, Start Speaking, and Level-Up will be placed prominently and consistently throughout the platform to minimize cognitive load and guide learners naturally through their learning journey.

- **UI-1:** Verbally's screens will follow HCI principles of being easy to learn and easy to use, particularly for users with low to moderate technical skills who are focused on improving their English proficiency rather than navigating complex software interfaces.
- **UI-2:** The system will provide a centralized dashboard that gives learners immediate access to all six learning modules including Vocabulary, Grammar, Writing, Listening, and Speaking, along with quick visibility into their current CEFR level, daily streak, and progress highlights.
- **UI-3:** The design will adhere to Web Content Accessibility Guidelines ensuring that the platform is inclusive and usable by individuals regardless of any physical impairment, with proper contrast ratios, keyboard navigability, and screen reader compatibility.
- **UI-4:** All error messages and system notifications will be displayed in plain language and will be highlighted appropriately so that learners can quickly understand and resolve any issues without frustration.

### 3.4.2 Hardware Interfaces

Since Verbally is a web-based platform, it will not be utilizing any hardware interfaces. Users must have a laptop, phone, or tablet to access Verbally, along with a decent internet connection. Having access to a microphone will allow the user to use the speech modules.

### 3.4.3 Software Interfaces

The software interfaces that will be utilized to develop Verbally are:

**Table 3.45: Software Interfaces**

Software Tools and Technology	Reason
Visual Studio Code	Code editor
React, React Native	Frontend UI library
TailwindCSS	A CSS framework to design user interfaces
Nest.Js	Backend development framework built on Node.js
PostgreSQL	SQL-based database
TypeScript	To ensure type-safety
GeminiAPI	Generative AI model
Google TTS	An AI-model for natural sounding text-to-speech service
Deepgram	For audio transcription
Montreal Forced Aligner	For phoneme-level speech analysis
Railway	For backend deployment
Vercel	For frontend deployment
Git and GitHub	For version control and collaboration
WebSockets	For real-time communications

**Note:** The backend api responses tend to take around 10-15 seconds due to the usage of external apis like Gemini API. To make the user experience smooth, we utilize loading spinners and skeleton loading.

### **3.4.4 Communications Interfaces**

The system utilizes WebSockets to allow real-time chatting for the chatting and friendship modules. All the interactions between components are secured with HTTPS and API tokens.

### **3.5 Database Requirements**

Verbally utilizes PostgreSQL, an object-relational database system known for its performance, reliability, and strong adherence to standards. PostgreSQL ensures efficient data handling and consistency in production environments. Some key production rules that are followed include:

- All sensitive data is encrypted, and user passwords are securely hashed using industry-standard algorithms.
- ACID (Atomicity, Consistency, Isolation, Durability) properties are strictly maintained to ensure reliable transactions.
- Proper use of indexes, primary keys, foreign keys, and enums to optimize query performance, maintain relationships, and enforce data validation.

### **3.6 Non-Functional Requirements**

Verbally follows certain non-functional requirements to make sure that it fulfills user requirements and works well in real-life situations. They respond to the question of the performance of the system and not the performance of what is done by the system. These requirements consider the general quality, security and performance of the system outside of the functional features.

#### **3.6.1 Performance Requirements**

The performance requirements which Verbally must follow are::

- Sign-in/authentication time should take  $\leq 1s$ .
- Data should take 10 -15 seconds to be fetched using AI-based modules.
- Long wait times should be shown with constant visual feedback (e.g. skeleton loading, spinners) as a result of UI interactions.

- The beta phase should have a minimum capacity of 100 simultaneous users in the system.
- It should be a system with uptime of 99%.

### 3.6.2 Safety Requirements

The safety requirements that Verbally should adhere to are:

- The generated AI content should be filtered to avoid exposing users to harmful, offensive, discriminatory or inappropriate content.
- Feedback provided by AI should be positive and supportive, making use of positive and encouraging words and expressions. It must not be disheartening or humiliating.
- The sensitive user information should not be revealed or displayed to other users such as their audio recordings.

### 3.6.3 Security Requirements

The security requirements that Verbally complies with are:

- Client-server communications are all through HTTPS.
- The passwords of the users are safely hashed and stored in a secure database.
- The system implements role-based access control to features that only admins can access (e.g., User Management).
- All API endpoints authenticate user inputs to avert cases such as SQL injections or prompt injection attacks.
- To avoid overuse of Gemini API, the system makes use of rate-limiters.

### 3.6.4 Software Quality Attributes

The other quality attributes which Verbally must follow are:

- **Availability:** The system will be able to operate at 99 percent uptime under normal load conditions.
- **Usability:** The user-interface must be user-friendly, receptive and accommodating to everyone.

- **Maintainability:** The codebase is expected to be modular. Similar coding standards and naming conventions should also be applied to the codebase.
- **Reliability:** During the beta testing of the system, it should be able to support 100 active users simultaneously without a critical failure.
- **Scalability:** The backend of the system must be able to scale to handle 1000 concurrent I/O requests.

### 3.7 Project Feasibility

- **Technical Feasibility:** Verbally is a web-based and app-based platform that is developed on the basis of properly-established technologies such as React, NestJS, etc. The third-party AI services like Google Gemini and Montreal Forced Aligner have been well-documented and supported and the system is technically feasible in the context of an academic project.
- **Operational Feasibility:** The platform will be created with a simple interface that will not demand technical skills on the part of the end users. Clearly navigated and with an onboarding placement test, learners can start using the platform productively during the very first session.
- **Legal and Ethical Feasibility:** All user data, such as audio recordings and personal information are addressed safely by means of encrypted communication. The content produced by AI is screened to avoid harmful or inappropriate content and the user is in full control of their data which adheres to ethical standards of privacy and data protection.

### 3.8 Conclusion

In the chapter above we have categorized the requirements as functional and non-functional requirements and detailed descriptions of the use cases. The specifications set out in Verbally make it a platform that will be easy to use and learn English language. The functional requirements were determined according to the expectations of learners and administrative needs whereas the non-functional requirements were determined based on considerations of performance, security, scalability and software quality. Although speech analysis and content generation powered by AI has an intrinsic processing overhead, the platform will be designed in such a way that it is a rewarding experience to all learners.

## Chapter 4

### System Design

Verbally design structure is expounded in this chapter. It focuses on how the system is designed to be and how each module will interact with the other components. We have taken a simple and at the same time a systematic road towards making sure the design is easy to use, adopt and maintain.

#### 4.1 Design Approach

Verbally Language Learning System is elaborated on the code of software engineering to attain scalability, maintainability and modularity. The system has a hybrid architectural design, a modular monolithic backend and a dedicated microservice, which is a part of the ModelView Controller (MVC) design pattern.

The paradigm of MVC facilitates the separation of concerns, where the system is divided into three principal parts i.e. the Model, View and Controller. It provides the system with the flexibility and extensibility and enables components of the system to be developed, tested and maintained separately.

The MVC is used as:

**Model Layer:** The layer that represents the data is the model layer that deals with business rules and persistence. It is used together with Prisma ORM on PostgreSQL relational database which provides access and schema consistency that are type-safe. The system defines many different entities like user related data (User, UserProfile), the learning and assessment data (UserAssessments, UserVocabulary, UserModulesStats), progression tracking data (UserXpLedger, UserDailyGoal, Achievements), social interaction data (Friendships, Conversations, Messages). This layer comprises the operations of the whole database operations and makes sure that data stays intact and does not permit direct access to the user interface. Also, S3-compatible object storage is used to store unorganised data like audio recordings, thus enhancing system performance and scale.

**View Layer:** The View layer is the user interface and is executed as a cross-platform application in React Native (Expo) and it supports web browsers. This layer is responsible for

rendering dashboards, quizzes, learning modules, and chat interfaces. It is configured to be passive, that is, it does not have any business logic or do direct data manipulation. Rather, it shows information that is sent by the Controller layer. Contacting the backend is done by means of:

1. RESTful API of normal operations.
2. WebSocket based real-time features.

**Controller Layer:** Controller layer deals with the communication between the View and Model through processing the user requests and implementing business logic. Verbally system applies this layer on two elements:

**01. NestJS API (Primary Backend):**

The main backend is developed using the NestJS framework [8] (TypeScript [10]), organised into modular components such as authentication, learning modules, progression, chat, and personalisation. Controllers process HTTP requests, call services and update the Model layer.

**02. Microservice of Speech Analysis (FastAPI):**

It has a microservice that is Python-based and handles speech-related jobs. It publishes RESTful services of pronunciation and fluency analysis, which undertake computationally expensive tasks that are not related to the main backend.

## **4.2 Design Constraints**

Some of the limitations, which influence the system design are related to AI implementation, real-time communication, and computations.

### **4.2.1 AI Inference Latency**

The system is based on AI services in the creation of learning materials and feedback. These services add unpredictable latency and possible failures.

The system is implementing:

- Exponentiated backoff.
- Configurable request timeouts
- Good error management and recovery procedures.

- Output Sanitisation of malformed responses.

#### **4.2.2 Speech Processing Constraints**

The resource-consuming processes in speech analysis include phoneme alignment, accents classification and prosody.

In order to overcome these limitations:

- The speech processing is referred to as a microservice.
- Parallel and asynchronous processing is used.
- Ready-to-go models conserve start up time.

#### **4.2.3 Real-Time Communication Constraints**

Such real-time capabilities as messages and notifications demand effective connection management.

WebSocket-based communication is used by the system to support:

- Bi-directional messaging
- Typing hint and read receipts.
- Multi-device synchronisation

#### **4.2.4 Security and Rate limiting.**

The security mechanisms which have been implemented in the system are:

- Authentication by use of JWT and access and refresh token.
- Role-based access control
- To minimize use to avoid abuse.
- There is a secure password reset option.
- These are preventative measures that ensure access control and safeguard of data.

## 4.3 System Architecture

Verbally system uses a hybrid monolith-microservices architecture that uses a distributed three-tier model. This solution provides simplicity of the system with the needs of scalability and performance.

### 4.3.1 Architectural Overview

The three key layers of the system are:

- Presentation Layer (Client Tier)
- Application Tier (Service Layer)
- Persistence Tier (Data layer)

Application Layer is again divided into a monolithic backend (modular in nature) and Specialised speech microservice.

#### Presentation Layer

Presentation Layer is concerned with the interface interaction and the way it is rendered. It is distilled into a cross-platform (mobile and web) client.

Its responsibilities include:

- Showing dashboard and progress in learning.
- Presenting quizzes and study material.
- Managing chat interfaces
- Handling of audio recording and uploading.
- The client is also only communicating with the backend services through APIs and WebSockets.

#### Application Layer

Application Layer is constructed in the central system logic and includes two aspects:

- **Modular Monolith Backend (NestJS API):** This component handles business logic with domain specific modules, such as authentication, learning, progression and communication features.

- **Speech Analysis Microservice (FastAPI):** This is the part of speech processing that uses specialised machine learning methods, and is not connected to the main backend.

## **Data Layer**

In charge of all data in the system is the Data Layer which is made up of:

- **Database (PostgreSQL):** Stores structured data such as user data, learning status and system metadata.
- **S3-Compatible Object Storage:** Can store audio recordings, accessed via secure presigned URLs and is unstructured.



## 4.5 Dynamic View

### 4.5.1 Sequence Diagram

#### 4.5.1.1 Signup and Onboarding:

Figure 4.2 shows the sequence diagram for the signup and onboarding sequence.. It represents how various entities (e.g. actor, controllers, database) interact over time to achieve a successful signup and onboarding.

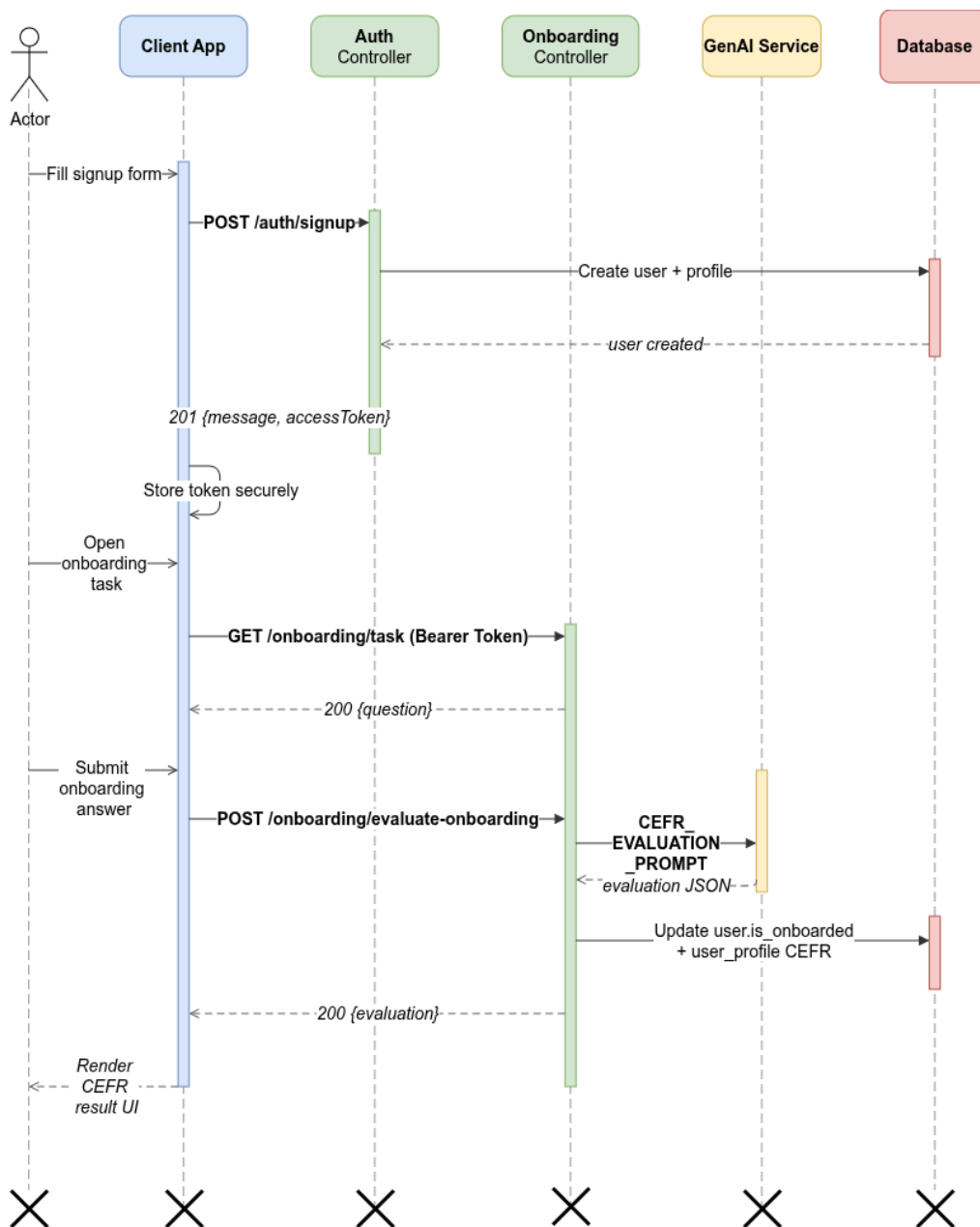


Figure 4.2: Signup and onboarding sequence diagram

### 4.5.2.2 Vocabulary learning and Practice

Figure 4.3 shows the sequence diagram for vocabulary learning and practice. It represents how various entities (e.g. actor, controllers, database, APIs) interact over time to achieve a successful vocabulary module sequence.

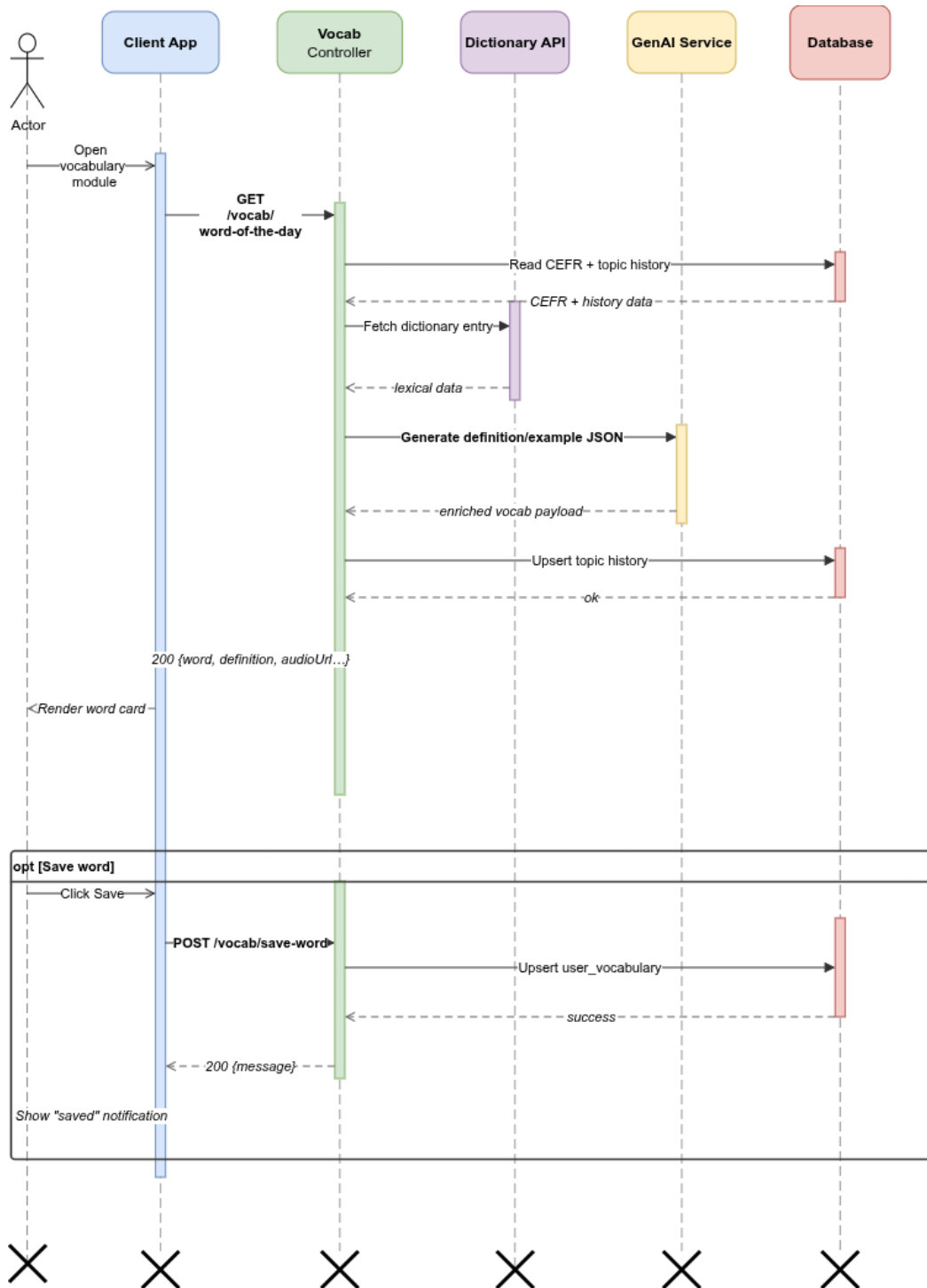


Figure 4.3: Vocabulary learning and Practice Sequence Diagram

### 4.5.2.3 Listening Practice

Figure 4.4 shows the sequence diagram for listening practice. It represents how various entities (e.g. actor, controllers, database, APIs, AI services) interact over time to achieve a successful listening module sequence.

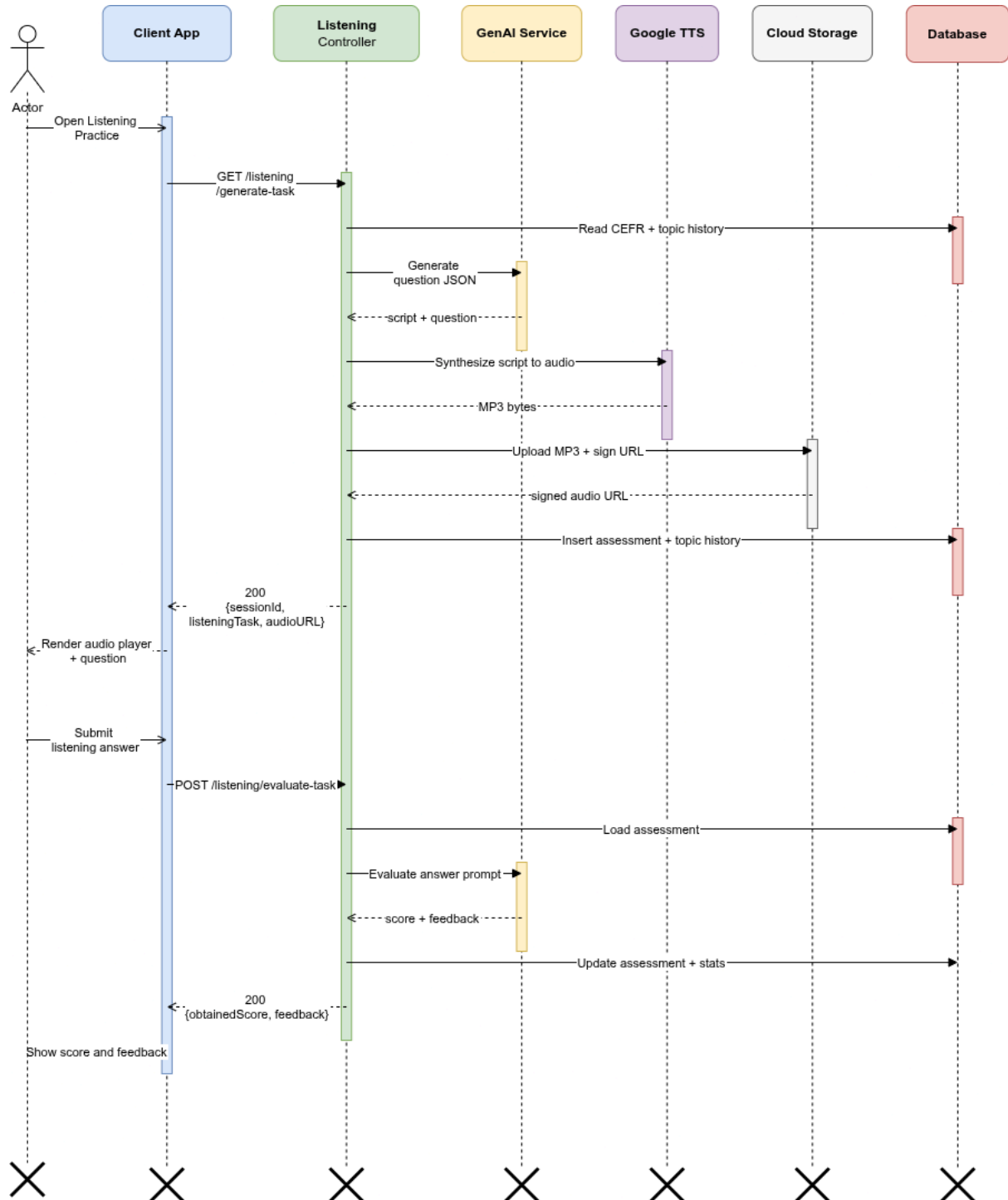


Figure 4.4: Listening Practice Sequence Diagram

#### 4.5.2.4 Grammar Lesson and Practice

Figure 4.5 shows the sequence diagram for grammar learning and practice. It represents how various entities (e.g. actor, controllers, database, APIs) interact over time to achieve a successful grammar module sequence.

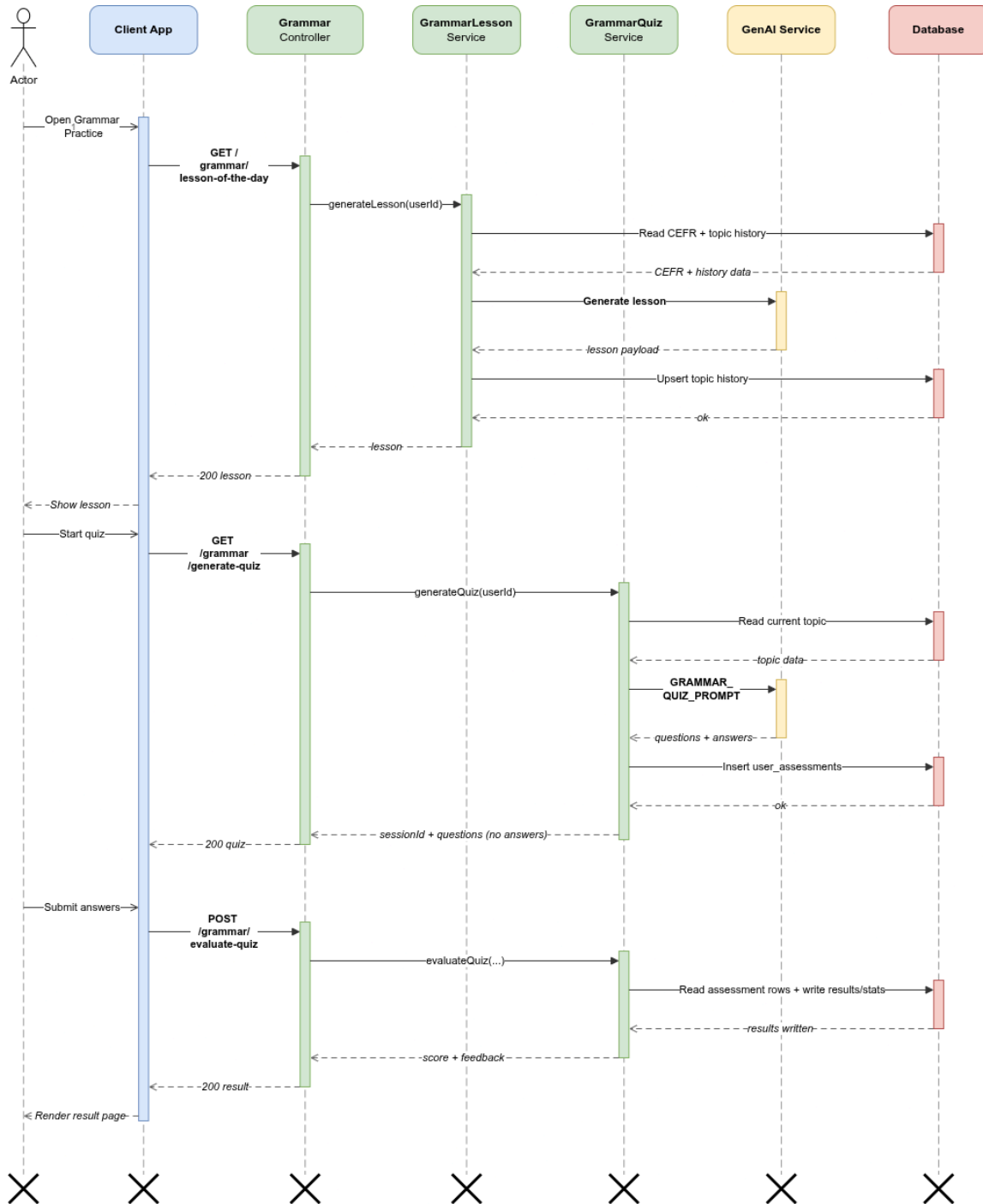


Figure 4.5: Grammar Lesson and Practice Sequence Diagram

### 4.5.2.5 Accent Speaking Practice

Figure 4.6 shows the sequence diagram for accent adaption speaking practice. It represents how various entities (e.g. actor, controllers, database, APIs) interact over time to achieve a successful accent speaking practice sequence.

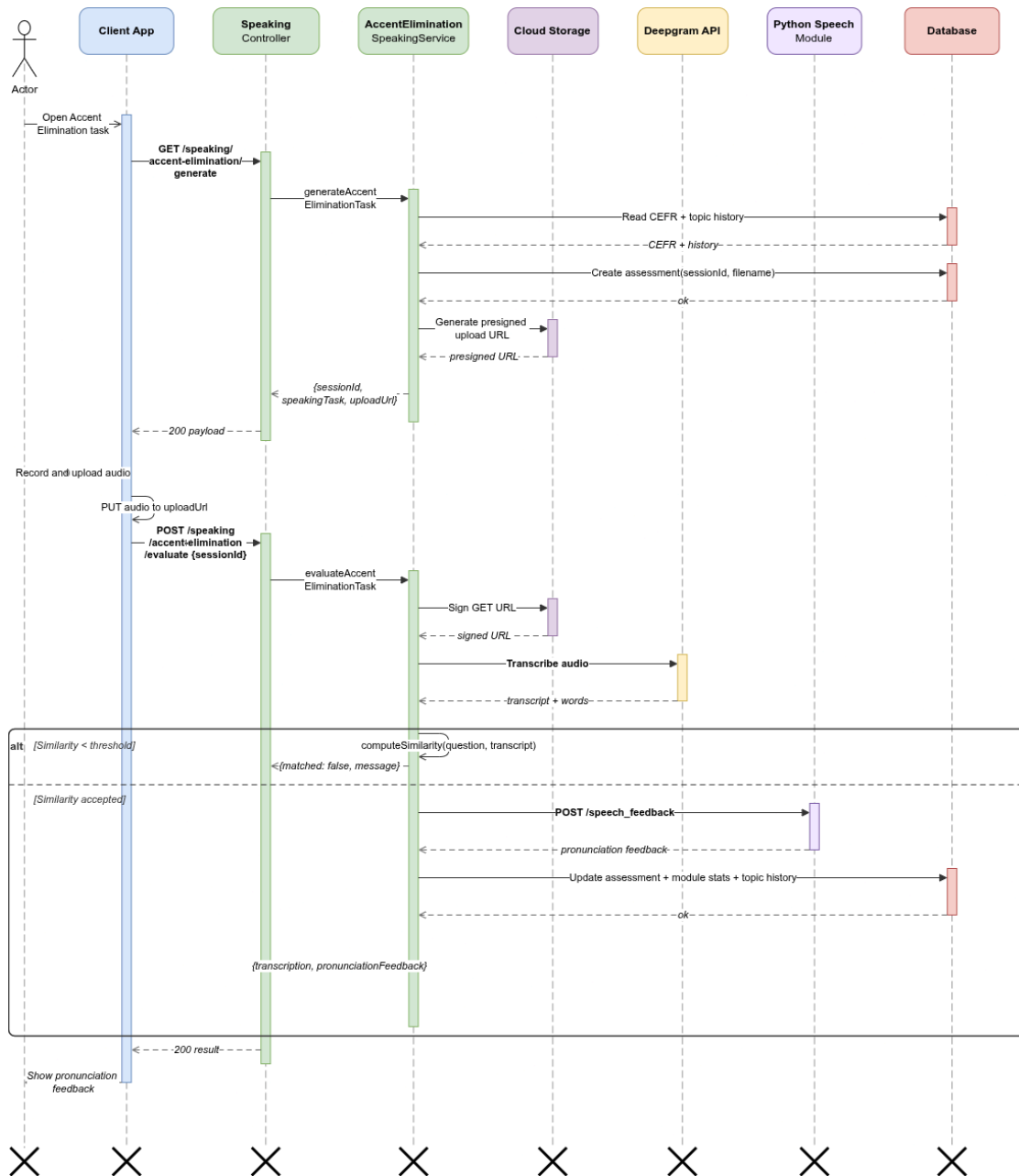


Figure 4.6: Accent Speaking Practice Sequence Diagram

### 4.5.2.6 Writing Practice

Figure 4.7 shows the sequence diagram for writing practice. It represents how various entities (e.g. actor, controllers, database, APIs) interact over time to achieve a successful writing practice sequence.

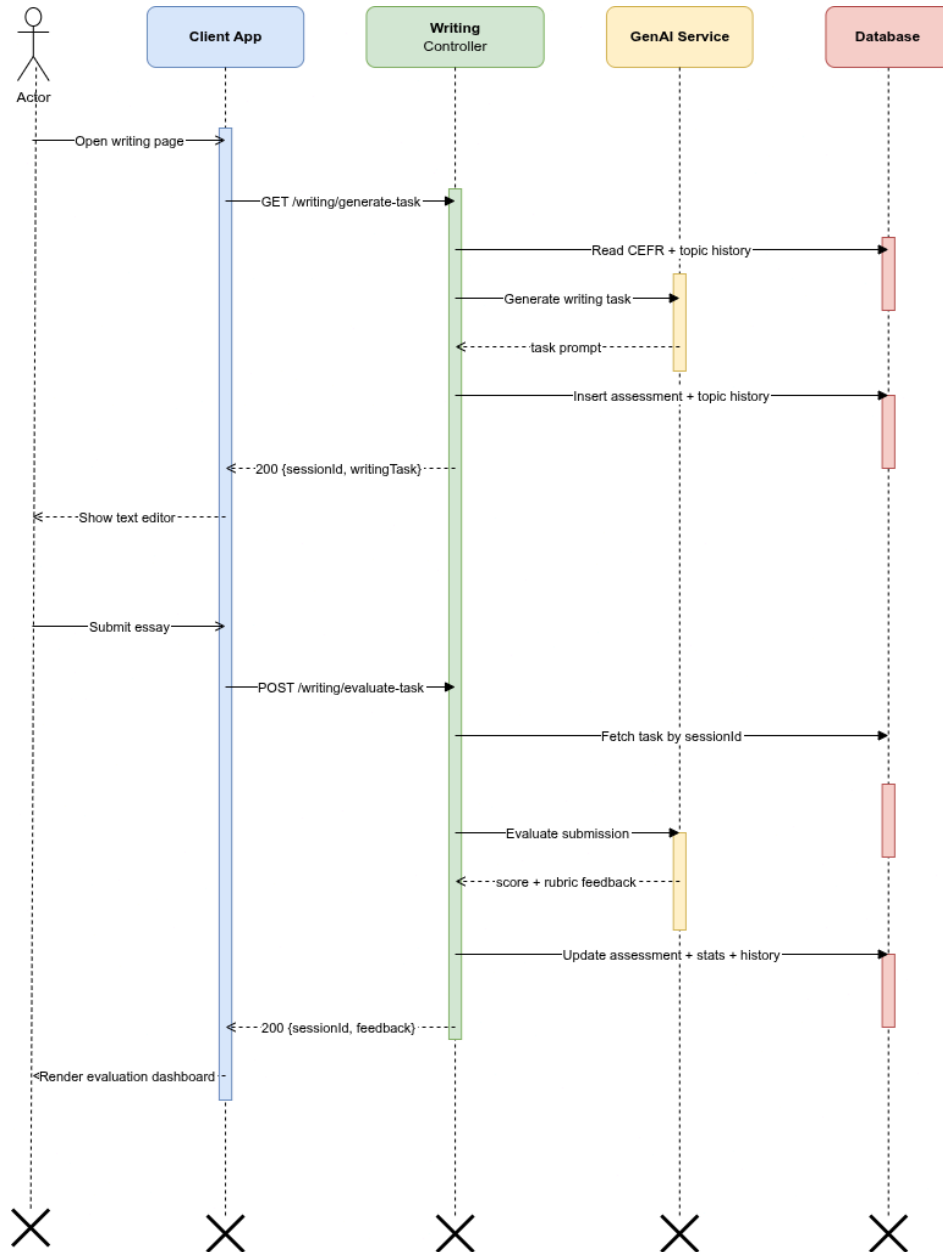


Figure 4.7: Writing Practice Sequence Diagram

### 4.5.2.7 Fluency Speaking Practice

Figure 4.8 shows the sequence diagram for fluency speaking practice. It represents how various entities (e.g. actor, controllers, database, APIs) interact over time to achieve a successful fluency speaking module sequence.

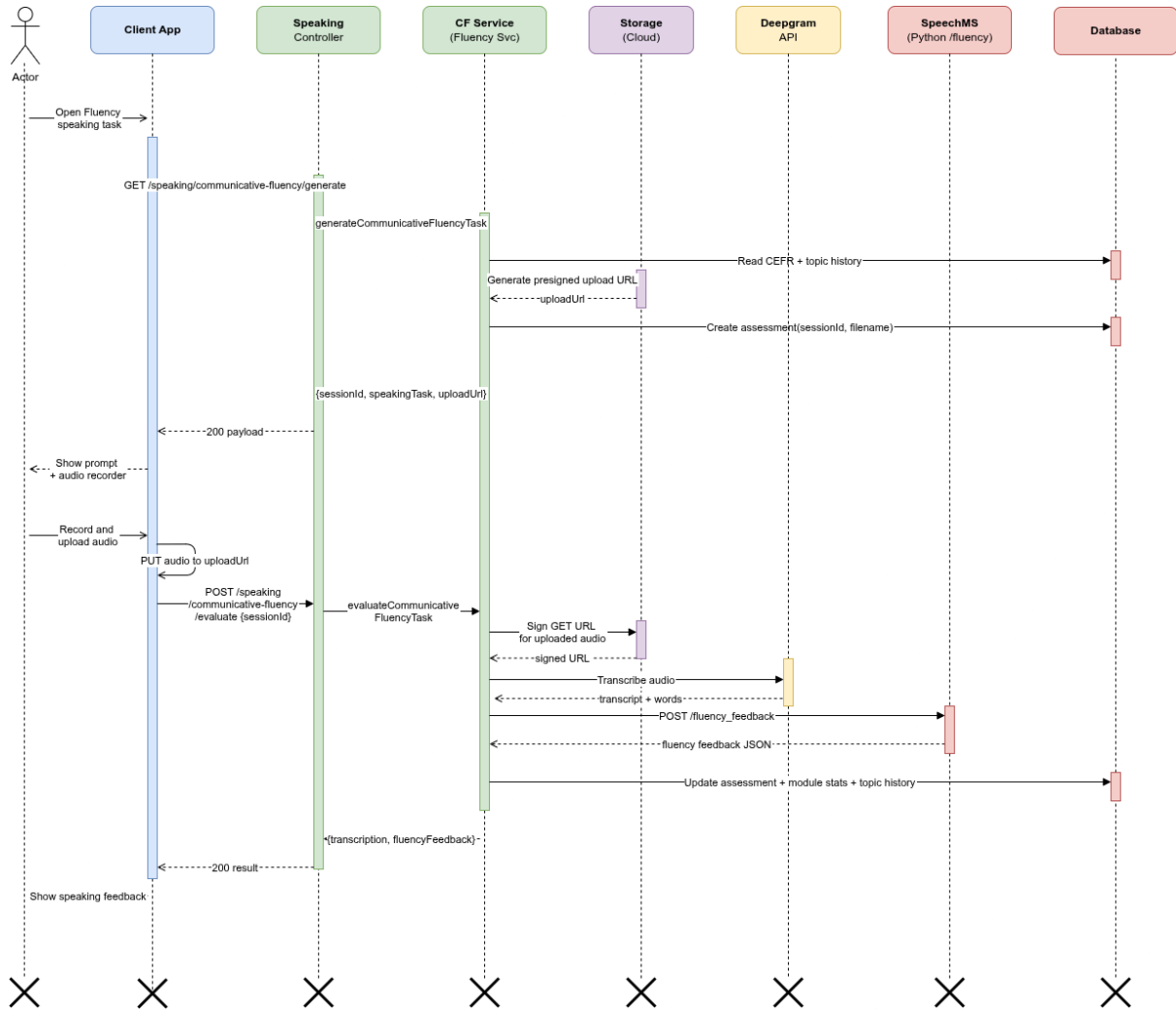


Figure 4.8: Fluency Speaking Practice Sequence Diagram

### 4.5.2.8 Realtime Chat

Figure 4.9 shows the sequence diagram for realtime chat. It represents how various entities (e.g. actors, services, database) interact over time to achieve a successful chatting module sequence.

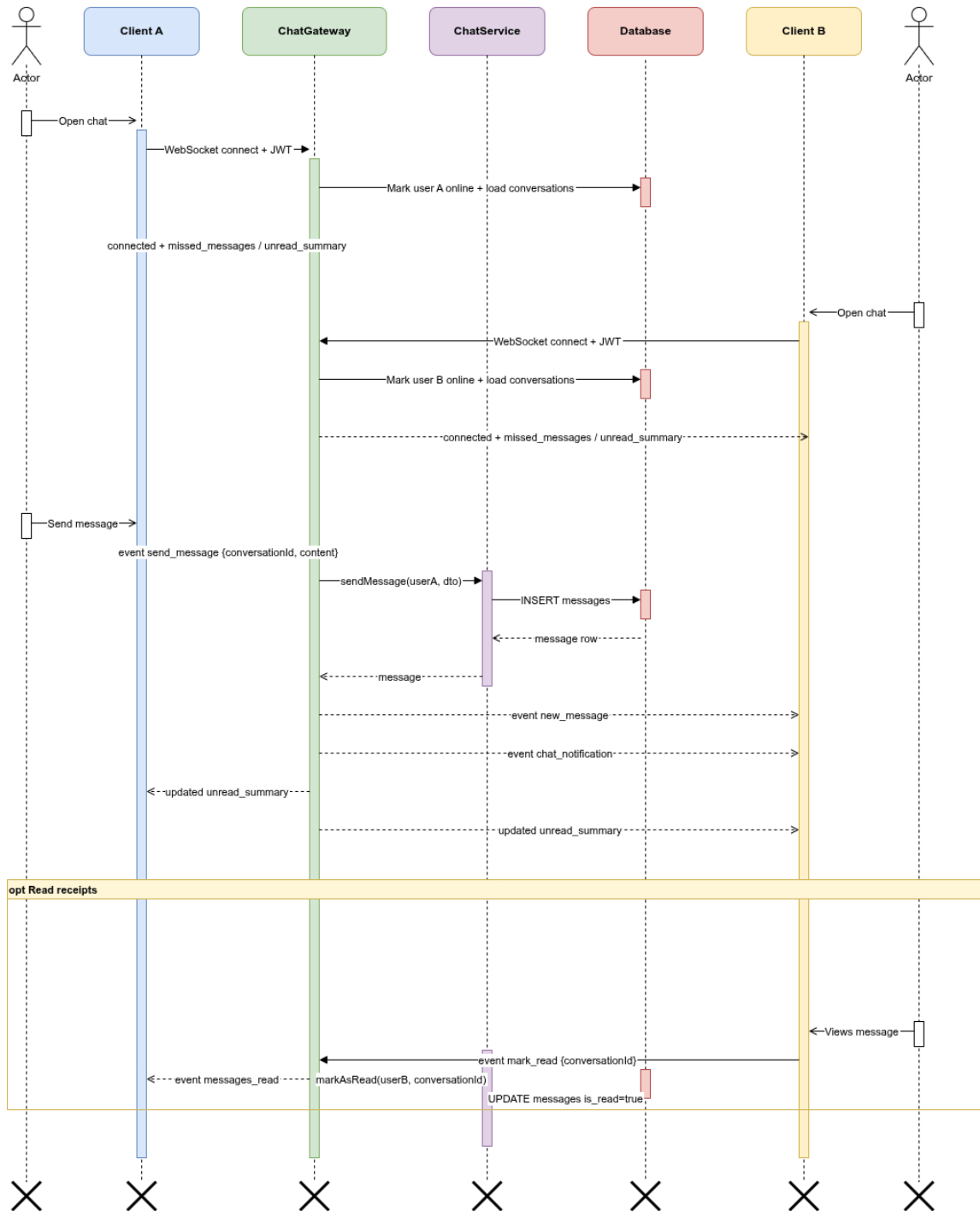


Figure 4.9: Realtime Chat Sequence Diagram

### 4.5.2.9 View Admin Dashboard

Figure 4.10 shows the sequence diagram for viewing the admin dashboard. It represents how various entities (e.g. actor, controllers, database) interact over time to achieve a successful view admin dashboard sequence.

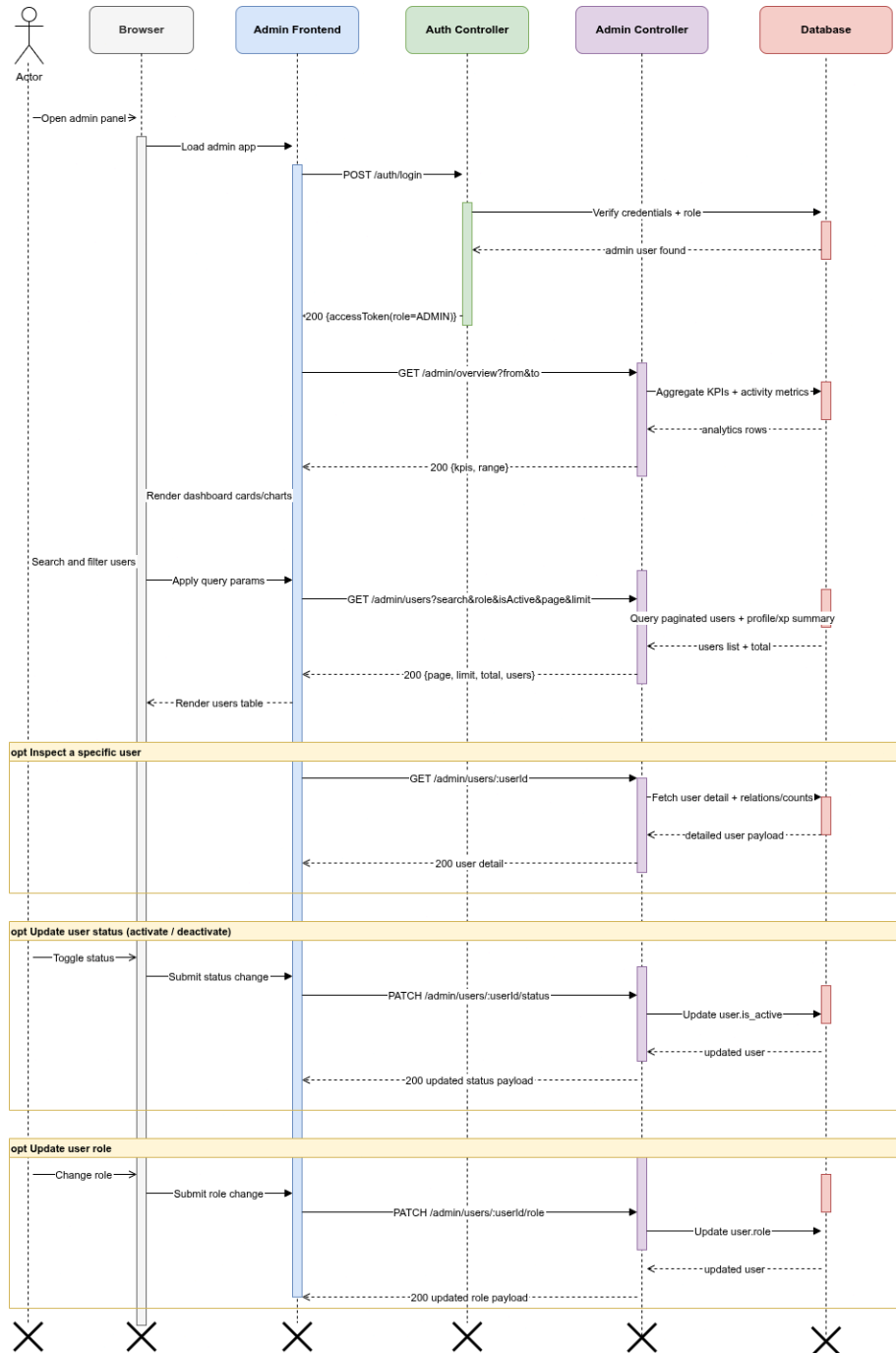


Figure 4.10: Admin Dashboard Sequence Diagram

## 4.6 Component Design

### 4.6.1 Component Diagram

Figure 4.11 shows the component diagram of Verbally. It models the physical architecture of Verbally and shows the various dependencies between system modules.

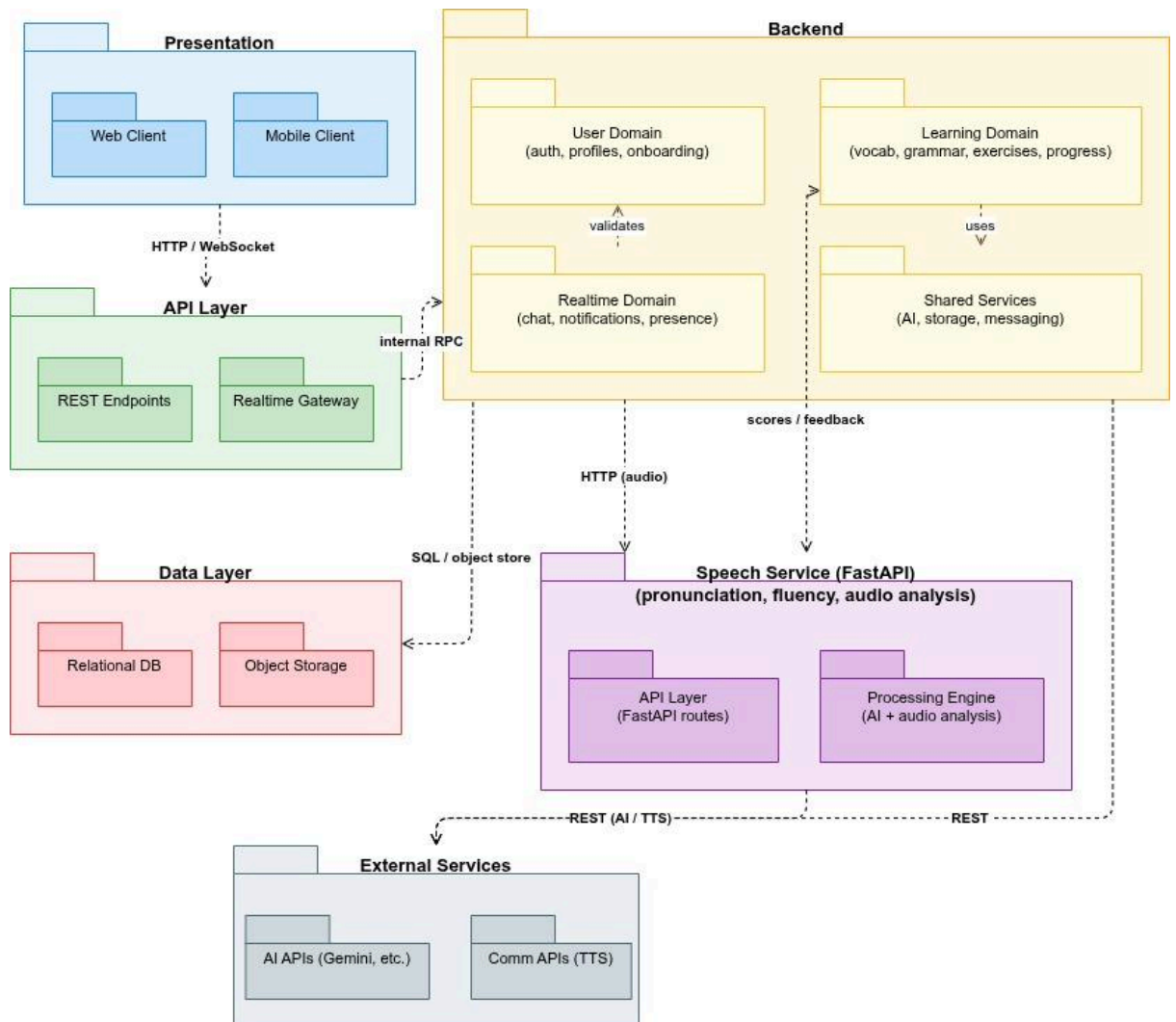


Figure 4.11: A High Level Component Diagram of Verbally

## 4.6.2 Deployment Diagram:

Figure 4.12 shows the deployment diagram of Verbally. It models the physical runtime architecture of Verbally.

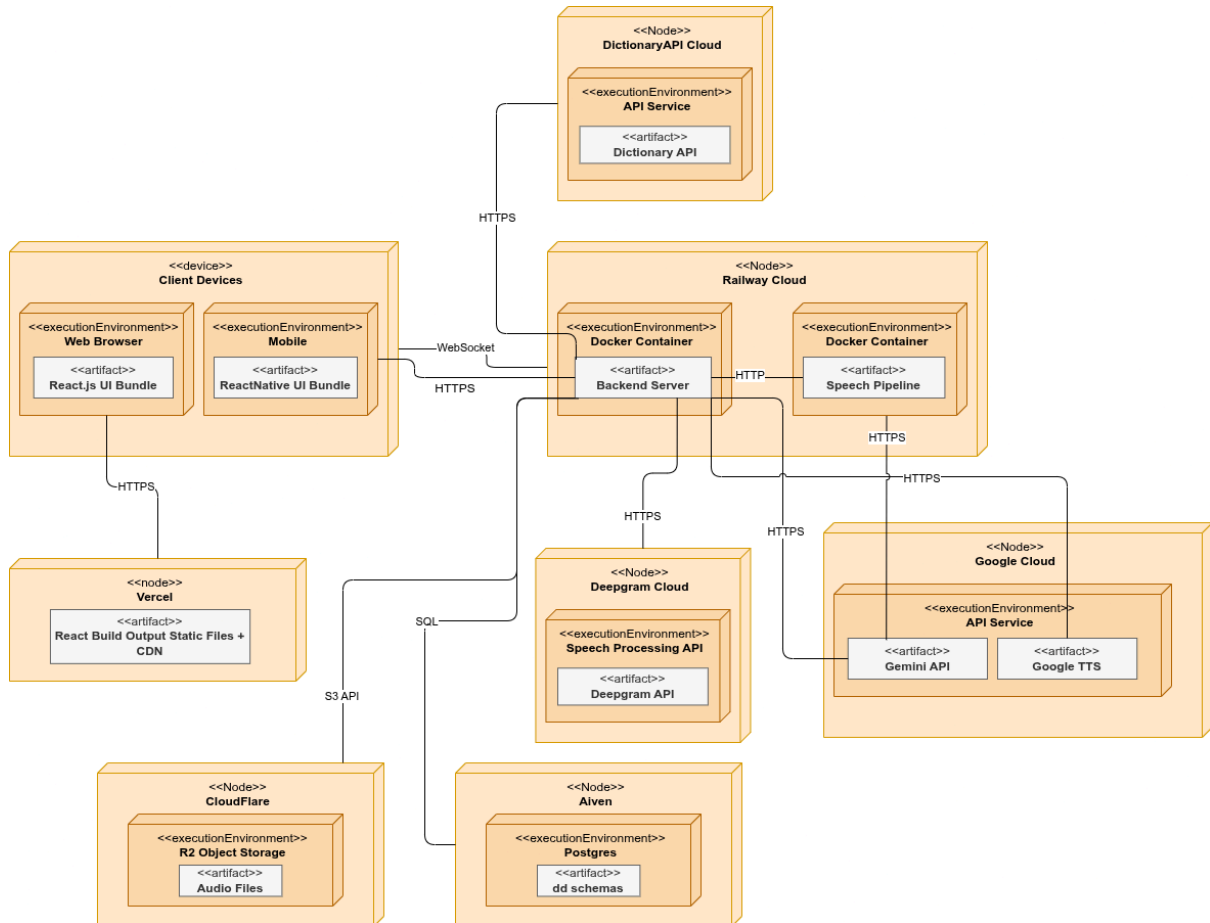


Figure 4.12: Deployment Diagram of Verbally

## 4.7 Data Models:

### 4.7.1 ER Diagram

Figure 4.13 shows the entity-relationship diagram for Verbally. It shows how various entities in the Verbally database relate to each other.

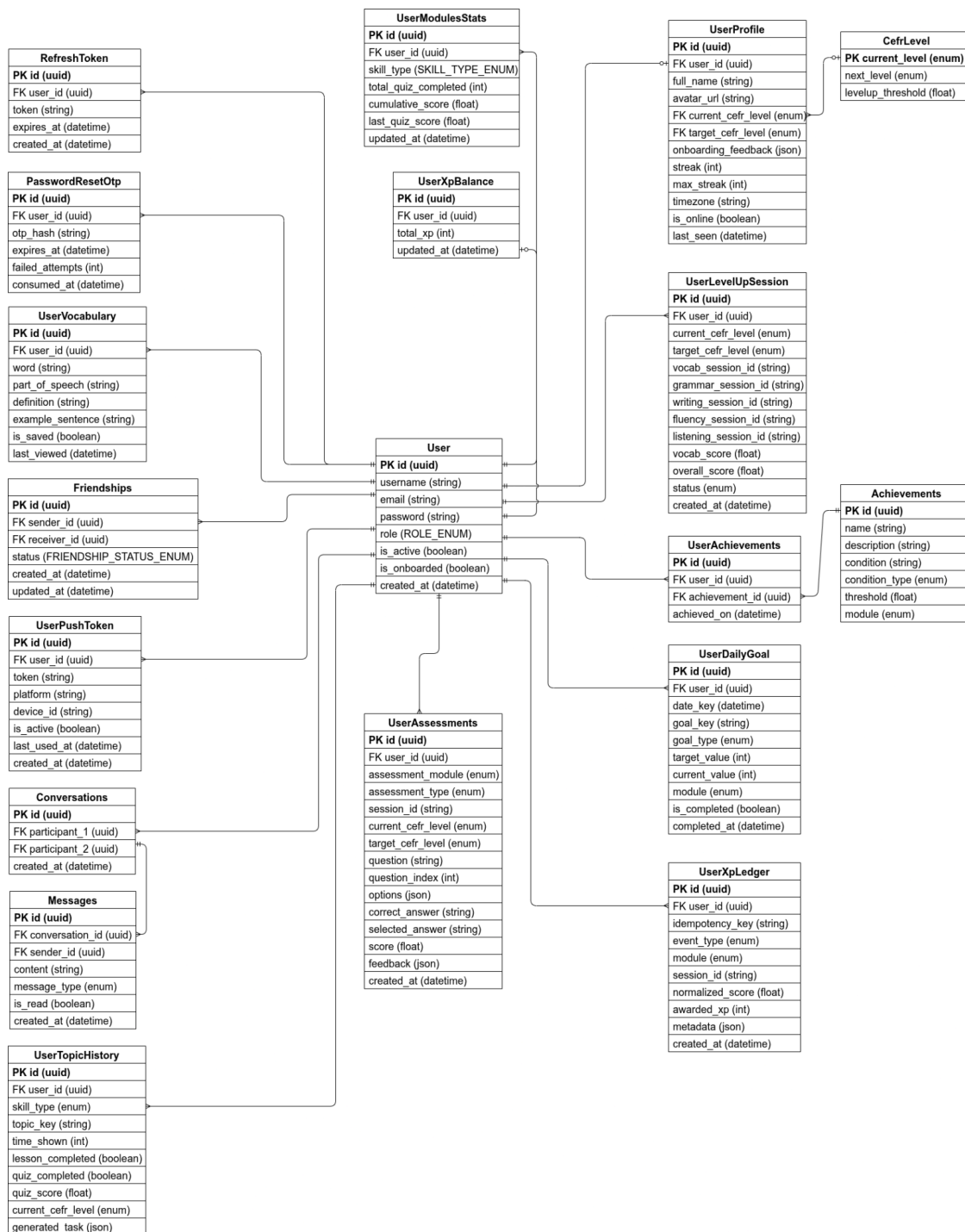


Figure 4.13: Entity Relationship Diagram of Verbally

## 4.8 User Interface Design

### 4.8.1 Web UI

Figure 4.14 shows the hero section of the landing page. The landing page is developed to attract people to Verbally and give them an overview.

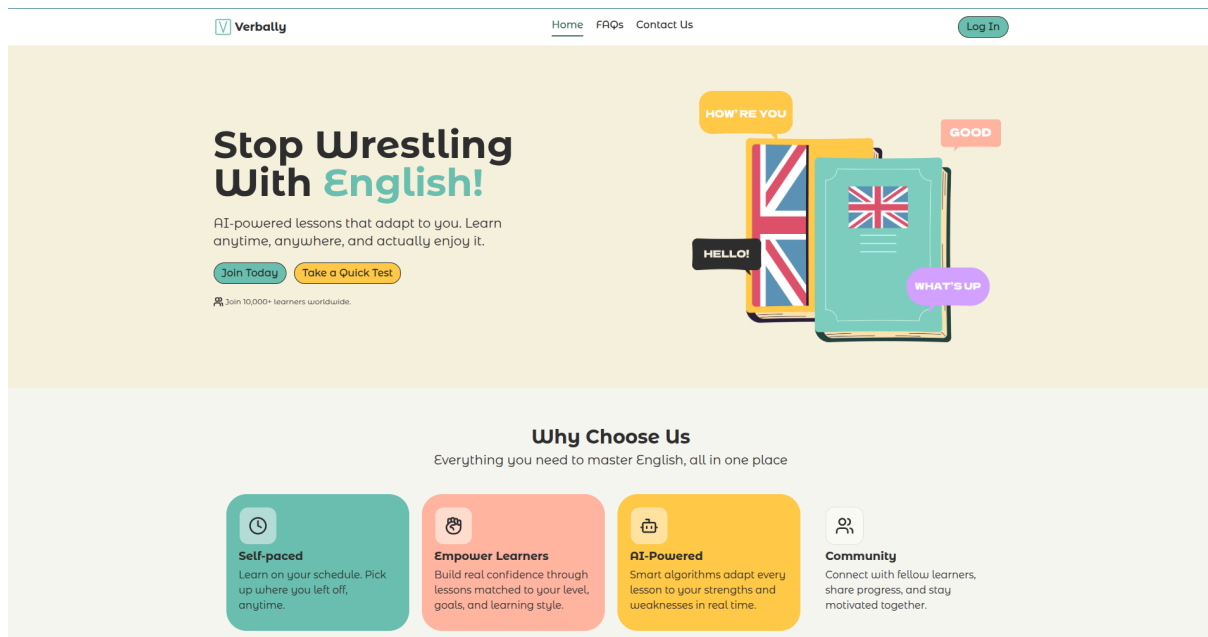


Figure 4.14: Landing Page

Figure 4.15 shows the 'key features' section of the landing page. It gives people an overview of the key features of Verbally.

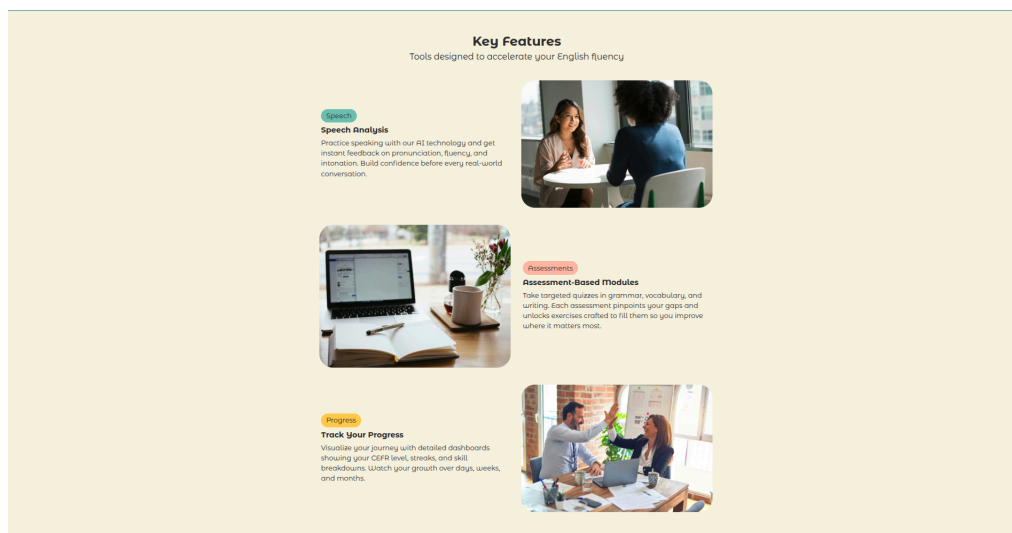


Figure 4.15: Features Section

Figure 4.16 shows the reviews and ‘how it works’ section of the landing page. It gives people reviews from users and a brief overview of how Verbally works.



Figure 4.16: Review Section

Figure 4.17 shows frequently asked questions by people.

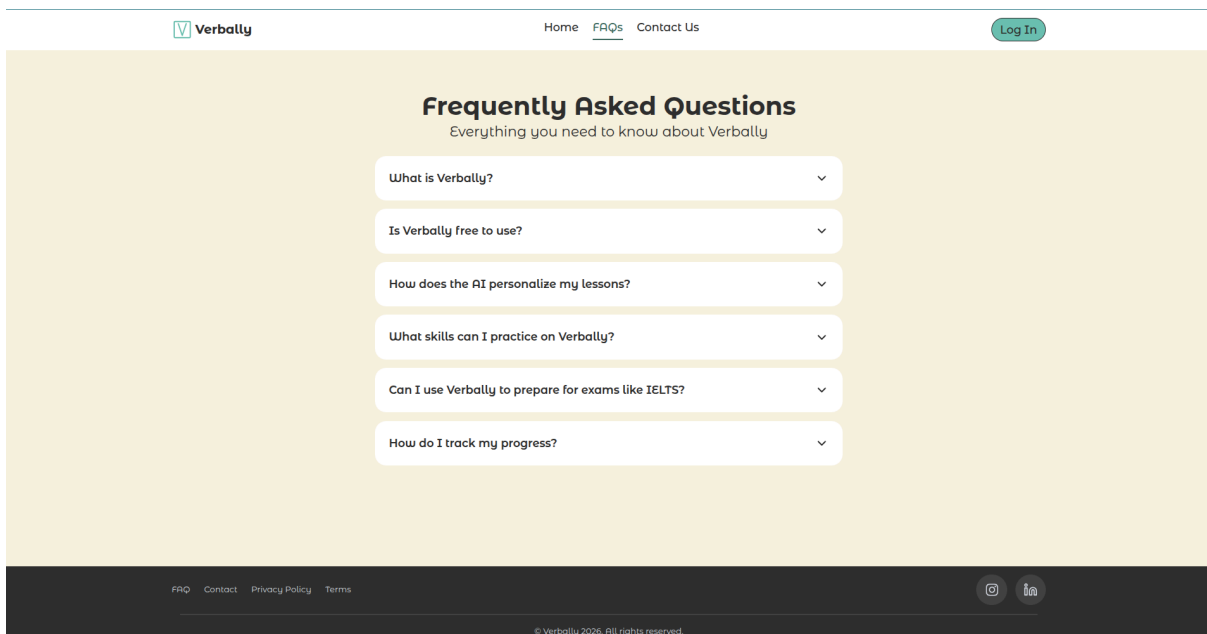


Figure 4.17: FAQ Section

Figure 4.18 shows the contact us page for people who have any queries about Verbally.

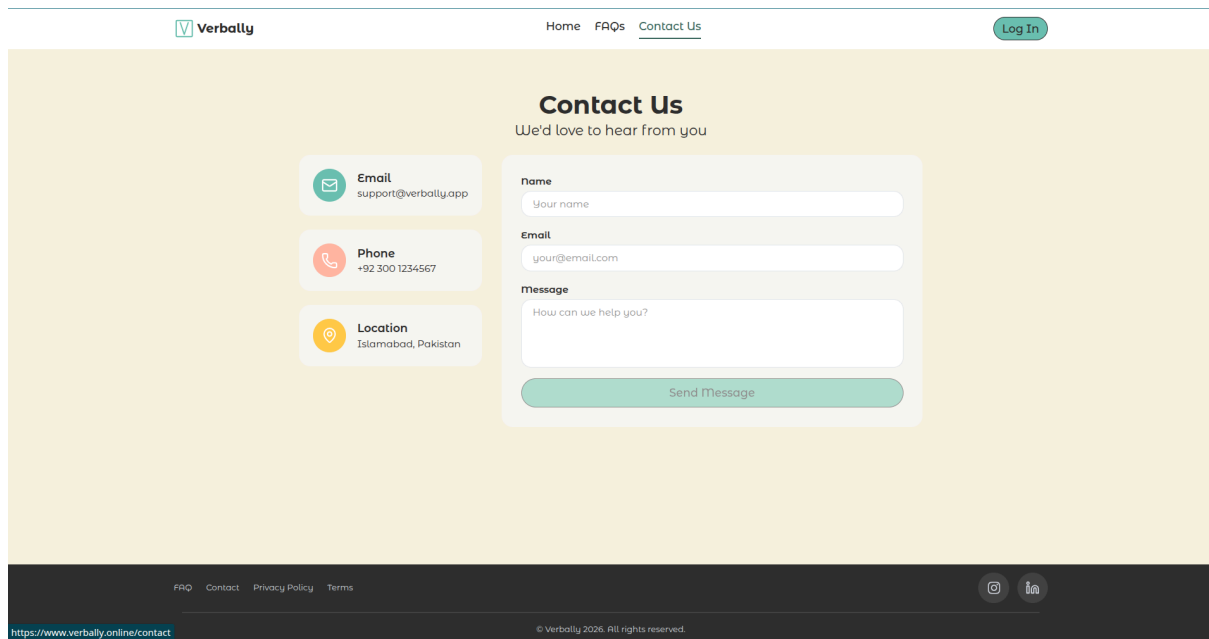


Figure 4.18: Contact Us Section

Figure 4.19 shows the login page for Verbally users.

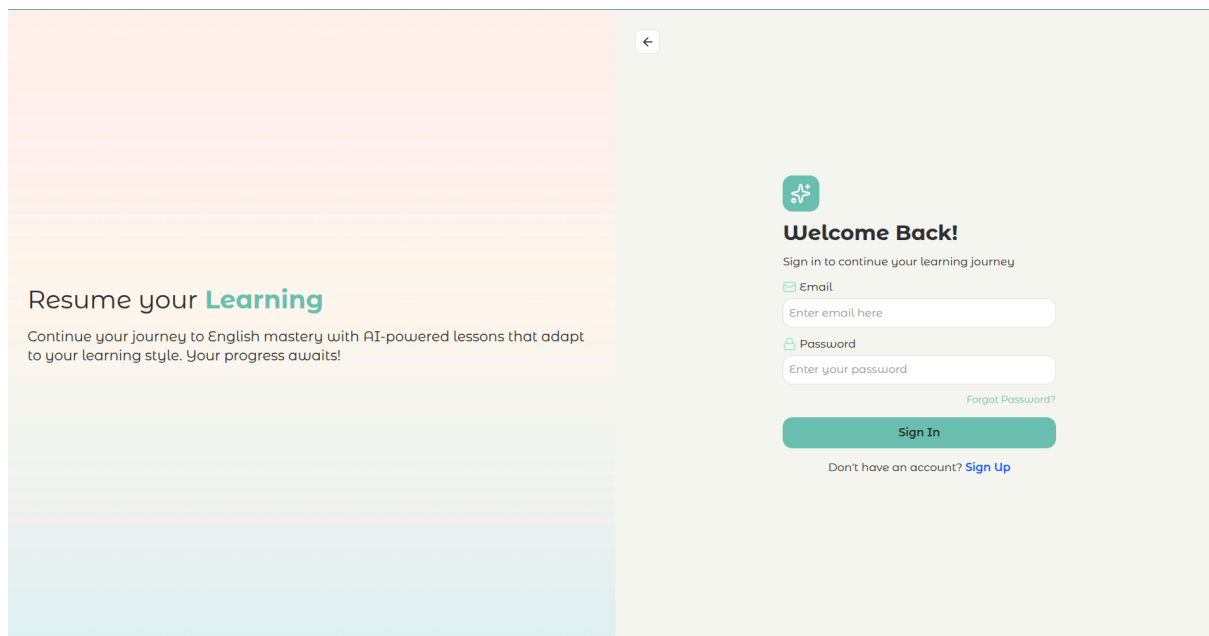


Figure 4.19: Login Page

Figure 4.20 shows the learner dashboard. It displays all the key learning modules: vocabulary, grammar, speaking, writing, and listening.

The dashboard is titled "Good Night, Saad!" and includes a navigation bar with "Modules", "Friends", "Progress", and "Level Up".

**Vocabulary**

- Word of the Day:** nightmare /nɪtˈmɛər/. Part of Speech: noun. Definition: A very bad dream that is frightening and unpleasant. Example: "Waking up after that bad dream felt like a total nightmare." Includes a "Play Audio" button.
- Today's Vocabulary Quiz:** 5 multiple choice questions. Includes a "Start Quiz" button.

**Grammar**

- Grammar Lesson:** Wishing for a Different Past or Present. To express a wish about the present, use 'wish/if only' + past simple. To express regret about the past, use 'wish/if only' + past perfect. Includes a "Read more" button.
- Test Your Grammar Skills:** 5 multiple choice questions. Includes a "Start Quiz" button.

**Speaking**

- Daily Speaking:** Speak about a topic and get feedback. Includes a "Start Practice" button.
- Accent-Focused Speaking:** Get accent-specific feedback. Includes a "Start Practice" button.
- Correct Errors Autonomously:** Purpose: Fix mistakes without disrupting flow. Effective Words: sorry, actually, I mean. Includes a "Start Practice" button.

**Writing**

- Compare and Contrast:** Purpose: Highlight similarities and differences effectively. Effective Words: similarly, on the other hand, compared to, unlike. Includes a "Start Practice" button.
- Write and Get Feedback:** 5 multiple choice questions. Includes a "Start Writing" button.

**Listening**

- Hear and Understand:** 5 multiple choice questions. Includes a "Start Listening" button.
- Listening Tip:** Use sentence stress to locate the real message.

Figure 4.20: Dashboard

Figure 4.21 shows the ‘Saved Words’ page. It includes all the words that a user has saved from ‘word of the day’.

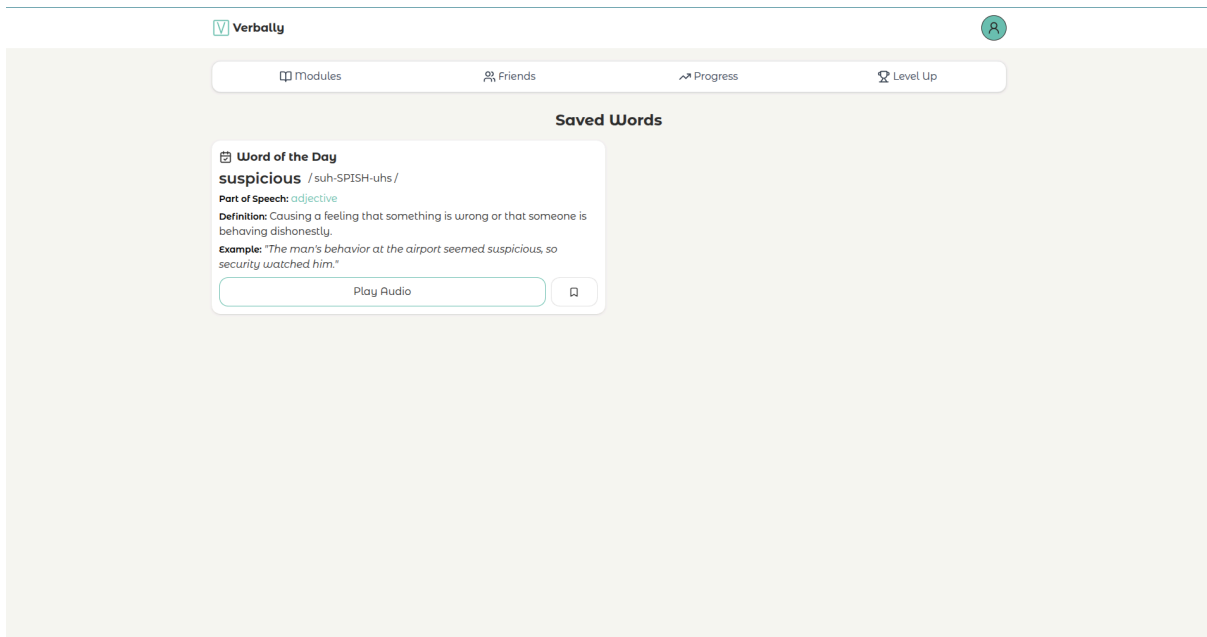


Figure 4.21: Save Word Screen

Figure 4.22 shows the daily grammar lesson modal. It is the detailed version of the grammar lesson from the dashboard.

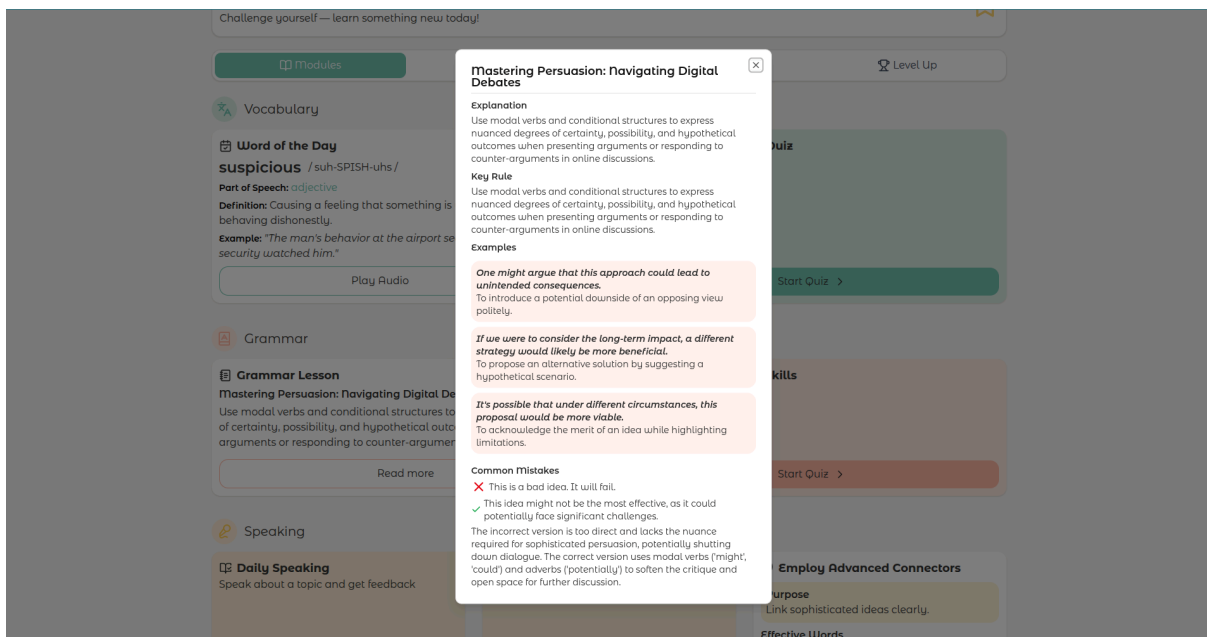


Figure 4.22: Grammar Lesson

Figure 4.23 shows the instructions page for vocabulary quiz. It guides users about the quiz and its contents.

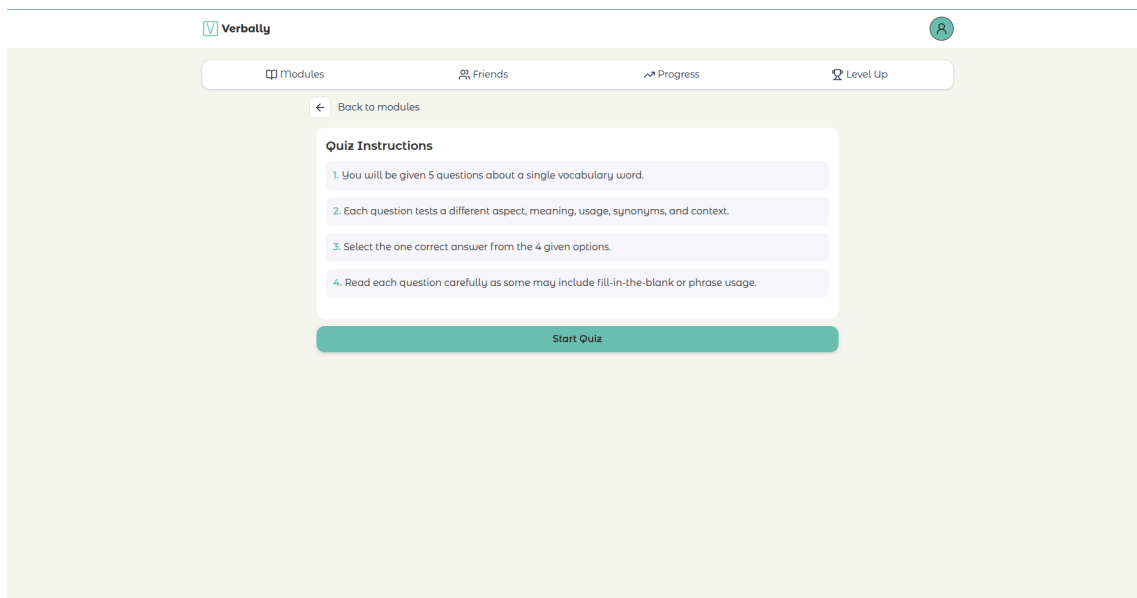


Figure 4.23: Vocab Quiz Instruction Screen

Figure 4.24 shows the vocabulary quiz with one of the questions and its multiple choices. A user must select one of the options before moving to the next question.

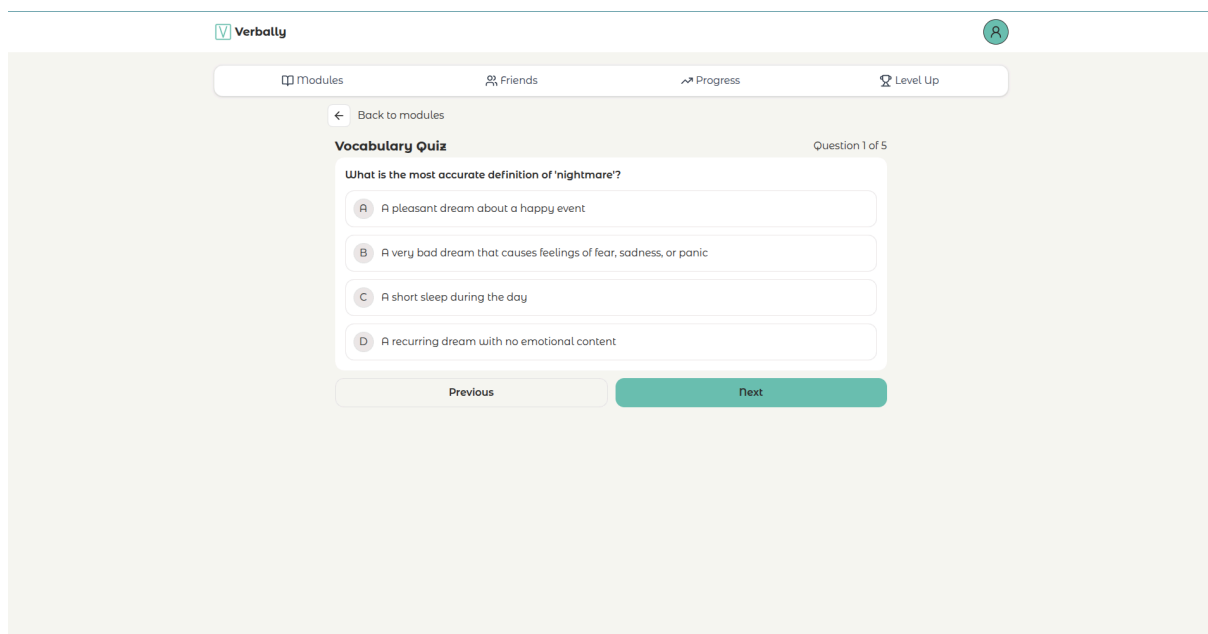


Figure 4.24: Vocab Quiz Screen

Figure 4.25 shows the results of the vocabulary quiz. It gives the overall score along with correct and incorrect answers. The incorrect answers also have feedback which includes the correct answer and the explanation.

**Verbalby**

Modules Friends Progress Level Up

Back to modules

**Quiz Complete**  
You scored 2 out of 5  
40%

Your answers

**Correct**

**Question 1:** Which of the following best defines the word 'suspicious'?

**Selected Answer:** Having or showing a feeling that something is wrong or that someone is behaving dishonestly

**Correct Answer:** Having or showing a feeling that something is wrong or that someone is behaving dishonestly

**Incorrect**

**Question 2:** Choose the sentence that uses 'suspicious' correctly.

**Selected Answer:** She gave a suspicious smile after winning the lottery.

**Correct Answer:** He made a suspicious amount of money in a very short time, which raised some eyebrows.

Sentence B correctly uses 'suspicious' to describe a situation that seems questionable or potentially dishonest due to the rapid accumulation of wealth.

**Correct**

**Question 3:** Which word is a synonym for 'suspicious'?

**Selected Answer:** Doubtful

**Correct Answer:** Doubtful

**Incorrect**

**Question 4:** Fill in the blank: The detective found the suspect's alibi to be quite \_\_\_\_\_, given the lack of corroborating evidence.

**Selected Answer:** plausible

**Correct Answer:** unconvincing

The context suggests that the alibi was not believable, making 'unconvincing' the most appropriate word. 'Suspicious' would also fit here, but 'unconvincing' directly relates to the lack of evidence.

**Incorrect**

**Question 5:** Based on the following sentence, what can you infer about the person's behavior?  
'When the normally quiet intern started asking unusually detailed questions about the company's finances, his colleagues grew suspicious.'

**Selected Answer:** They thought his questions were normal for an intern.

**Correct Answer:** They suspected he might have a hidden motive or be involved in something improper.

The colleagues' suspicion suggests they believe the intern's behavior is out of character and potentially indicates a hidden agenda or wrongdoing, rather than simple curiosity or ambition.

[Return to Dashboard](#)

Figure 4.25: Vocab Quiz Result Screen

Figure 4.26 shows the instructions page for the grammar quiz. It guides users about the quiz and its contents.

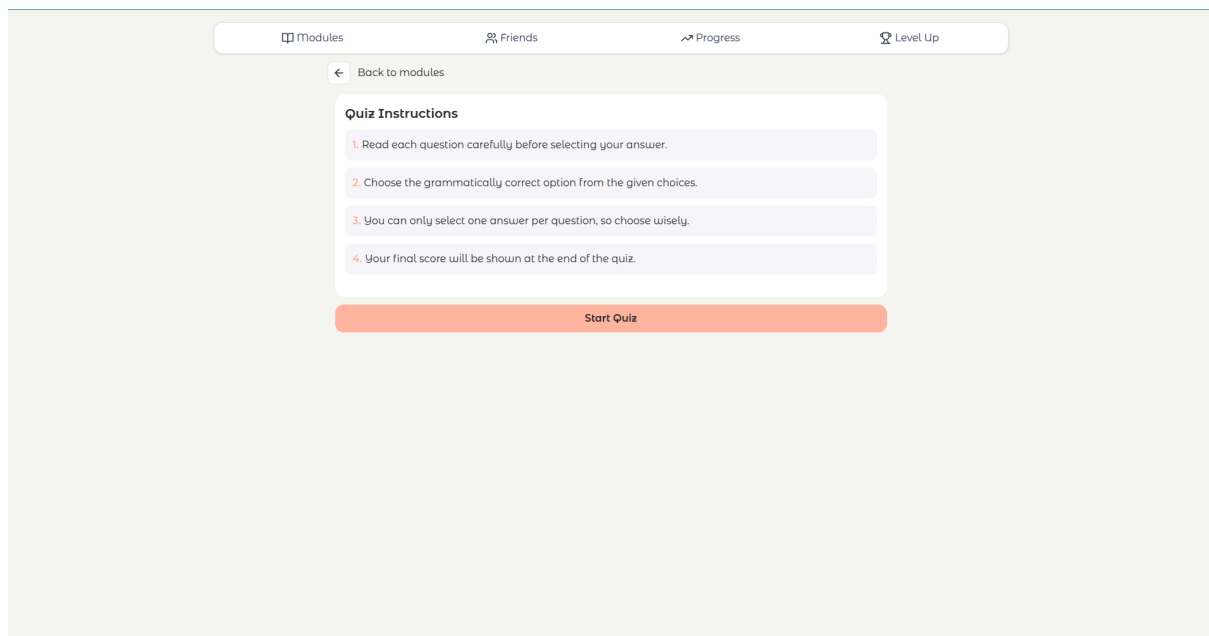


Figure 4.26: Grammar Quiz Instruction Screen

Figure 4.27 shows the grammar quiz with one of the questions and its multiple choices. A user must select one of the options before moving to the next question.

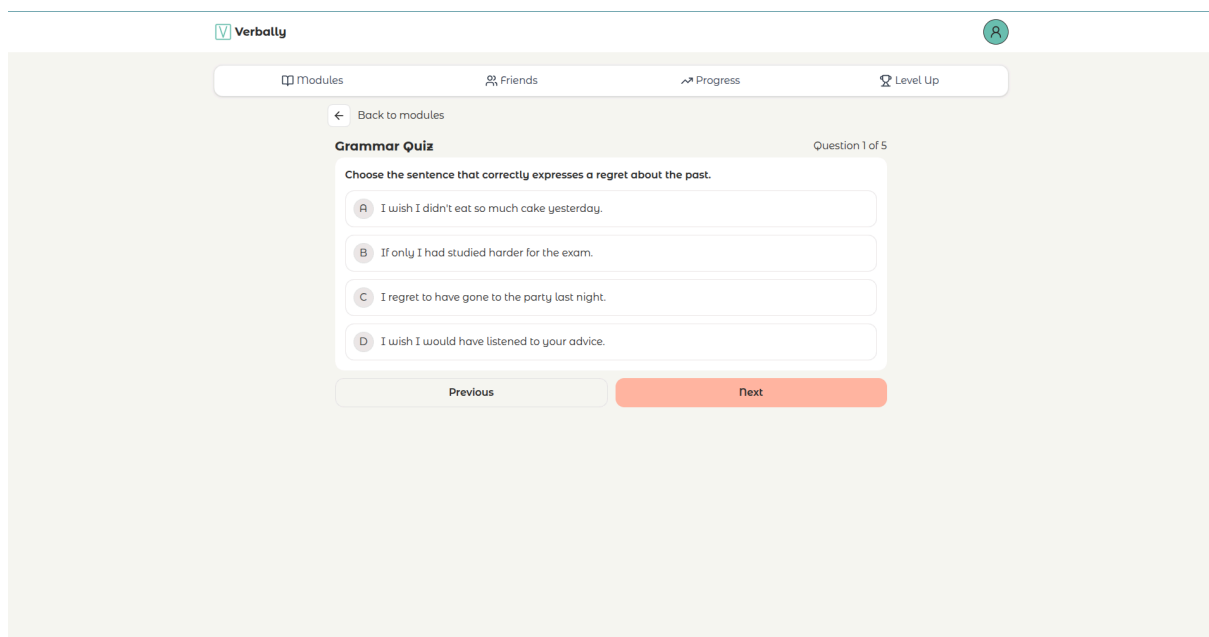


Figure 4.27: Grammar Quiz Screen

Figure 4.28 shows the results of the grammar quiz. It gives the overall score along with correct and incorrect answers. The incorrect answers also have feedback which includes the correct answer and the explanation.

**Verballly**

Modules Friends Progress Level Up

Back to modules

**Quiz Complete**  
You scored 2 out of 5  
40%

Your answers

**Incorrect**

**Question 1:** Which sentence best demonstrates digital persuasion in a high-stakes conflict scenario?  
**Selected Answer:** The company posted a generic apology online after a major data breach.  
**Correct Answer:** The negotiator shared a personal anecdote to build rapport before presenting their demands.  
Option B shows a strategic use of personal connection (rapport building) to influence the other party's perception, a key element of digital persuasion in sensitive situations. The other options are either too aggressive, too generic, or rely solely on emotional outburst rather than persuasive strategy.

**Correct**

**Question 2:** Identify the sentence with a subtle error in digital persuasion strategy.  
**Selected Answer:** During the online debate, he consistently reframed his opponent's arguments to appear unreasonable.  
**Correct Answer:** During the online debate, he consistently reframed his opponent's arguments to appear unreasonable.

**Incorrect**

**Question 3:** Choose the sentence that correctly applies a principle of digital persuasion in a conflict:  
**Selected Answer:** The team leader attempted to resolve the dispute by exclusively using emojis to express frustration.  
**Correct Answer:** She diffused the tense online meeting by acknowledging valid points from both sides before stating her proposal.  
Acknowledging valid points from opposing sides (option B) is a crucial de-escalation and persuasion tactic in conflict, showing respect and fostering a willingness to listen. The other options describe ineffective or aggressive communication methods.

**Incorrect**

**Question 4:** Complete the sentence: In a high-stakes online negotiation, it is crucial to \_\_\_\_ your message to resonate with the other party's underlying interests.  
**Selected Answer:** amplify  
**Correct Answer:** tailor  
'Tailor' means to adapt or adjust something for a specific purpose or person. In persuasion, tailoring your message ensures it addresses the specific needs and concerns of the other party, making it more effective. 'Obfuscate' means to make unclear, 'amplify' means to increase, and 'generalize' means to make broad, none of which are ideal for specific persuasion.

**Correct**

**Question 5:** Which of these sentences most effectively uses digital persuasion to de-escalate a high-stakes conflict?  
**Selected Answer:** The company representative responded to the public outcry with a carefully crafted message emphasizing shared values and a commitment to finding a solution.  
**Correct Answer:** The company representative responded to the public outcry with a carefully crafted message emphasizing shared values and a commitment to finding a solution.

Return to Dashboard

Figure 4.28: Grammar Quiz Result Screen

Figure 4.29 shows the instructions page writing quiz. It guides users about the quiz and its contents.

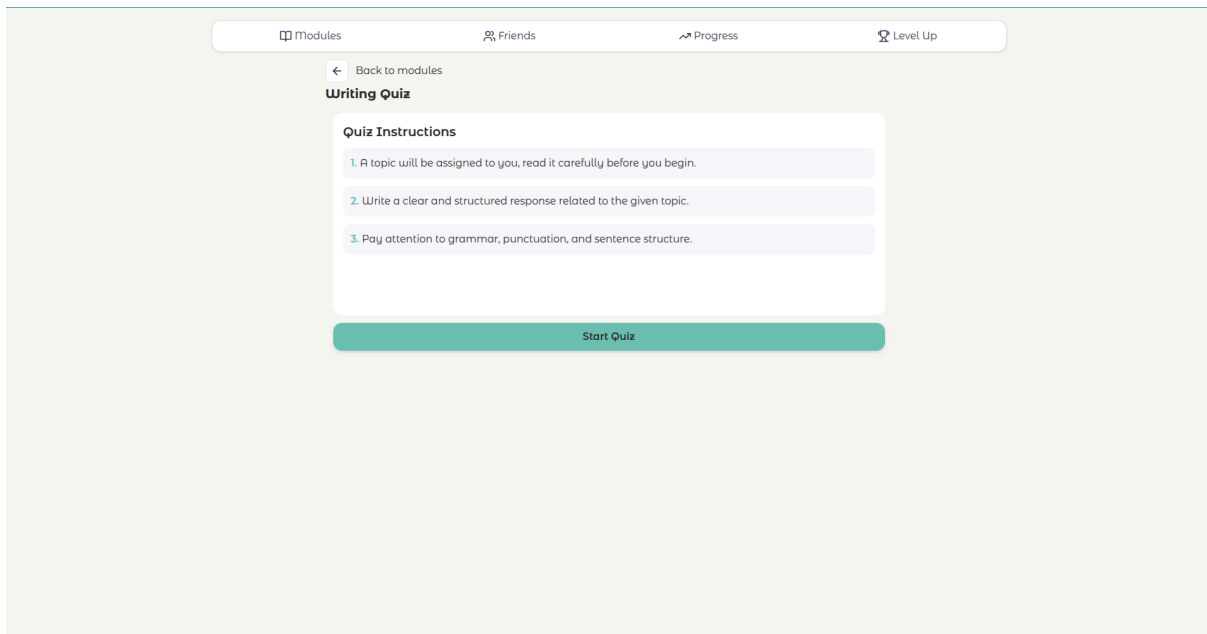


Figure 4.29: Writing Quiz Instruction Screen

Figure 4.30 shows the writing prompt for the writing quiz. The user is provided a text area to write and answer the prompt.

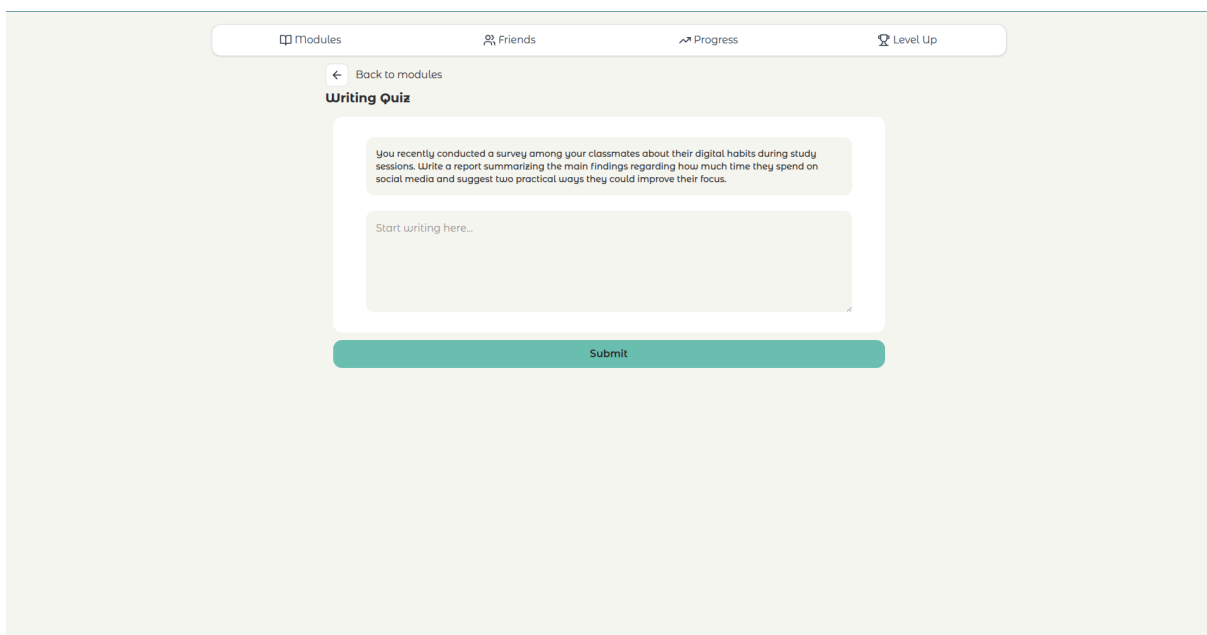


Figure 4.30: Writing Practice Screen

Figure 4.31 shows the feedback for the writing quiz. It provides the writing score and a detailed analysis on various areas.

**Verbalby**

Modules Friends Progress Level Up

Back to modules

### Writing Quiz

**Quiz Complete**  
You scored 4 out of 5  
**80%**

#### Feedback

The submission demonstrates a strong grasp of academic discourse, effectively articulating complex ideas related to algorithmic decision-making and democratic legitimacy. The arguments are well-structured and supported, showing a proficiency that aligns with the C1 level, particularly in nuanced vocabulary and sophisticated sentence construction.

Vocabulary Usage <b>90%</b>	Grammar Accuracy <b>95%</b>
Tone Appropriateness <b>95%</b>	Coherence and Structure <b>90%</b>

#### Strong Points

- Clear and logical argumentation
- Precise and academic vocabulary
- Effective synthesis of complex concepts

#### Weak Points

- Occasional minor sentence structure variation could enhance flow
- Deeper exploration of specific case studies could strengthen impact

#### Suggestions

- Vary sentence beginnings more frequently to improve rhythm
- Incorporate brief examples of real-world algorithmic governance challenges
- Consider exploring counterarguments or alternative perspectives more explicitly

[Return to Dashboard](#)

Figure 4.31: Writing Practice Result Screen

Figure 4.32 shows the instruction page for the communicative fluency assessment.

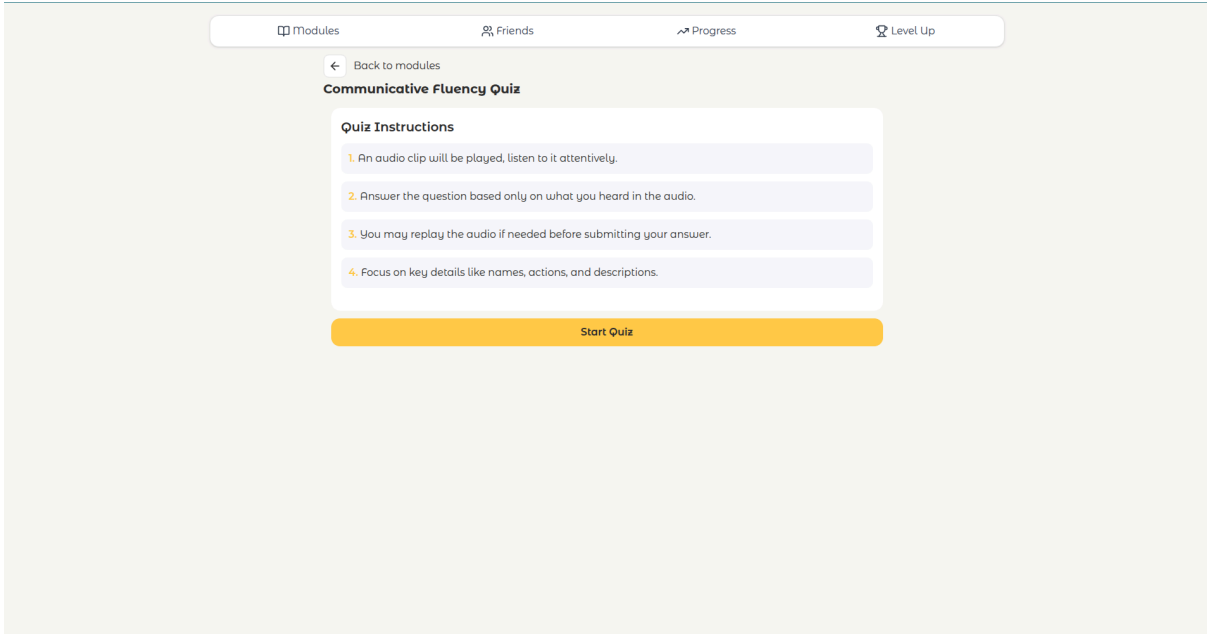


Figure 4.32: Communicative Fluency Instruction Screen

Figure 4.33 shows the speaking prompt for the communicative fluency module. The user must record themselves speaking and submit it.

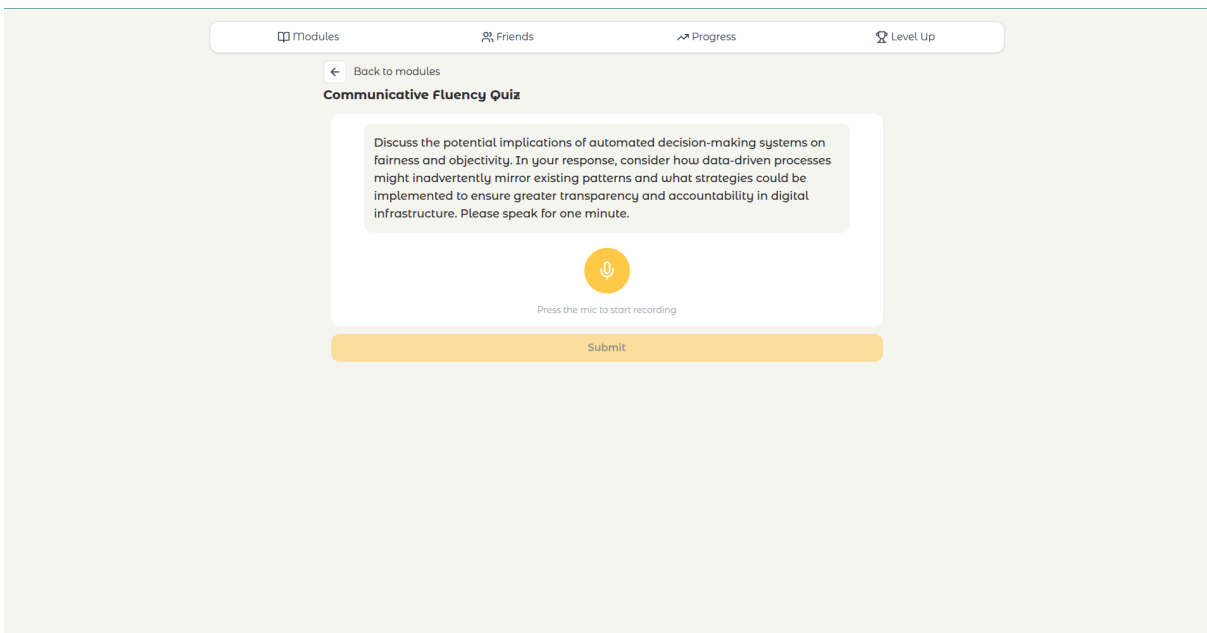


Figure 4.33: Communicative Fluency Quiz Screen

Figure 4.34 shows the feedback for the communicative fluency modules with detailed feedback on various areas of speech.

**Verbally**

Modules Friends Progress Level Up

Back to modules

### Communicative Fluency Quiz

**Quiz Complete**  
The speaker's delivery was clear and well-paced, with effective use of pauses and good intonation. However, there was a slight dip in vocal energy towards the end of sentences.  
**84%**

**Your Transcription**  
"Two important social consequences of increasing urbanization are changing in community life and advising social inequality. As cities expand, people experience weaker personal connections because urban living can be fast paced and less personal, reducing the sense of belonging."

**Stats**

<b>Filler Words</b> <b>0</b> No filler words detected. Excellent!	<b>Avg Pace</b> <b>1.69 wps</b> Good pace variation — your speech rhythm feels natural.	<b>Confidence</b> <b>80%</b> Confident overall, with a few areas to polish.
---	---	---

**Breakdown**

- Clarity** (Clear): The speech was easy to follow and articulate.
- Pace** (Natural Pace): The speaking speed was within a natural range and the pace was stable.
- Pauses** (Effective Pauses): Pauses were used effectively, with no hesitation pauses detected.
- Intonation** (Varied Intonation): Pitch variation was excellent, adding emphasis and interest to the delivery.
- Energy** (Slightly Inconsistent Energy): Vocal energy was generally consistent but showed a slight decay towards the end of some sentences.

**Areas to Improve**

- Maintain consistent vocal energy throughout each sentence.
- Slightly increase overall vocal energy to enhance engagement.

Return to Dashboard

Figure 4.34: Communicative Fluency Result Screen

Figure 4.35 shows the instruction screen for the accent assessment module.

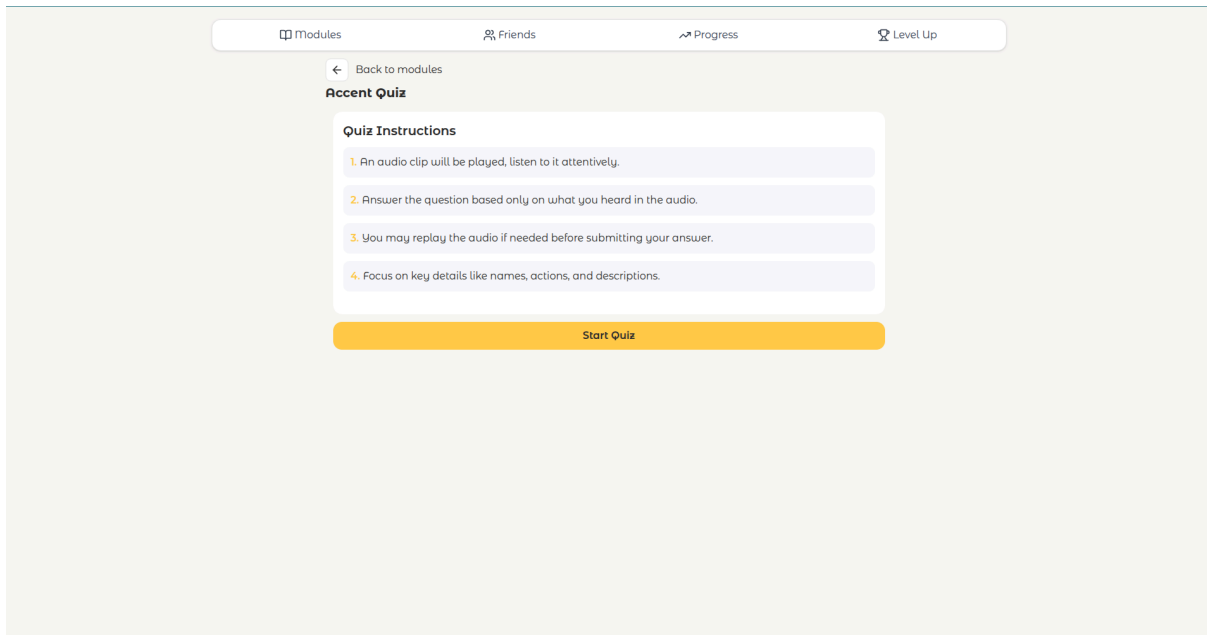


Figure 4.35: Accent Quiz Instruction Screen

Figure 4.36 shows the recitation prompt for the accent quiz. The user is supposed to recite the given text and submit it.

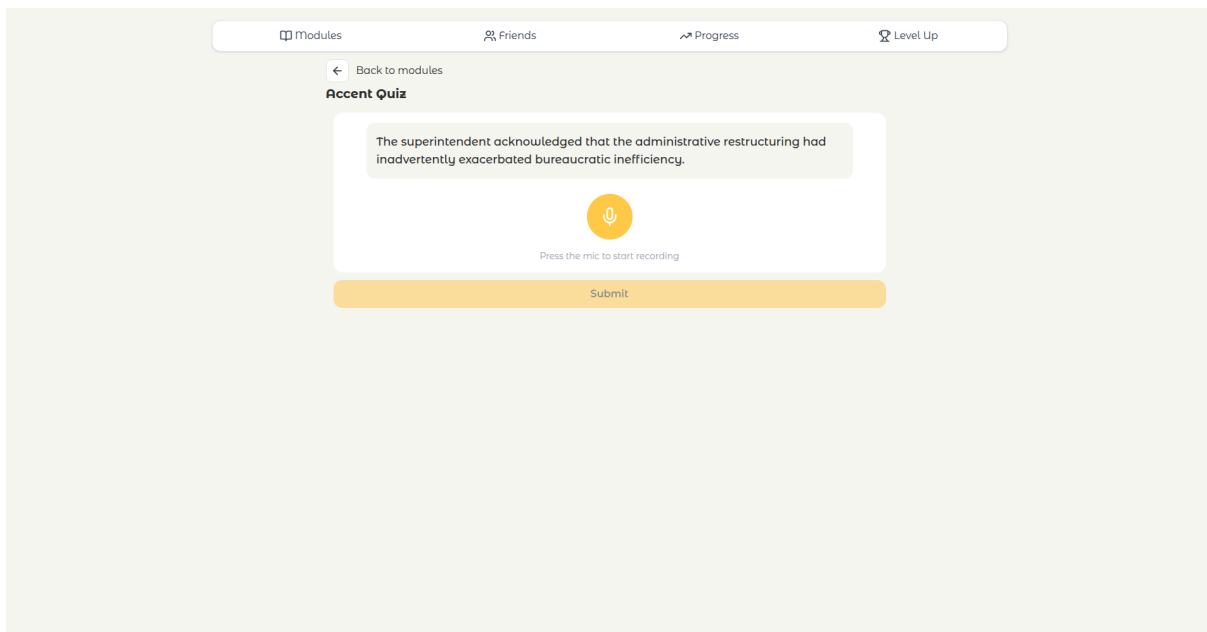


Figure 4.36: Accent Quiz Screen

Figure 4.37 shows the result of the accent quiz assessment with detailed accent-specific feedback.

**Verbally**

Modules Friends Progress Level Up

Back to modules

### Accent Quiz

**Quiz Complete**  
You're clear, but a few small mistakes to fix.

**81/100%**

**Your Transcription**

"The meteorological phenomena unexpectedly intensified causing unprecedented infrastructural damage across the peninsula."

**Stats**

<b>Accent</b> <b>Us</b>	<b>Avg Pace</b> <b>1.23 wps</b> A bit slow, try speaking faster	<b>Pauses</b> <b>1</b> Good flow, keep practicing!
----------------------------	---	--

**Mistakes**

You said: "phenomena" "phenomenon"

You used the plural form 'phenomena' instead of the singular 'phenomenon'. The singular form ends with an 'uh' sound (/ə/), while the plural ends with an 'h' sound followed by an 'n' sound (/ənh/).

**Tip:** Remember that 'on' is singular and 'a' is plural for this word.

**Practice:** Say 'phenomenon' and 'phenomena' several times, focusing on the different endings.

You said: "infrastructural" "infrastructural"

The 't' sound in 'infrastructural' was pronounced like a 'ch' sound (/tʃ/). In American English, when 't' comes before 'r', it often softens to a 'ch' sound, but in this word, it should remain a clear /t/ sound.

**Tip:** Focus on making a clear /t/ sound before the /r/ in 'infrastructural'.

**Practice:** Say 'in-FRAS-tract-urat' slowly, emphasizing the /t/ sound.

You said: "peninsula" "peninsula"

The final syllable of 'peninsula' was not clearly pronounced, and the pitch dropped to zero, indicating a lack of clear articulation. The expected ending is '-luh' (/lə/).

**Tip:** Make sure to articulate the final unstressed syllable clearly.

**Practice:** Say 'pen-IN-su-la' and focus on a clear 'la' sound at the end.

**Prosody Feedback**

**Intonation**  
Your intonation was generally flat, especially towards the end of the sentence. The pitch dropped significantly on 'across' and became zero on 'the' and 'peninsula', making the ending unclear.

**Stress**  
The stress on 'meteorological' and 'unexpectedly' was a bit weak. Ensure you emphasize the stressed syllables more strongly.

**Rhythm**  
The rhythm was a little uneven, with some words being pronounced too quickly ('across', 'the') and others with less clear endings ('peninsula').

**Practice Tips**

1. Pay close attention to word endings, especially plurals and unstressed syllables.
2. Practice the 't' sound before 'r' in words like 'infrastructural' to ensure clarity.
3. Work on maintaining a more consistent pitch range throughout the sentence to improve intonation.
4. Focus on stressing the correct syllables in longer words like 'meteorological' and 'unexpectedly'.
5. Record yourself reading the sentence multiple times and compare it to a native speaker to identify areas for improvement.

[Return to Dashboard](#)

Figure 4.37: Accent Quiz Result Screen

Figure 4.38 shows the overview page for the level-up modules. It tells the user that they will be tested on vocabulary, grammar, writing, fluency, and listening.

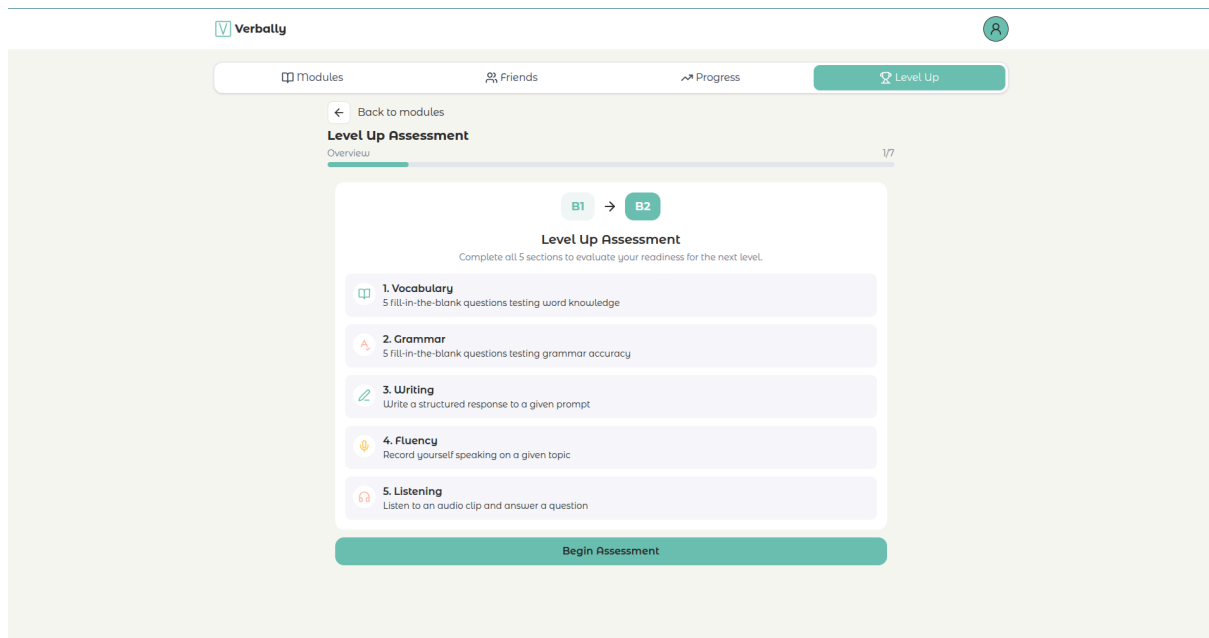


Figure 4.38: Level up overview screen

Figure 4.39 shows the vocabulary part of the level-up module. The user must complete this section before moving to the next part.

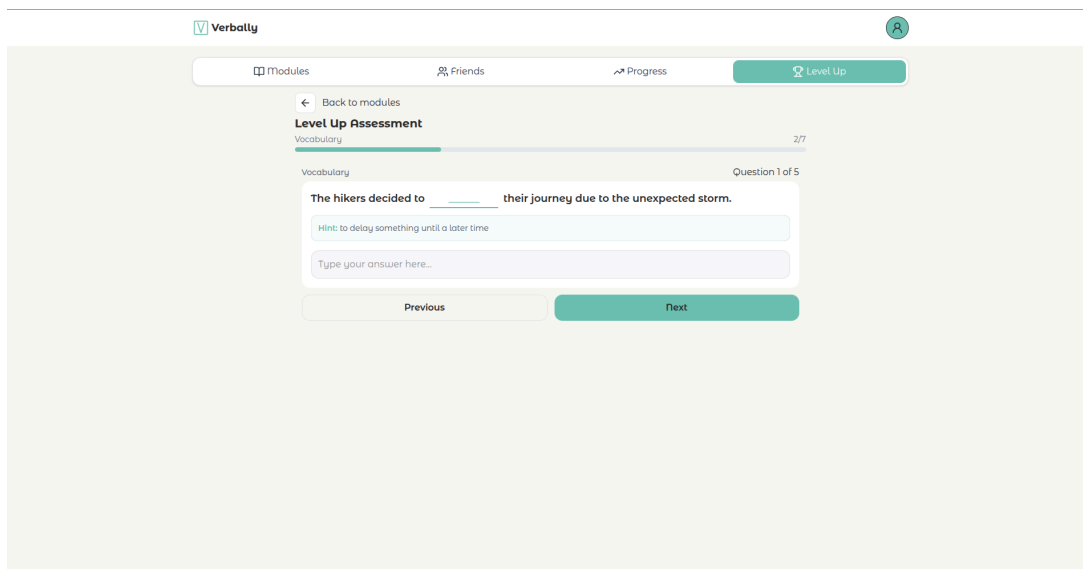


Figure 4.39: Level up vocab module

Figure 4.40 shows the grammar part of the level-up module. The user must complete this section before moving to the next part.

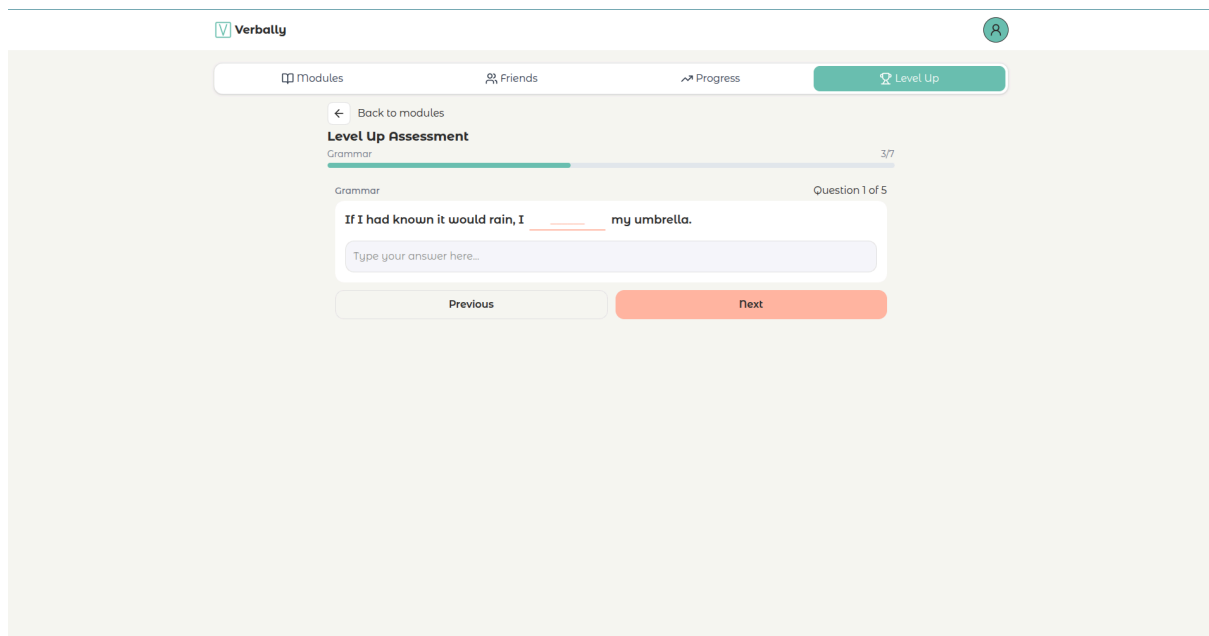


Figure 4.40: Level up grammar module

Figure 4.41 shows the writing part of the level-up module. The user must complete this section before moving to the next part.

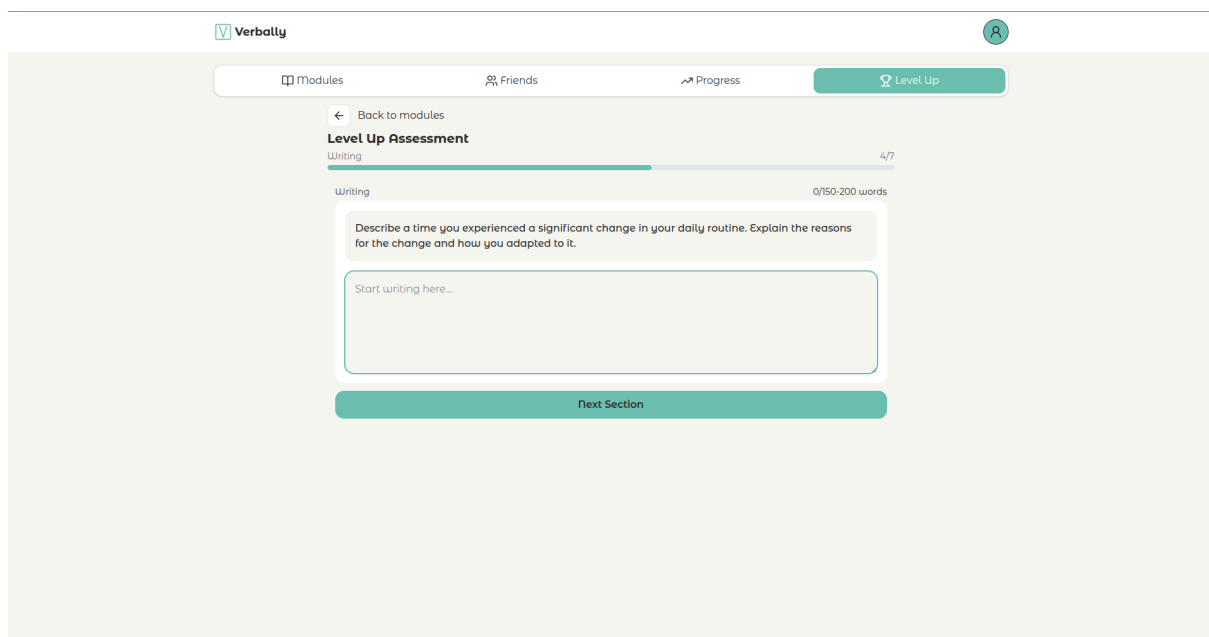


Figure 4.41: Level up writing module

Figure 4.42 shows the fluency part of the level-up module. The user must complete this section before moving to the next part.

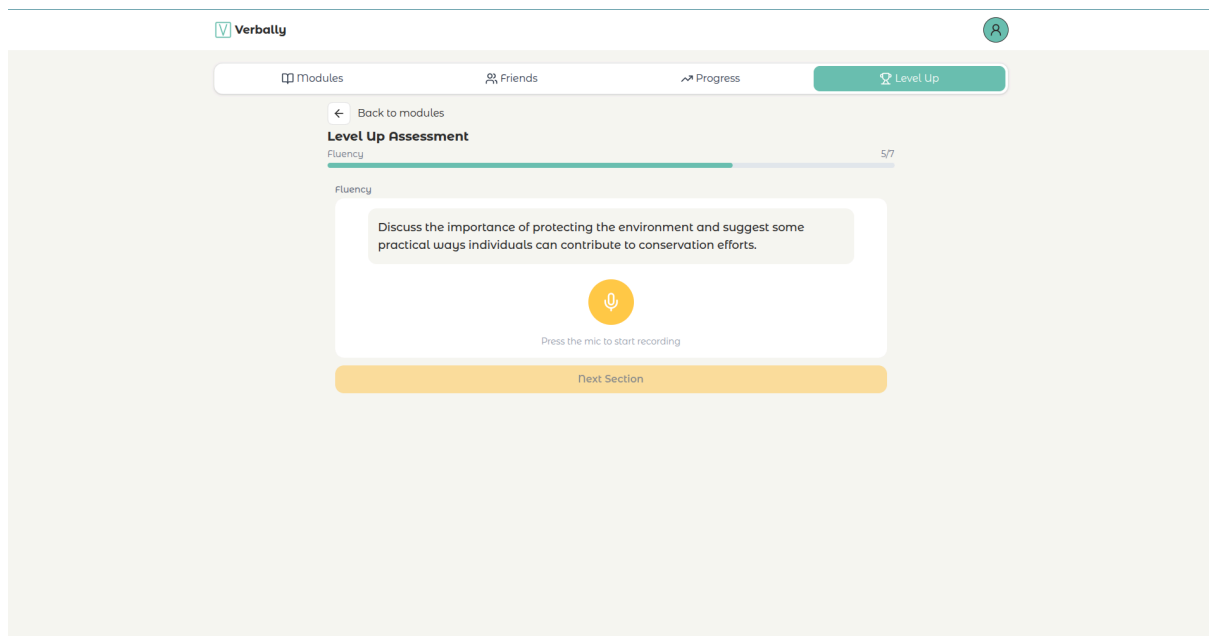


Figure 4.42: Level up fluency module

Figure 4.43 shows the listening part of the level-up module. The user must complete this section before moving to the next part.

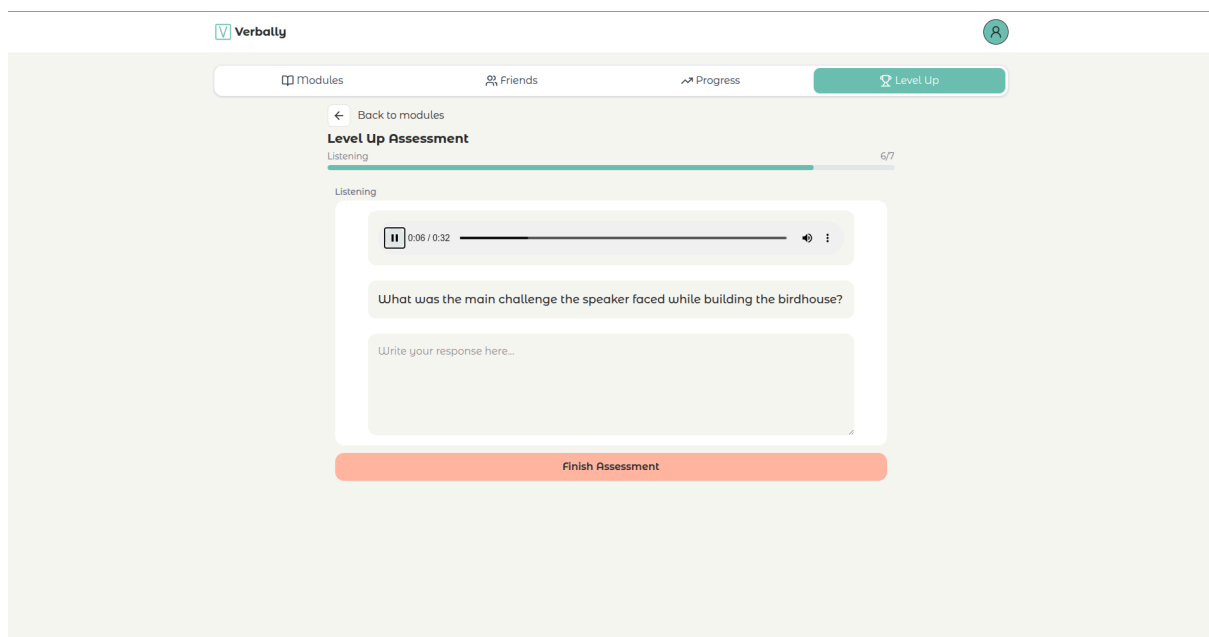


Figure 4.43: Level up listening module

Figure 4.44 shows the overview of all the parts of the level-up module complete before final submission.

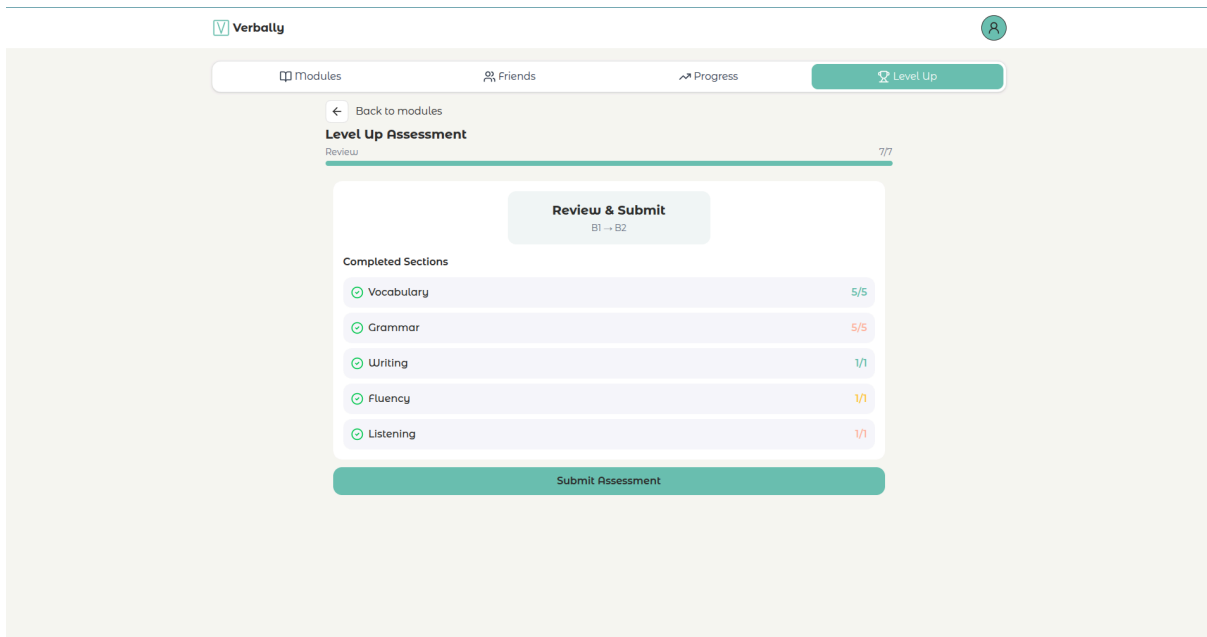


Figure 4.44: Level up submission screen

Figure 4.45 shows the results of the level-up assessment and the vocabulary assessment. The user will either pass or fail the level-up assessment. It gives detailed feedback about every single module completed in the level-up assessment.

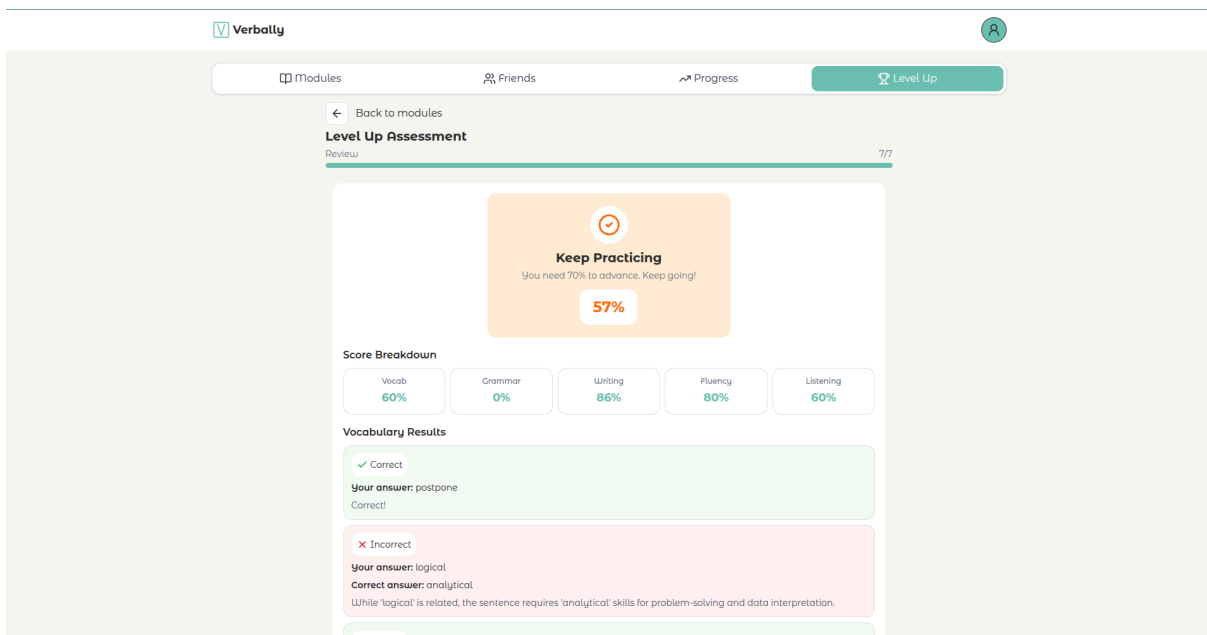


Figure 4.45: Level up result screen 01

Figure 4.46 shows the results for the grammar assessment in the level-up module.

The screenshot displays a grammar assessment interface. At the top, a green box indicates a correct answer: "Correct", "Your answer: overcome", "Correct!". Below this, the "Grammar Results" section lists five incorrect answers, each with a red 'X' icon and an explanation. The first incorrect answer is "would have", with the correct answer being "would have brought". The second is "was", with the correct answer being "must have been". The third is "made", with the correct answer being "shouldn't have made". The fourth is "lost", with the correct answer being "might have left". The fifth is "selected", with the correct answer being "could have found". At the bottom, the "Writing Results" section is partially visible.

Figure 4.46: Level up result screen 02

Figure 4.47 shows the results for the writing assessment in the level-up module.

The screenshot displays a writing assessment interface. At the top, the "Writing Results" section shows five performance metrics in rounded rectangular boxes: Task Completion (100%), Grammar Accuracy (80%), Vocabulary Range (80%), Coherence Cohesion (90%), and Cefr Appropriateness (80%). Below these metrics, a paragraph of feedback text states: "You have successfully described a significant change in your daily routine, explaining the reasons and your adaptation process. Your response is well-organized and uses appropriate vocabulary for the B2 level. To further enhance your writing, consider incorporating more complex sentence structures and a wider range of idiomatic expressions. While your grammar is generally accurate, occasional minor errors could be refined. Overall, this is a strong B2 response." The "Strengths" section lists four points: "Clear and logical organization of ideas.", "Effective use of cohesive devices (e.g., 'Instead of', 'At first', 'However', 'In addition', 'Over time').", "Good description of the challenges and the adaptation strategies.", and "Appropriate vocabulary for the topic and CEFR level." The "Areas for Improvement" section lists three points: "While grammar is mostly accurate, some minor improvements in verb tense consistency or preposition usage could be made.", "Consider using more varied sentence structures, including more subordinate clauses or inversions, to increase complexity.", and "Explore a slightly wider range of vocabulary, perhaps incorporating more nuanced adjectives or adverbs."

Figure 4.47: Level up result screen 03

Figure 4.48 shows the results for the fluency and listening assessments in the level-up module.

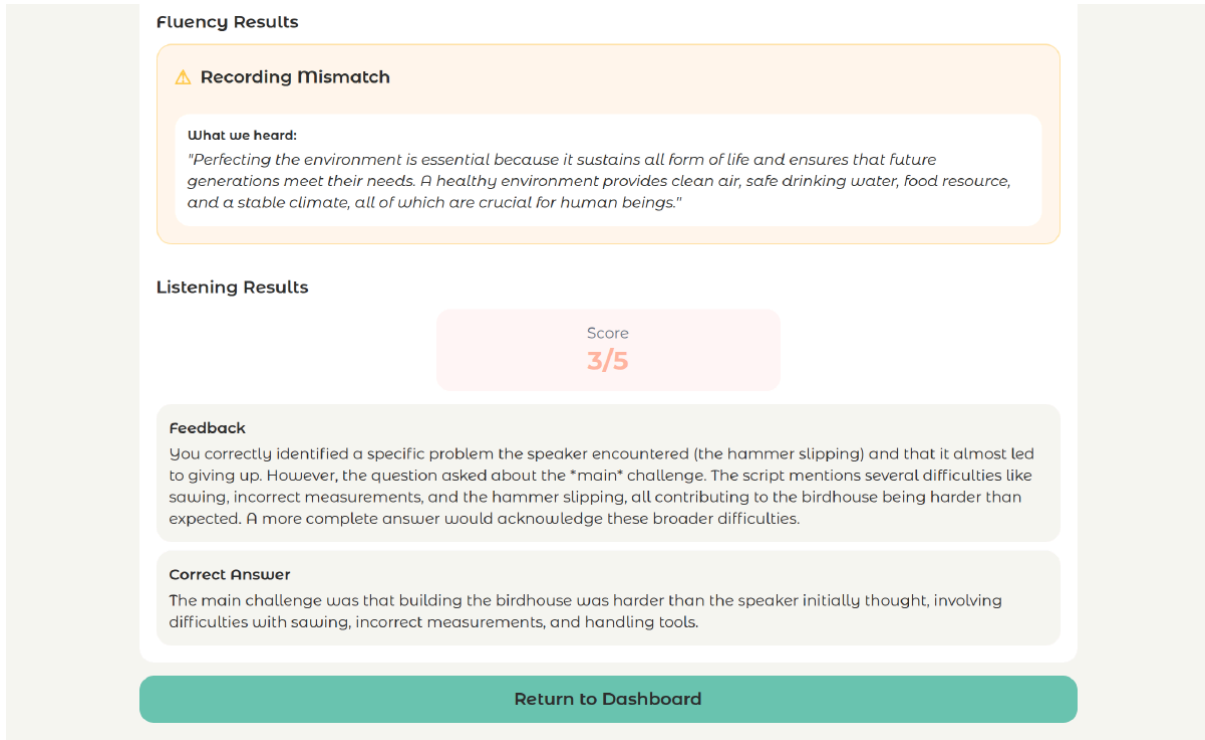


Figure 4.48: Level up result screen 04

Figure 4.49 shows the active conversations in the friendship module.

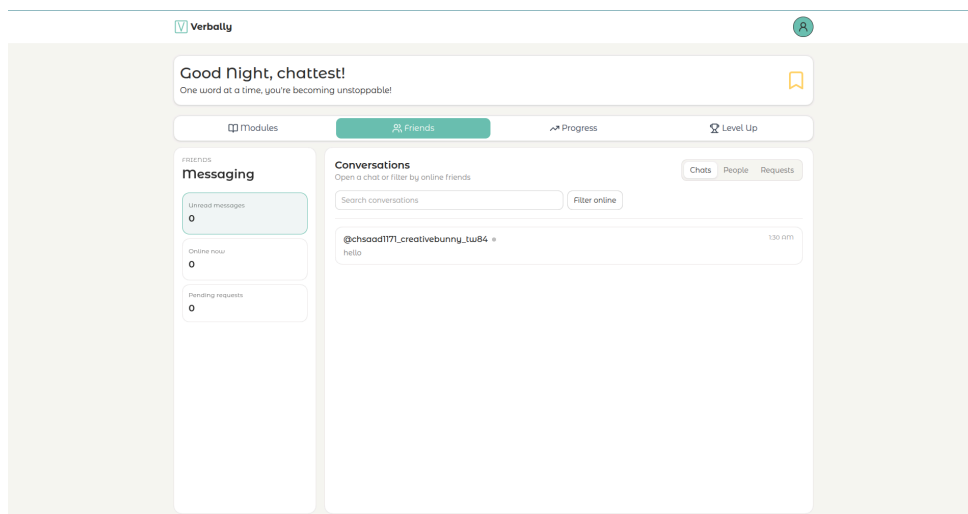


Figure 4.49: Friends Screen

Figure 4.50 shows the chatting screen which appears when a user starts chatting with another user.

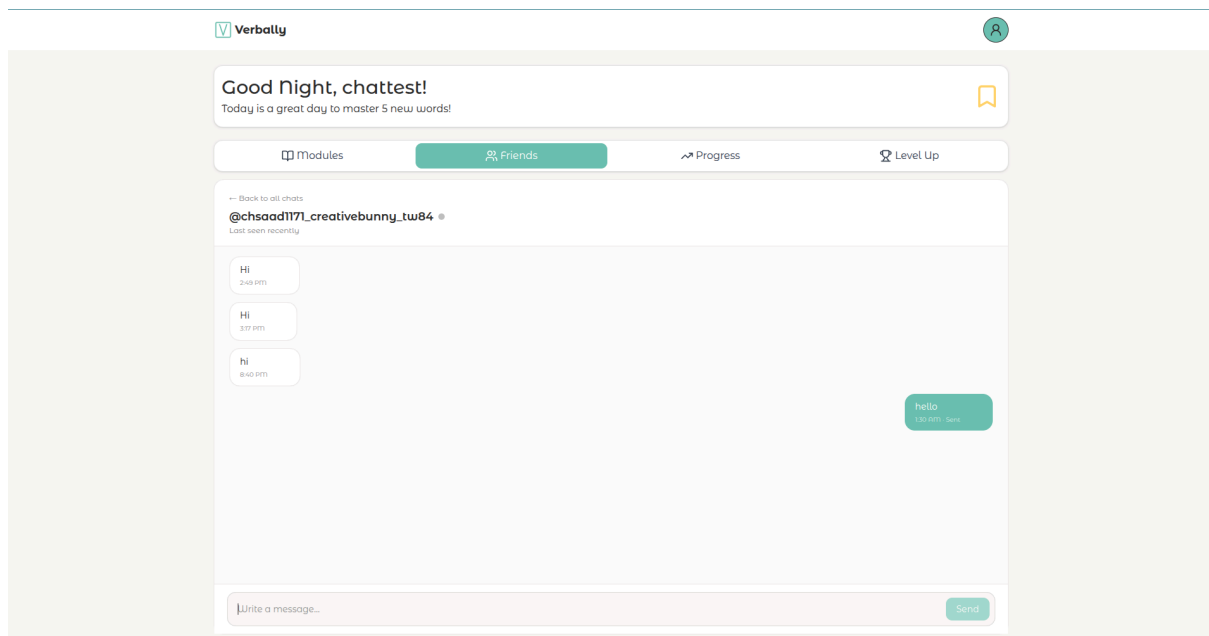


Figure 4.50: Conversation Screen

Figure 4.51 shows the suggested friends in the friendship module.

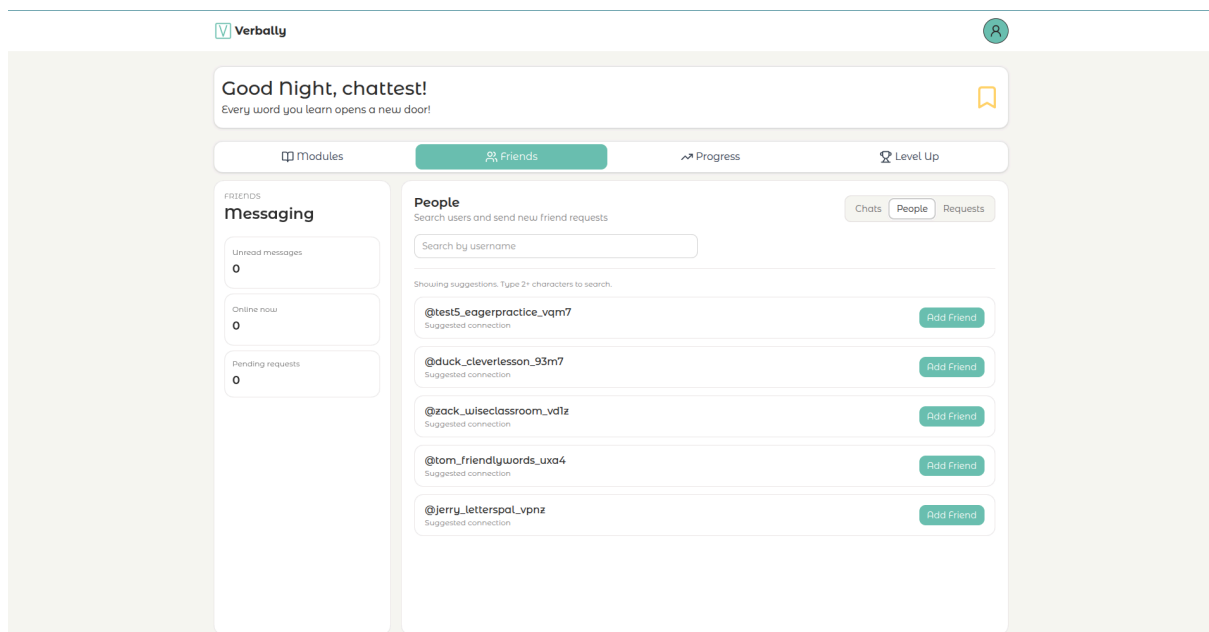


Figure 4.51: Suggested People Screen

Figure 4.52 shows the achievements and progress module. The first part of the screen shows the user's progress in all the learning modules while the second part shows the badges that they have achieved.

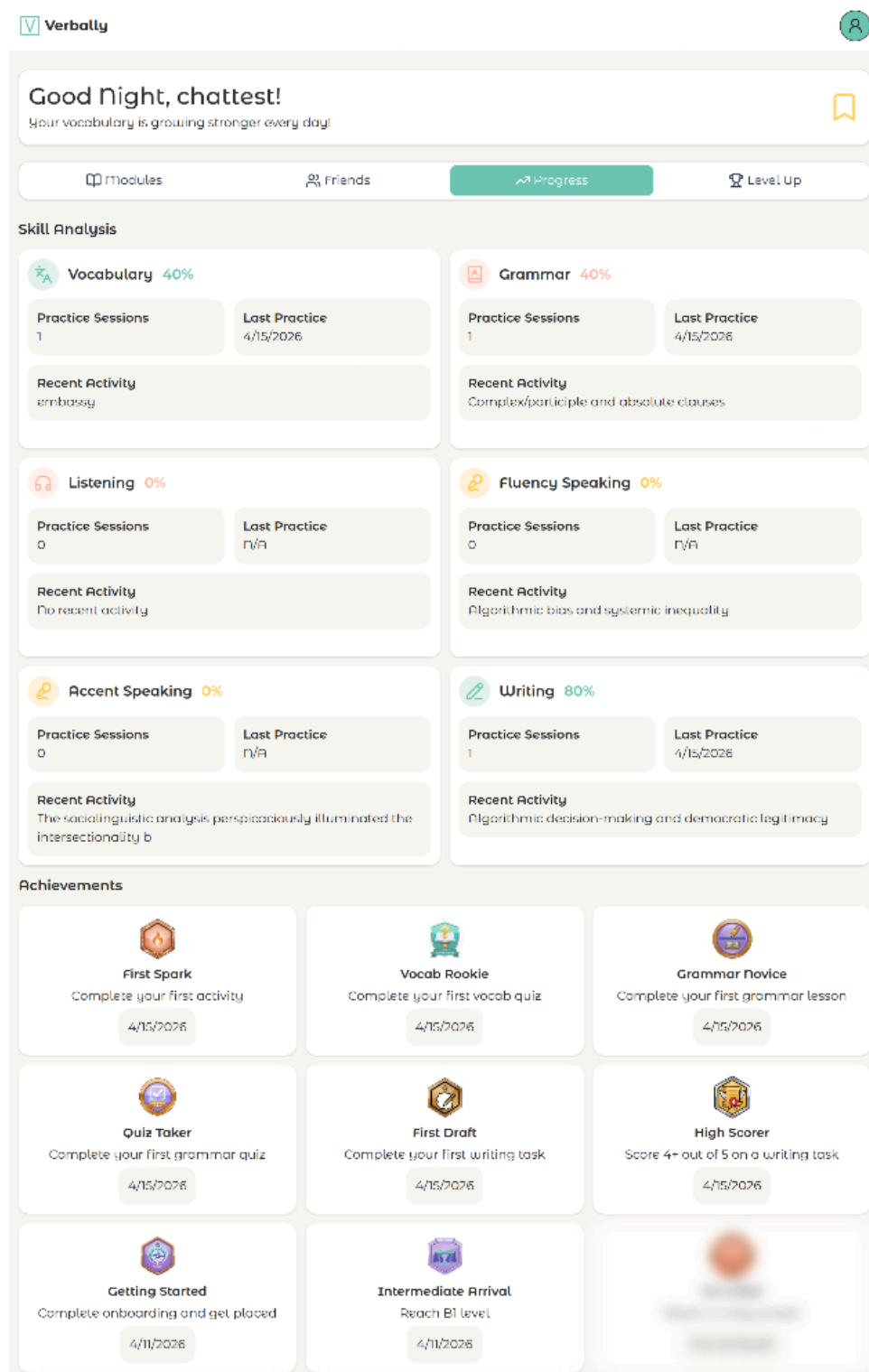


Figure 4.52: Progress Screen

Figure 4.53 shows the user profile page where they can change their bio, delete their account, view their CEFR level etc.

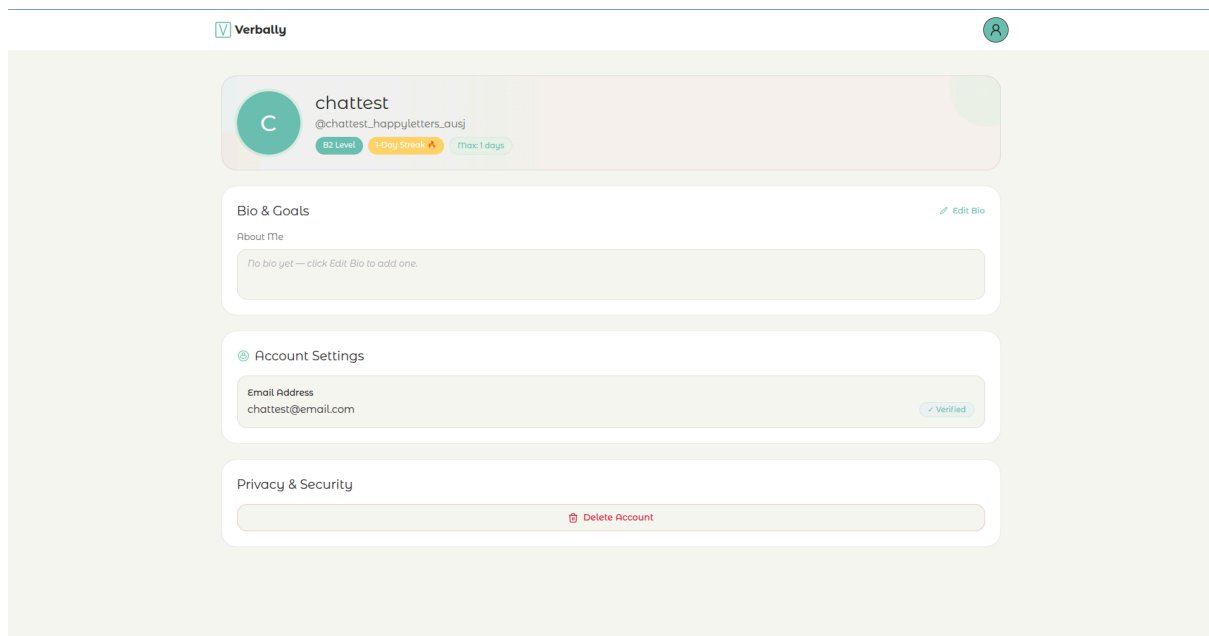


Figure 4.53: Profile Screen

## 4.8.2 Admin Panel

Figure 4.54 below shows the welcome page for the admin panel.

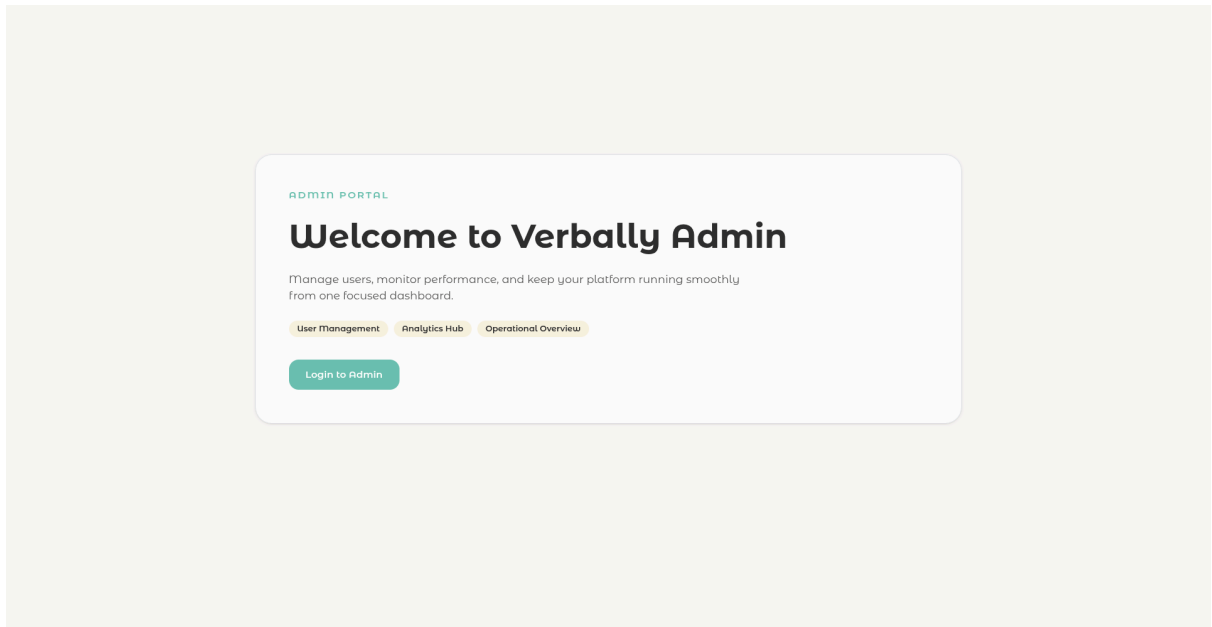


Figure 4.54: Admin Portal Landing Page

Figure 4.55 shows the sign in page for the admin panel..

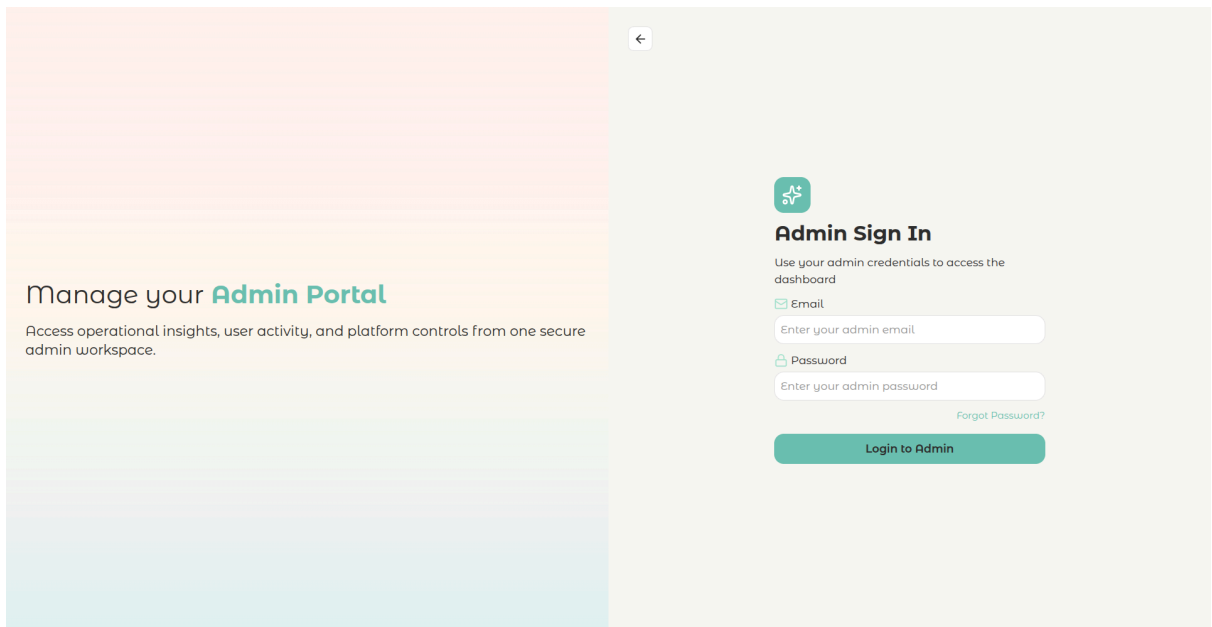


Figure 4.55: Admin Panel Login Screen

Figure 4.56 shows the admin dashboard with various statistics about users and other navigation links.

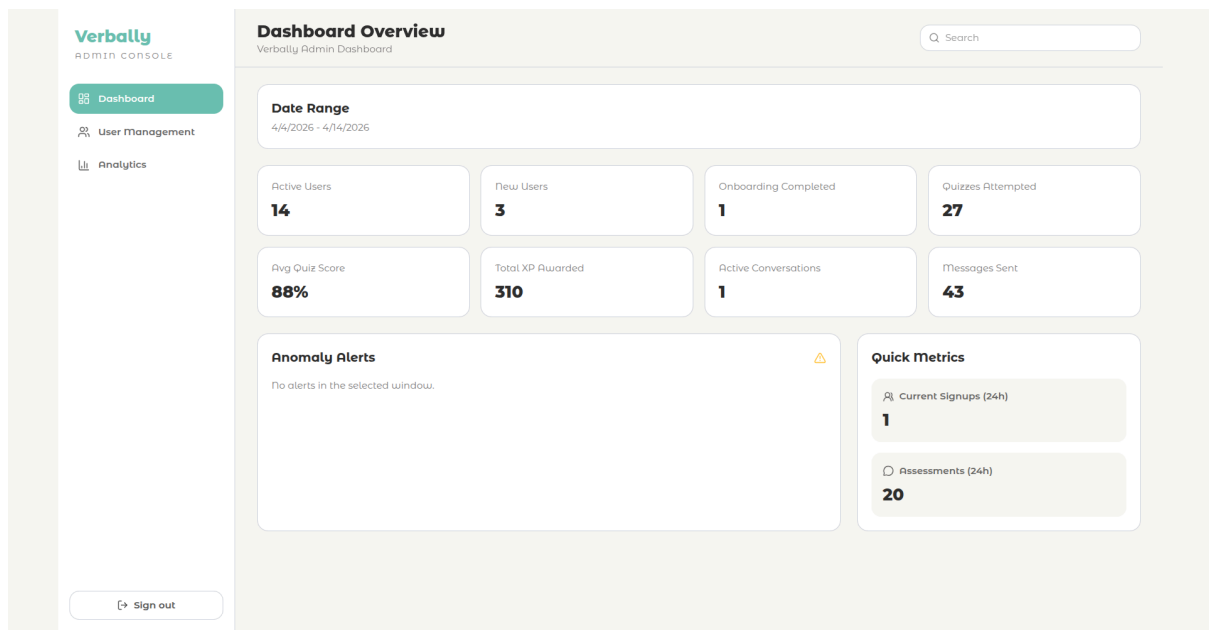


Figure 4.56: Dashboard Overview Screen

Figure 4.57 shows the user management section in the admin dashboard. The admin can view various details about users.

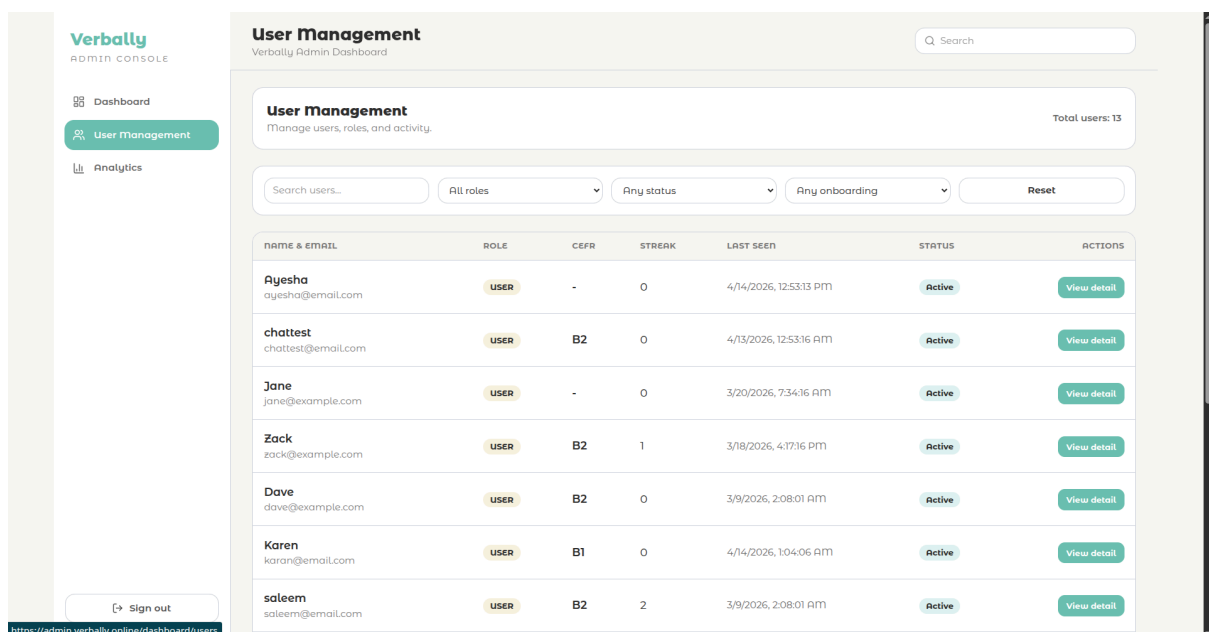


Figure 4.57: User Management Screen

Figure 4.58 shows the user detail screen. It allows the admin to deactivate users or promote them to admin.

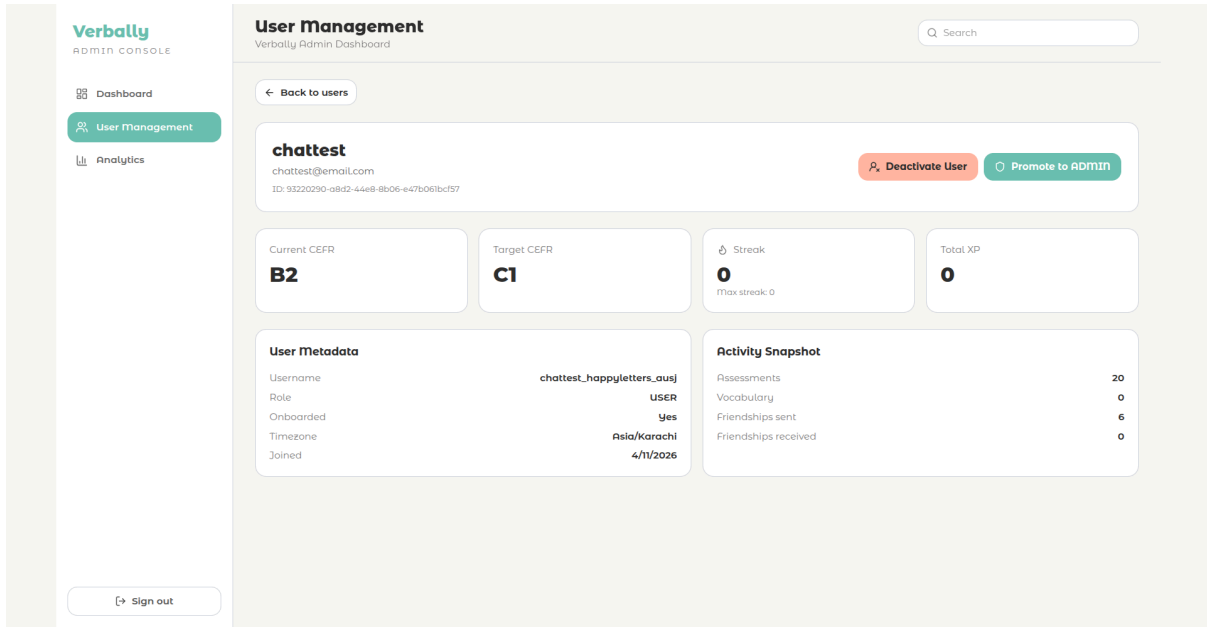


Figure 4.58: User Detail Screen

Figure 4.59 shows the social health of users in general. It includes things like message acceptance rates.

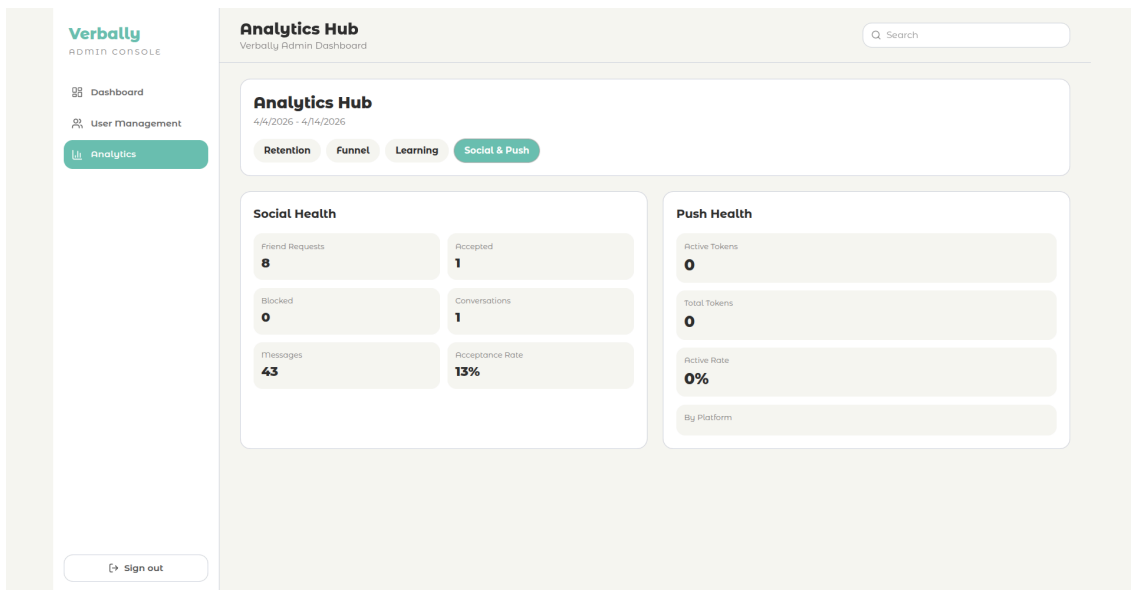


Figure 4.59: Social Push Overview Screen

Figure 4.60 shows the general learning analytics which includes things like learning outcomes and modules & topic performance.

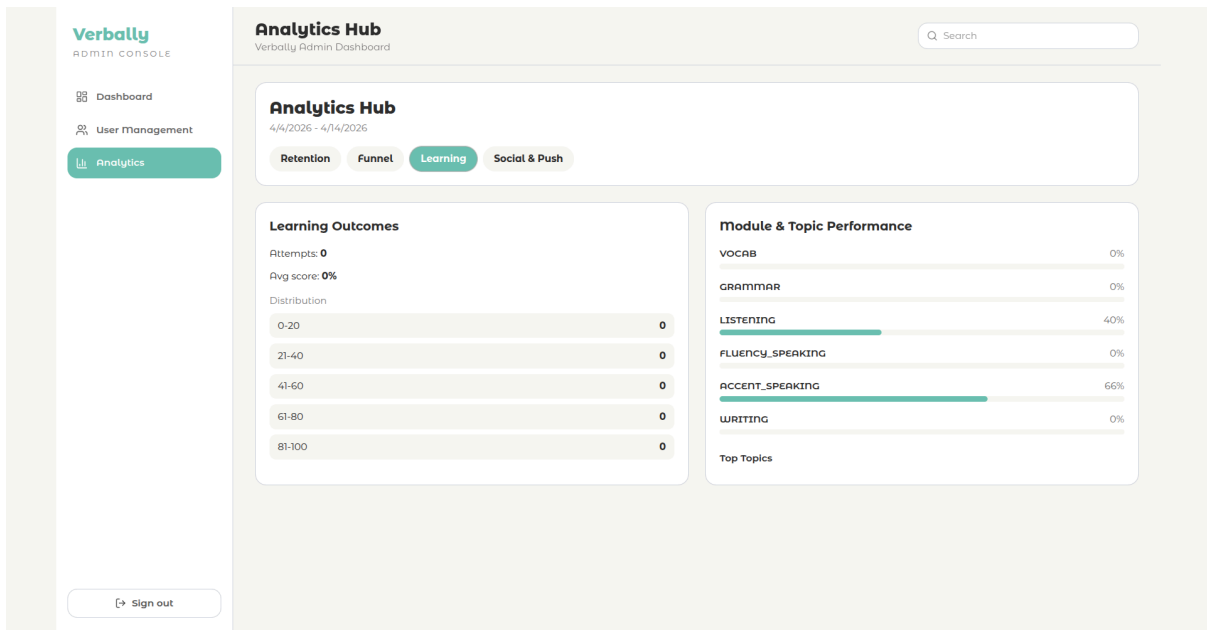


Figure 4.60: Learning Overview Screen

Figure 4.61 shows the general onboarding funnel.

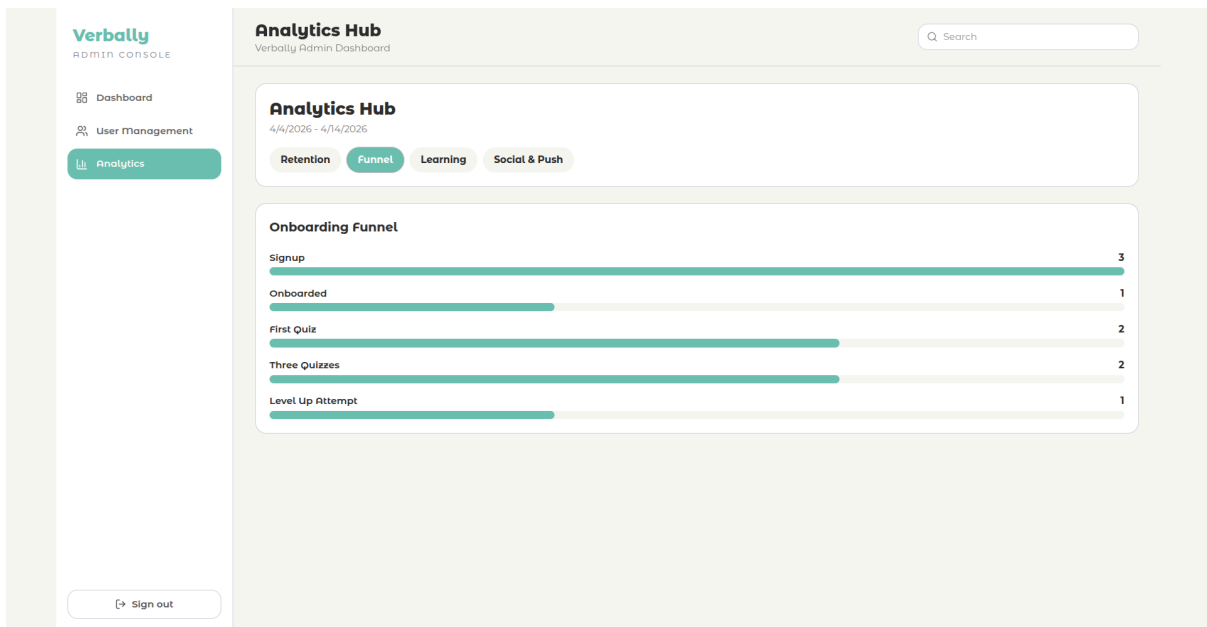


Figure 4.61: Funnel Screen

Figure 4.62 shows the general retention rates.

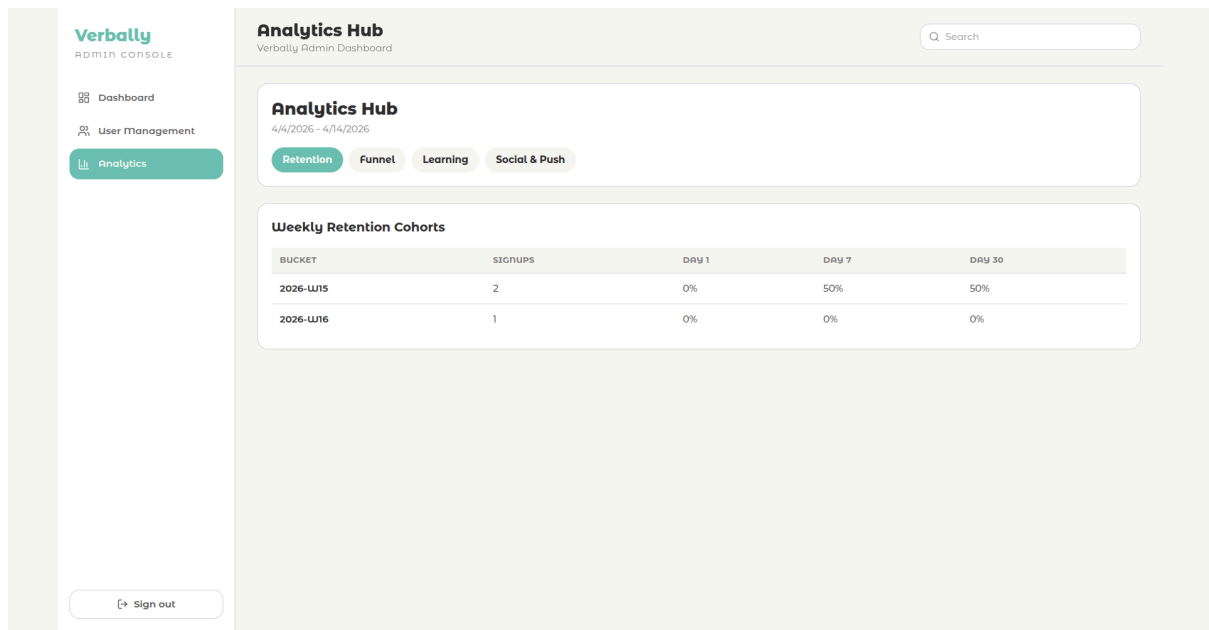


Figure 4.62: Retention Screen

### 4.8.3 Mobile UI

Figure 4.63 and Figure 4.64 show the login and forgot password screens for the mobile app version of Verbally.

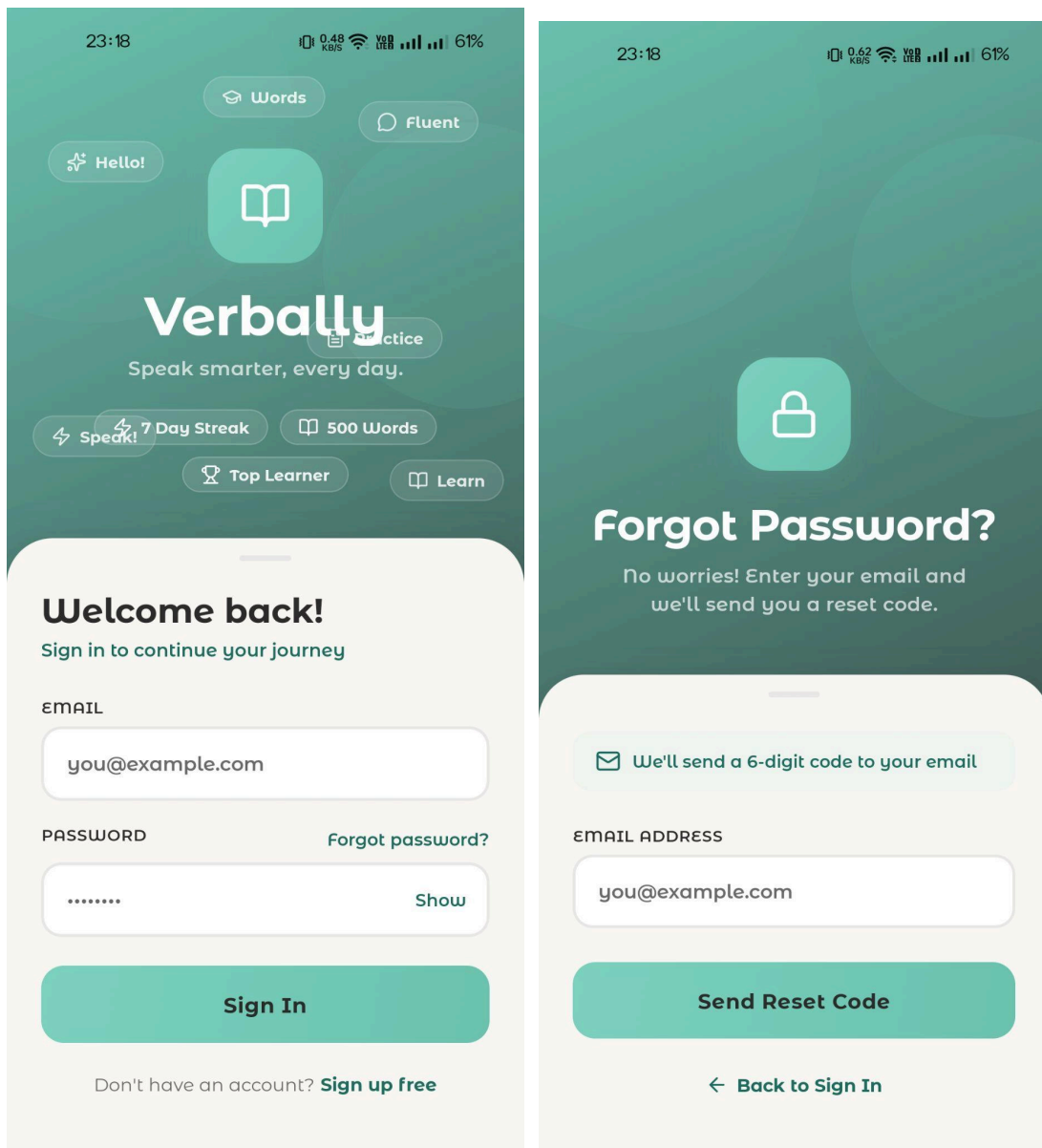


Figure 4.63: Mobile Login Screen

Figure 4.64: Forgot Password Screen

Figure 4.65 and Figure 4.66 below show the mobile sign up screen for new users and the main home page screen with all the learning modules.

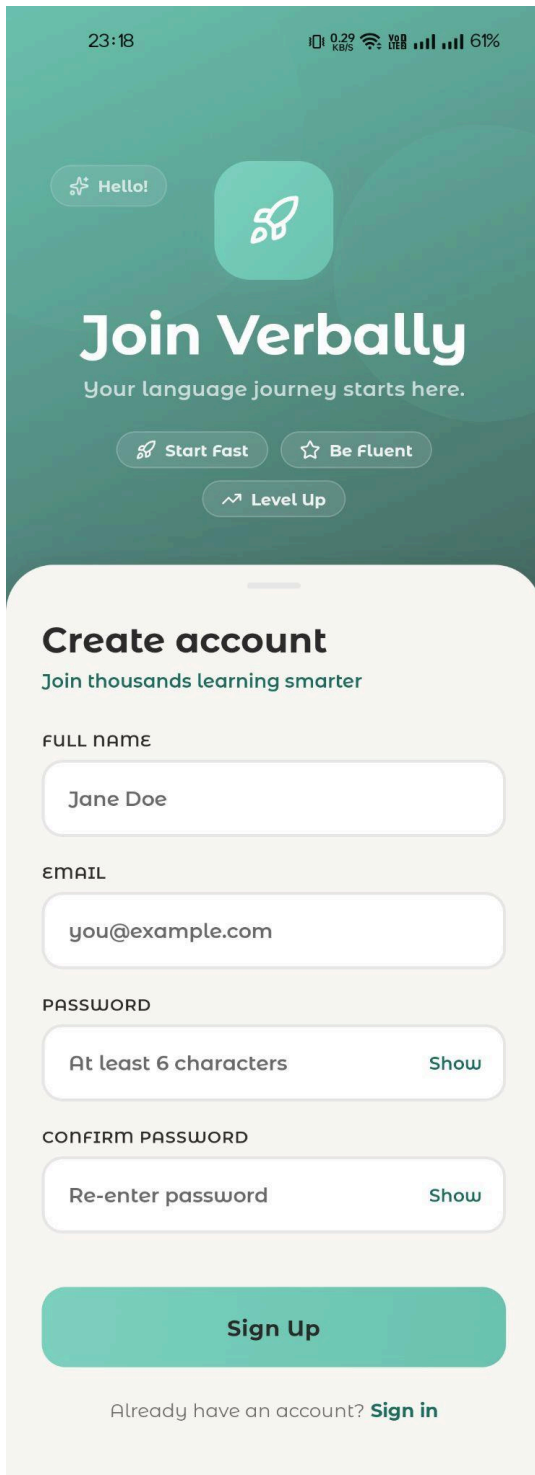


Figure 4.65: Mobile Sign up Screen

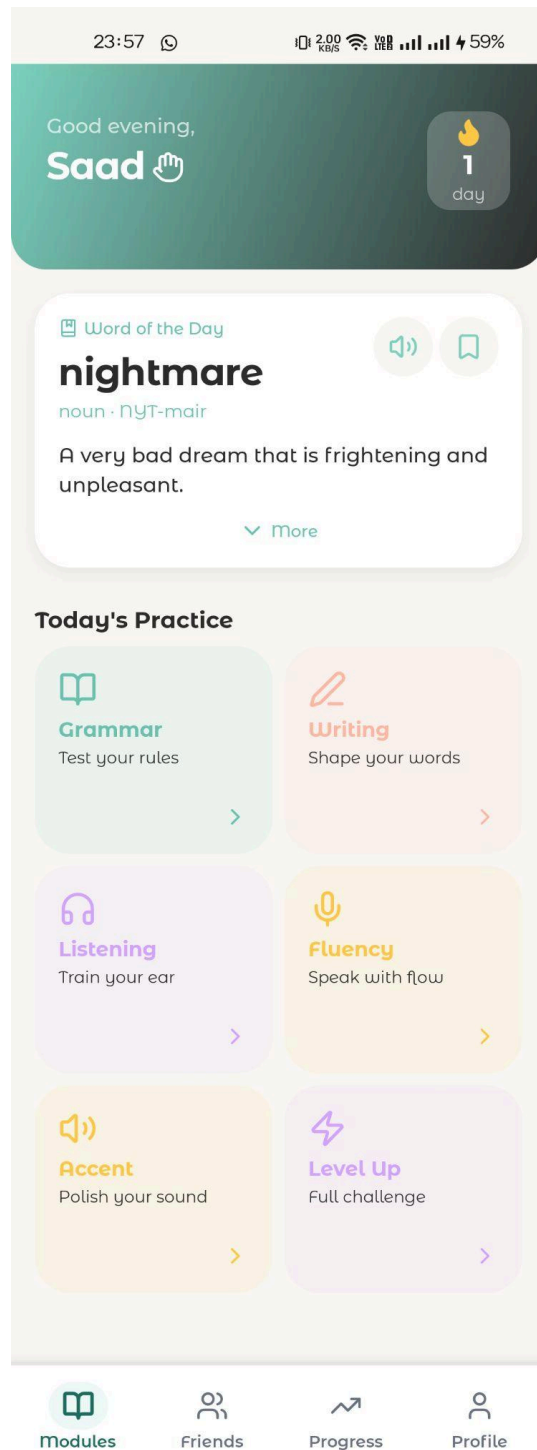


Figure 4.66: Home Screen

Figure 4.67 and Figure 4.68 show the vocabulary quiz screens of the Verbally mobile app. It includes the quiz and the result screen.

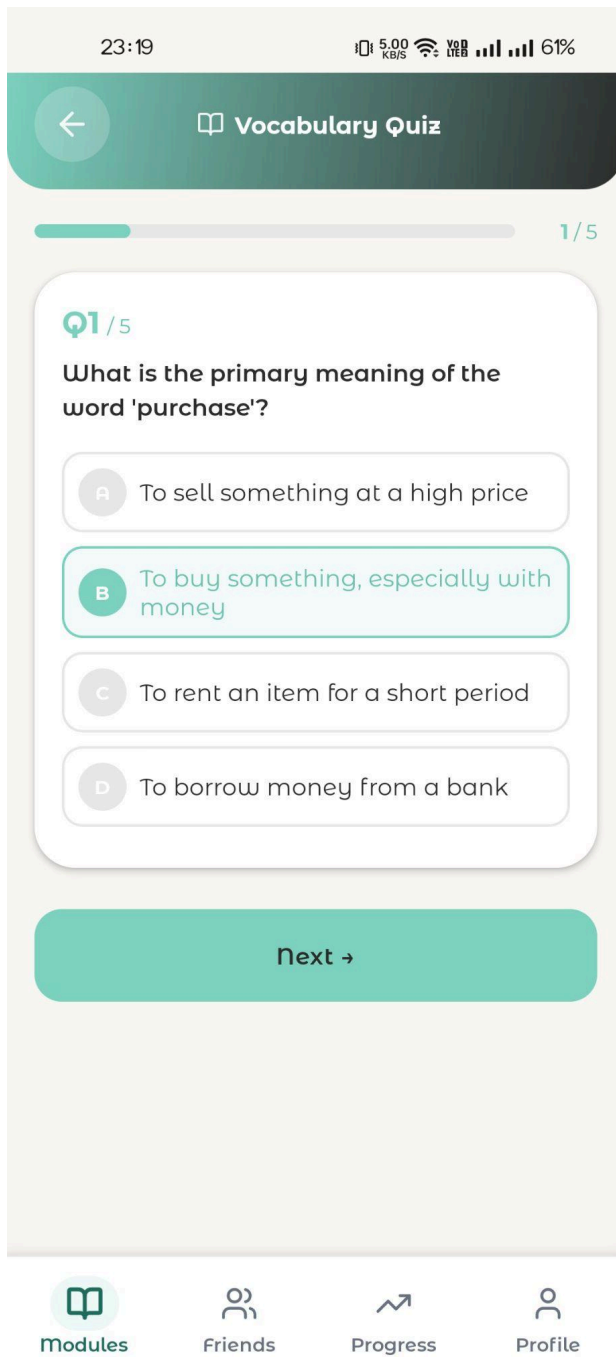


Figure 4.67: Vocab Screen

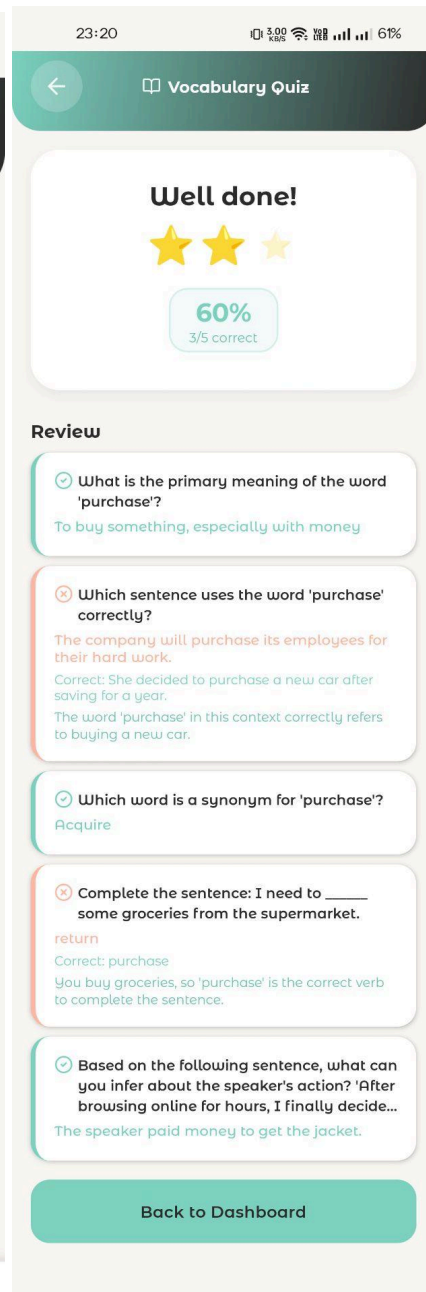


Figure 4.68: Vocab Result Screen

Figure 4.69 and Figure 4.70 show the writing tip and listening tip for the Verbally mobile app.

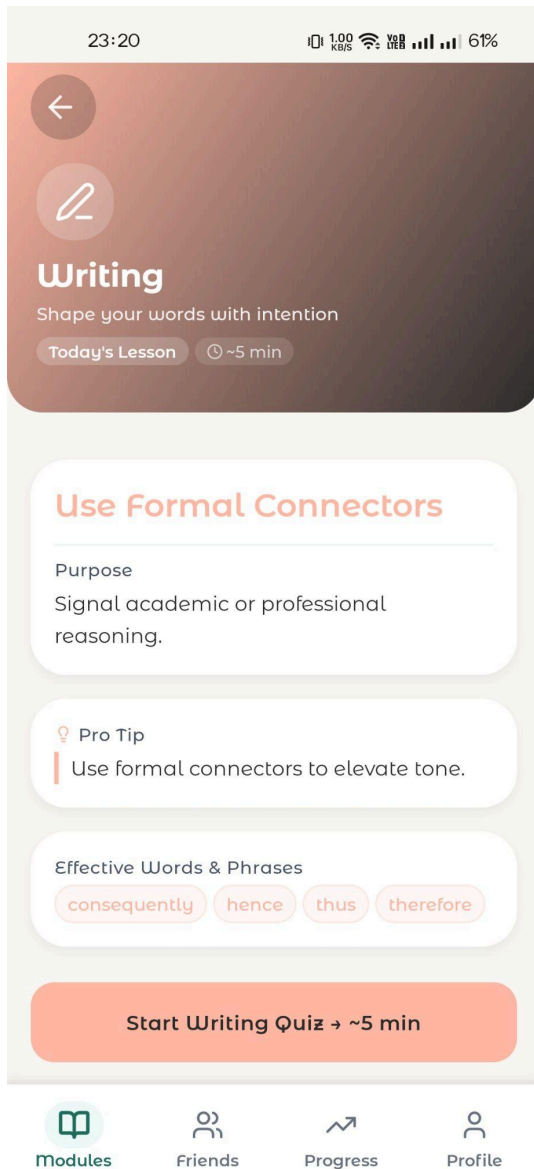


Figure 4.69: Writing Screen

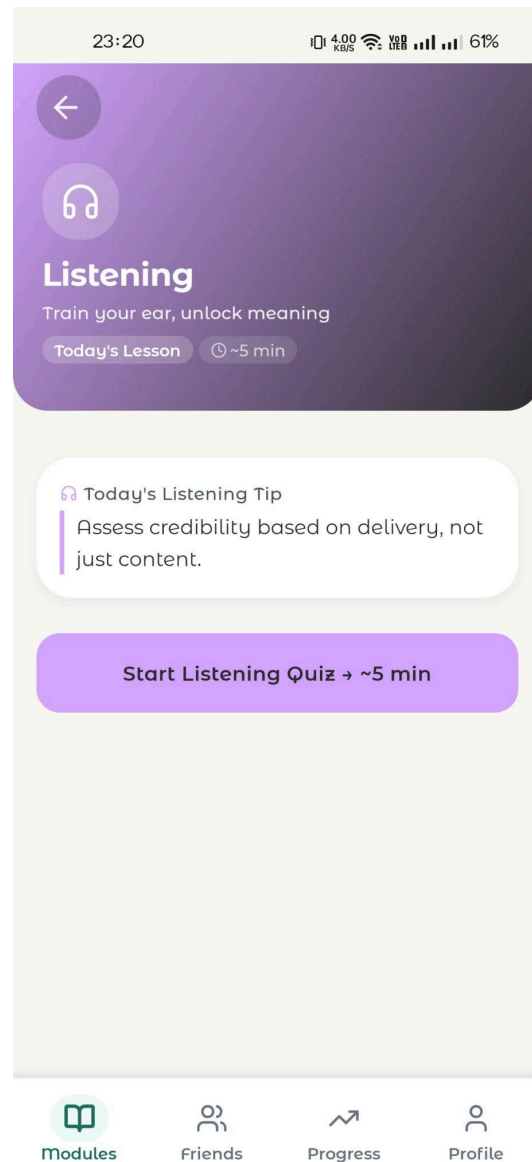


Figure 4.70: Listening Screen

Figure 4.71 and Figure 4.72 show the listening quiz with the audio player and text area and the result.

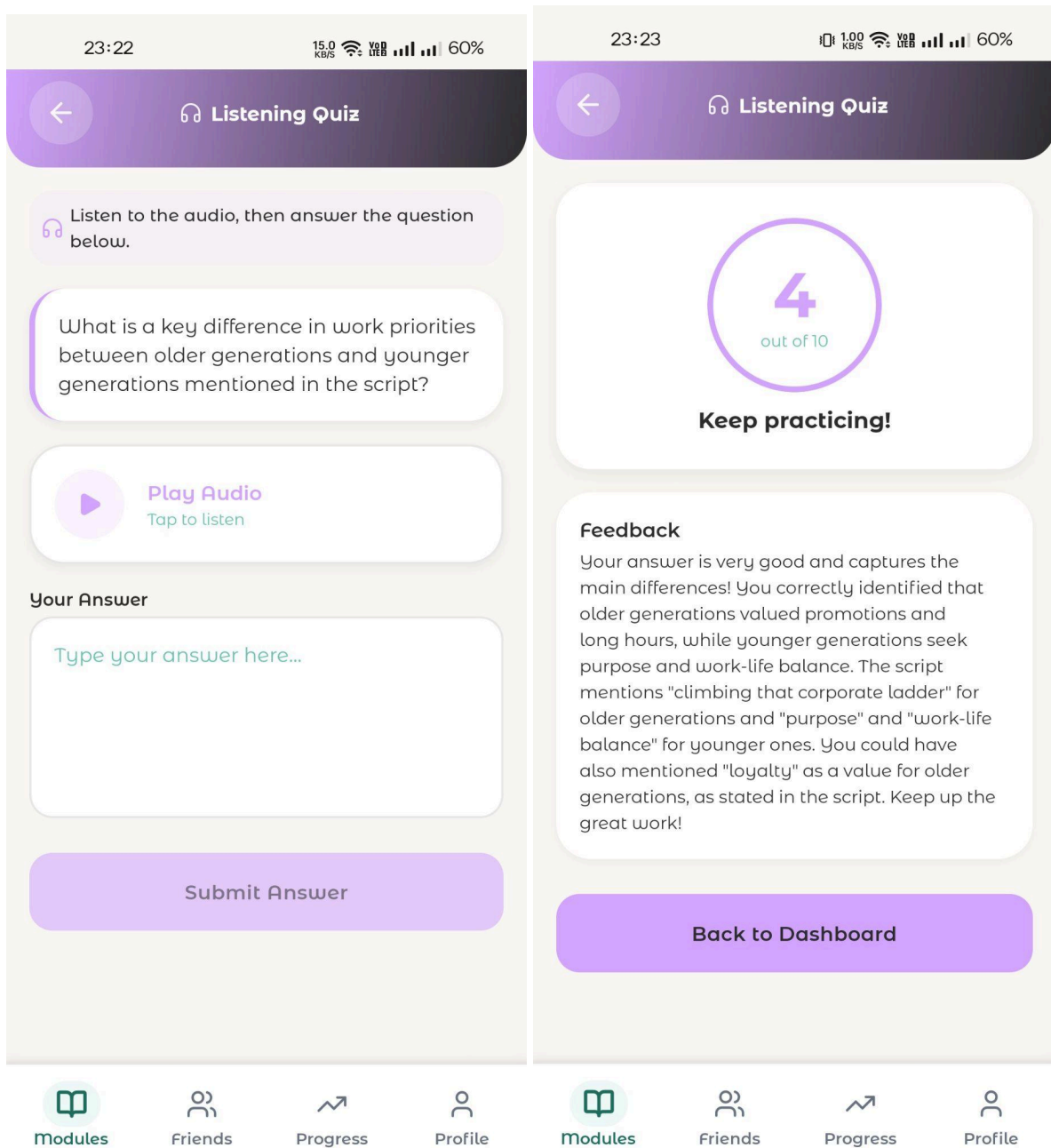


Figure 4.71: Listening Module Screen Figure 4.72: Listening Evaluation Screen

Figure 4.73 and Figure 4.74 show the speaking fluency tips and the speaking prompt for the user to record and submit.

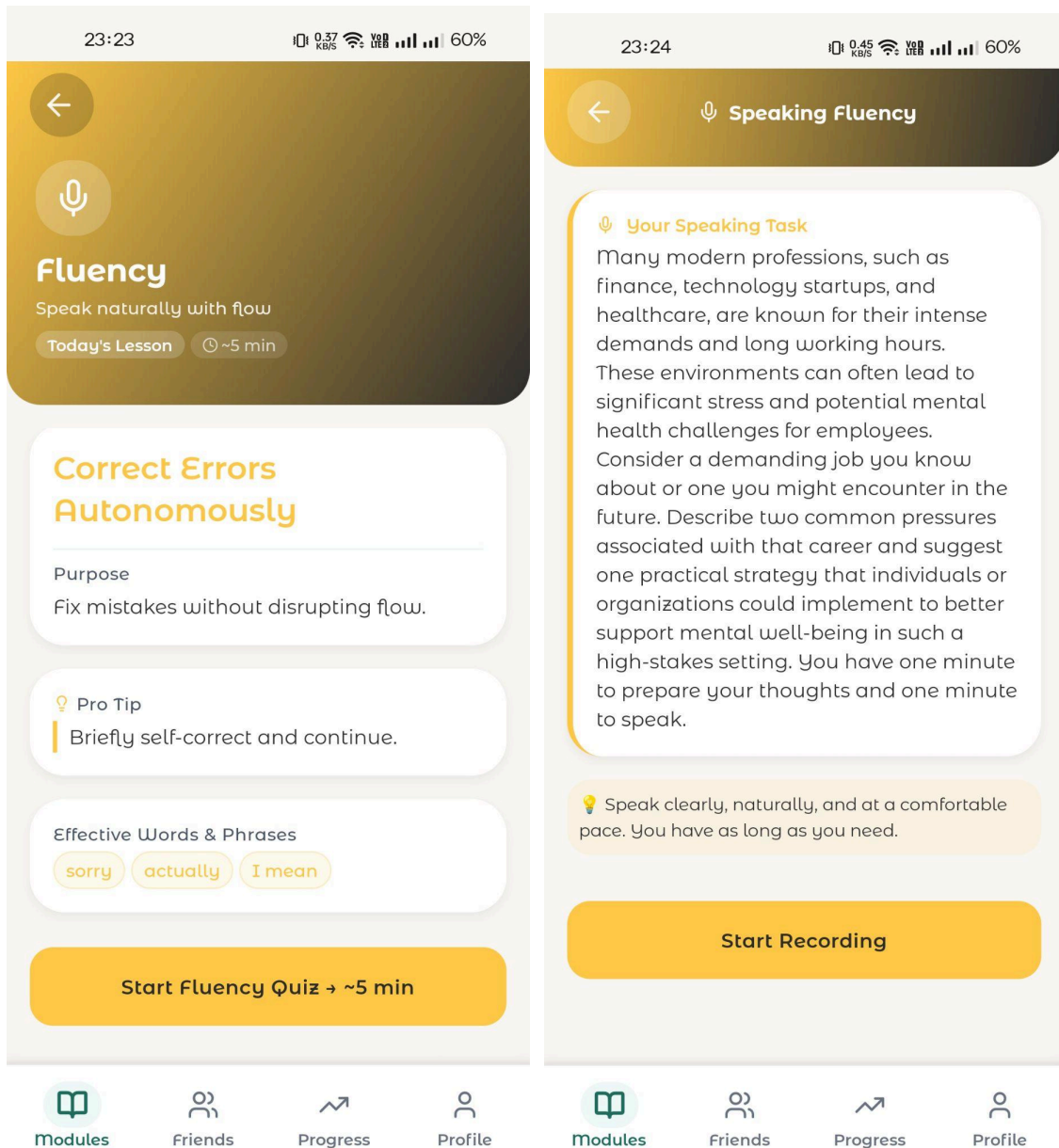


Figure 4.73: Fluency Module Screen    Figure 4.74: Fluency Question Screen

Figure 4.75 shows the result and detailed feedback of the fluency assessment. Figure 4.76 shows the accent-specific speaking tip.

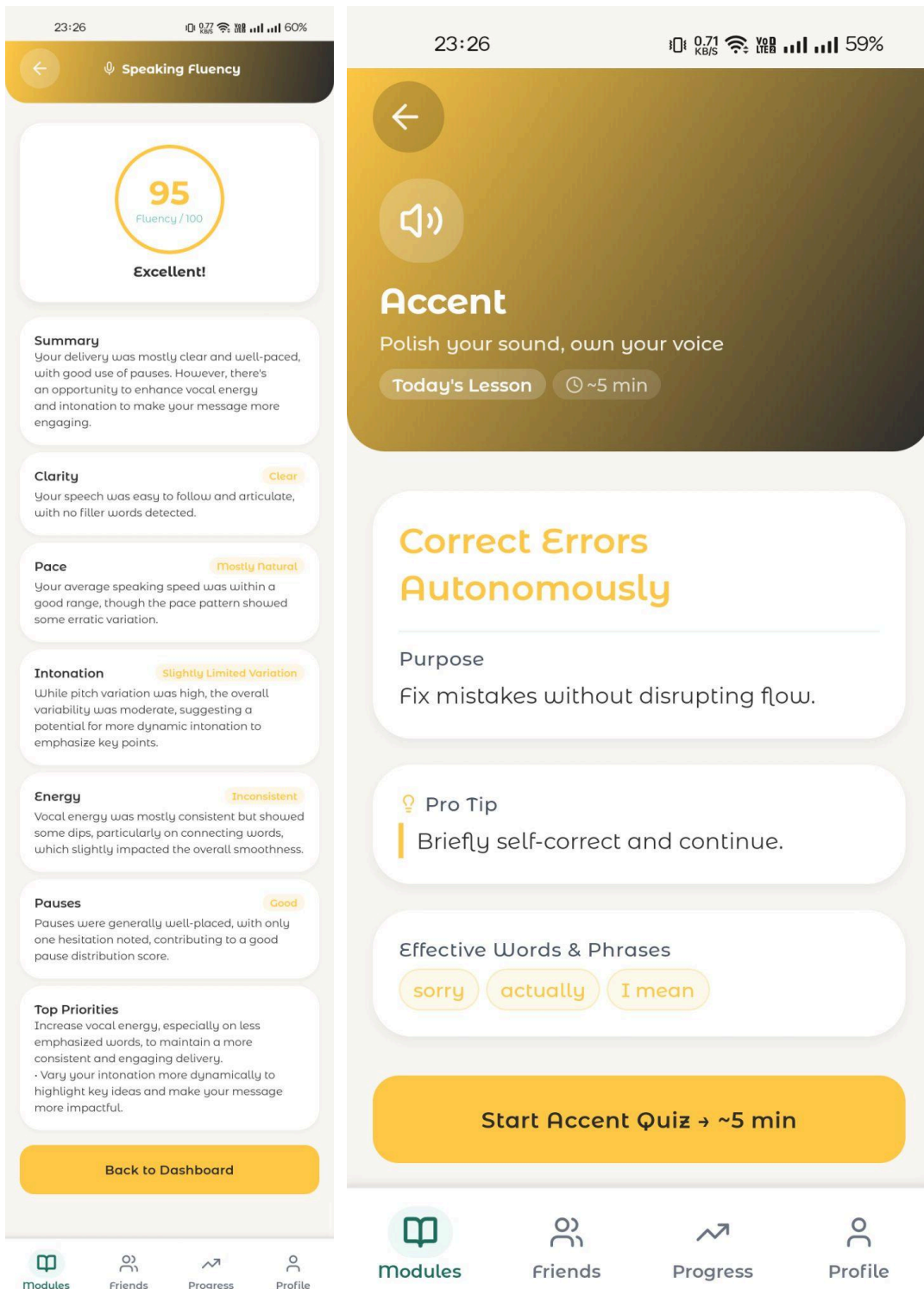


Figure 4.75: Fluency Result Screen    Figure 4.76: Accent Screen

Figure 4.77 shows the recitation prompt for accent training. Figure 4.78 shows the result and feedback of the accent training module.

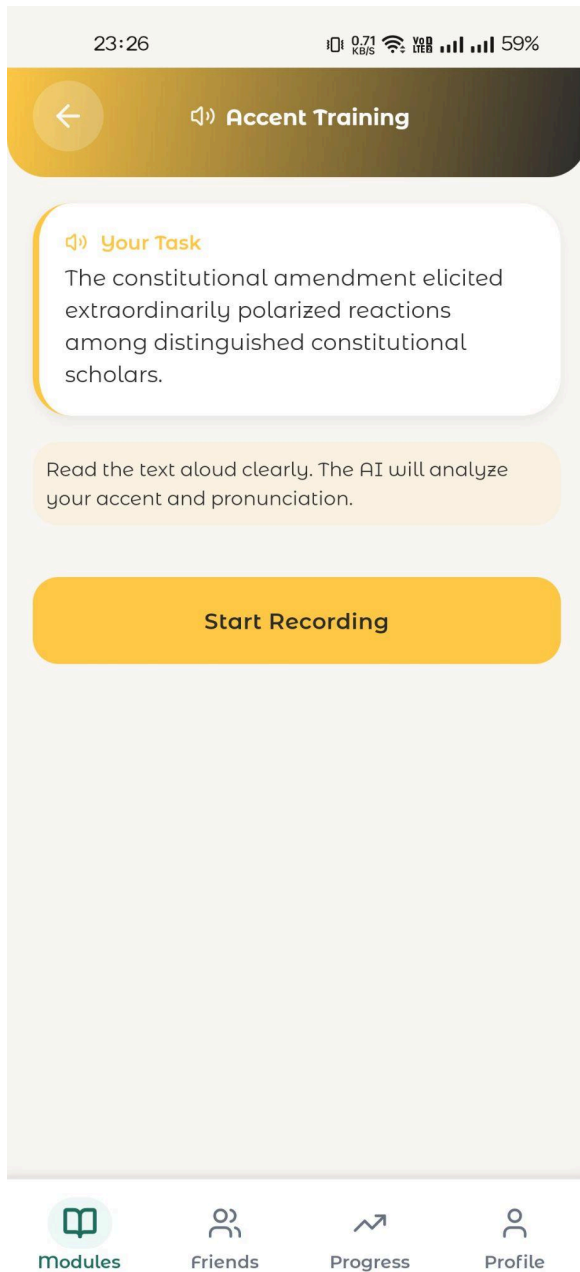


Figure 4.77: Accent Question Screen

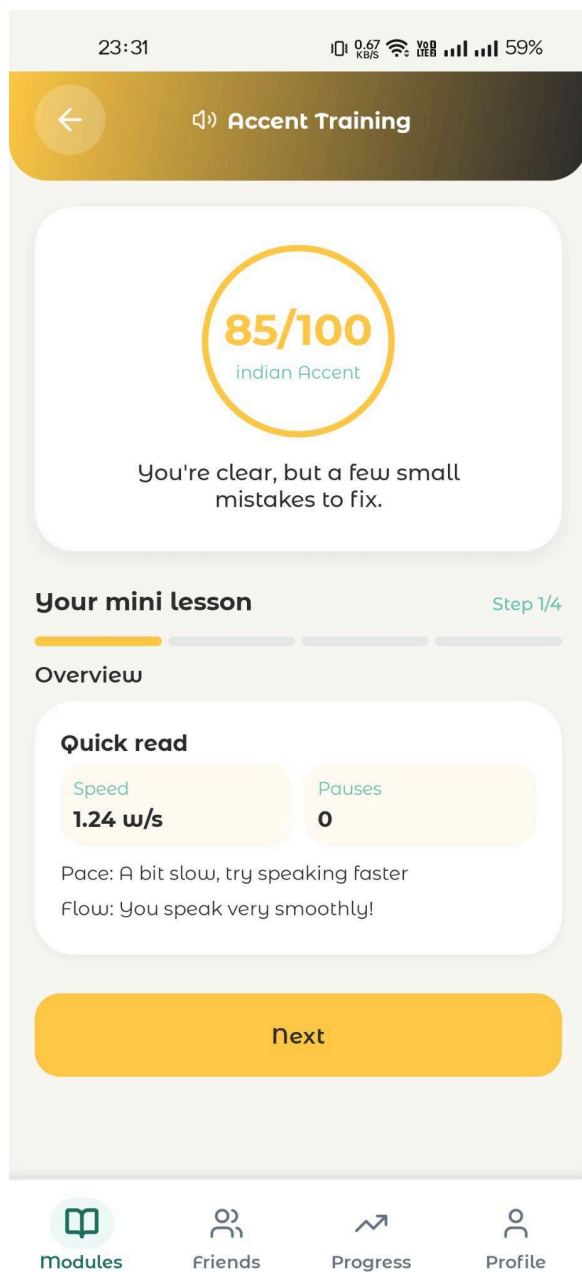


Figure 4.78: Accent Result Screen 01

Figure 4.79 and Figure 4.80 show detailed feedback for the result of the accent-training module.



Figure 4.79: Accent Result Screen 02

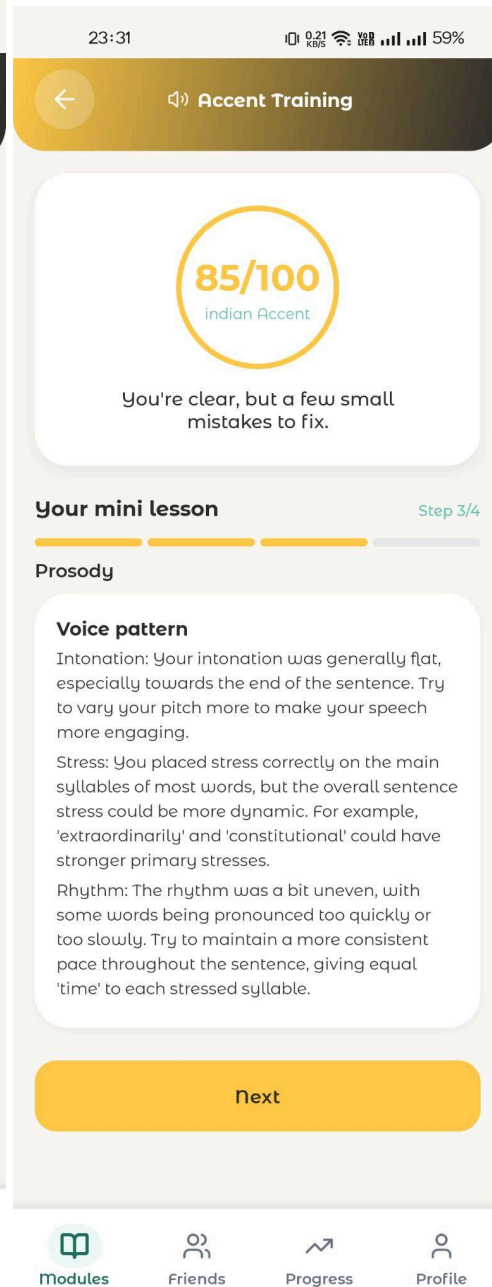


Figure 4.80: Accent Result Screen 03

Figure 4.81 and Figure 4.82 show detailed feedback for the result of the accent-training module and active conversations in the friendship and chatting module.

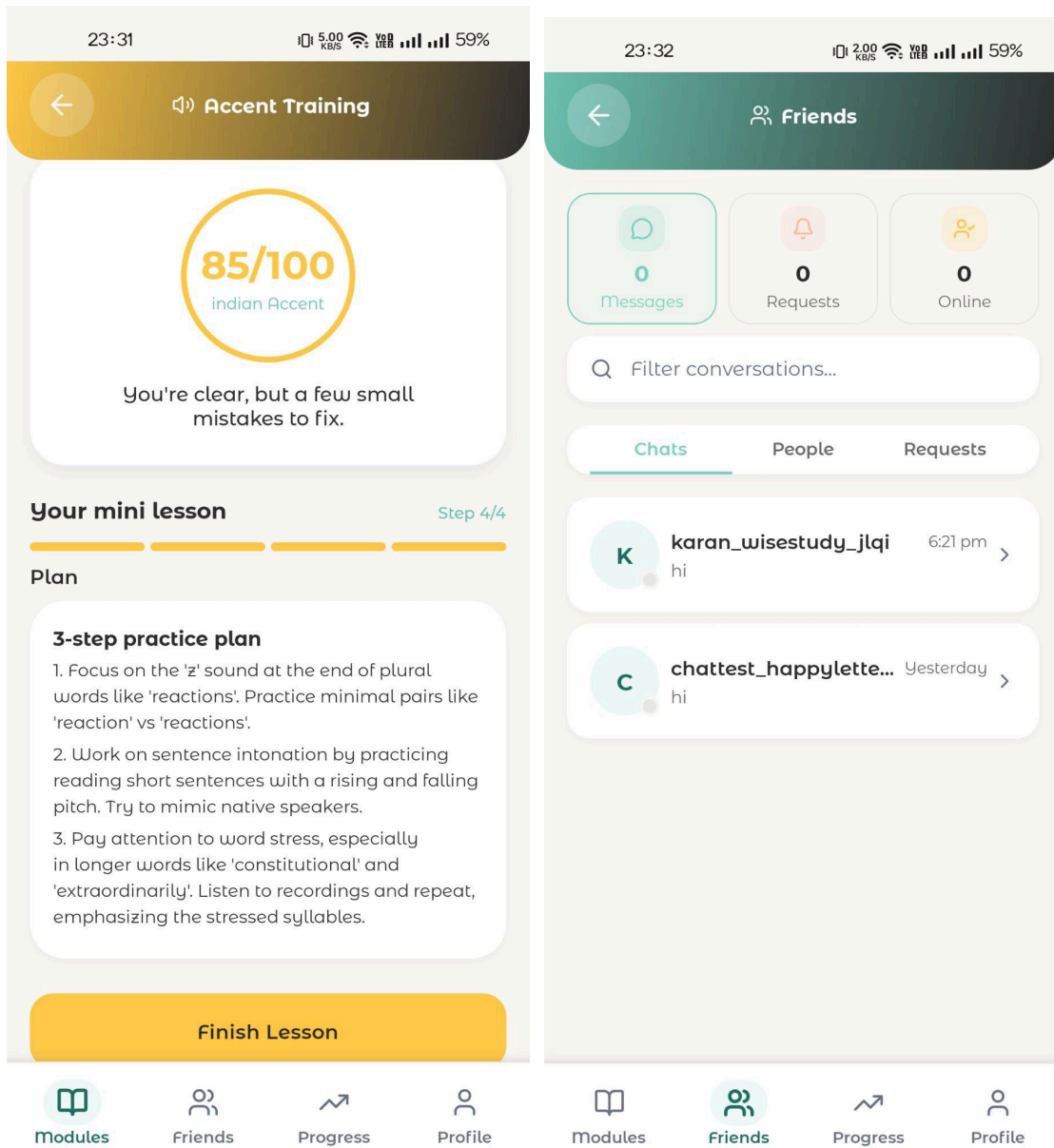


Figure 4.81: Accent Result Screen 04

Figure 4.82: Messaging Screen

Figure 4.83 and Figure 4.84 show an active conversation with another user and suggested people for friendship and chatting.

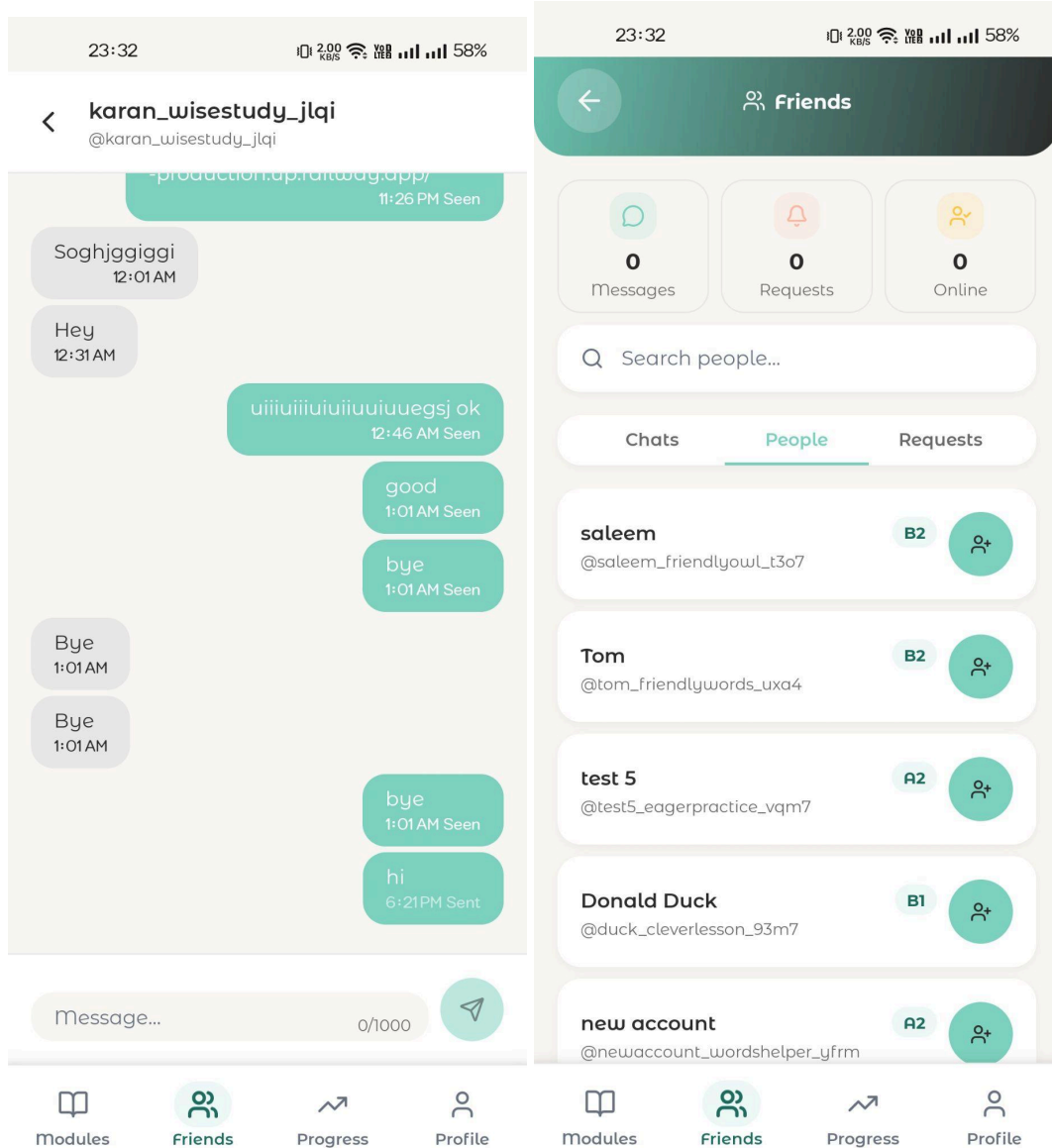


Figure 4.83: Chat Screen

Figure 4.84: People You may know Screen

Figure 4.85 and Figure 4.86 show progress in various modules (vocabulary, grammar, writing, speaking, and listening) and the various badges achieved by the user.

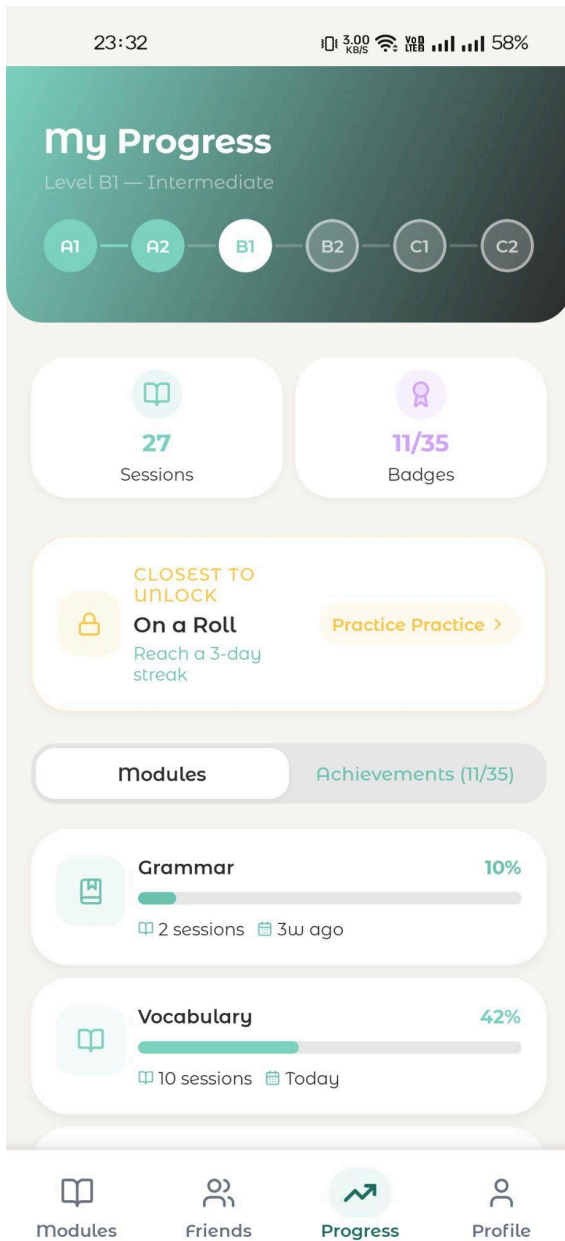


Figure 4.85: Progress Screen 01

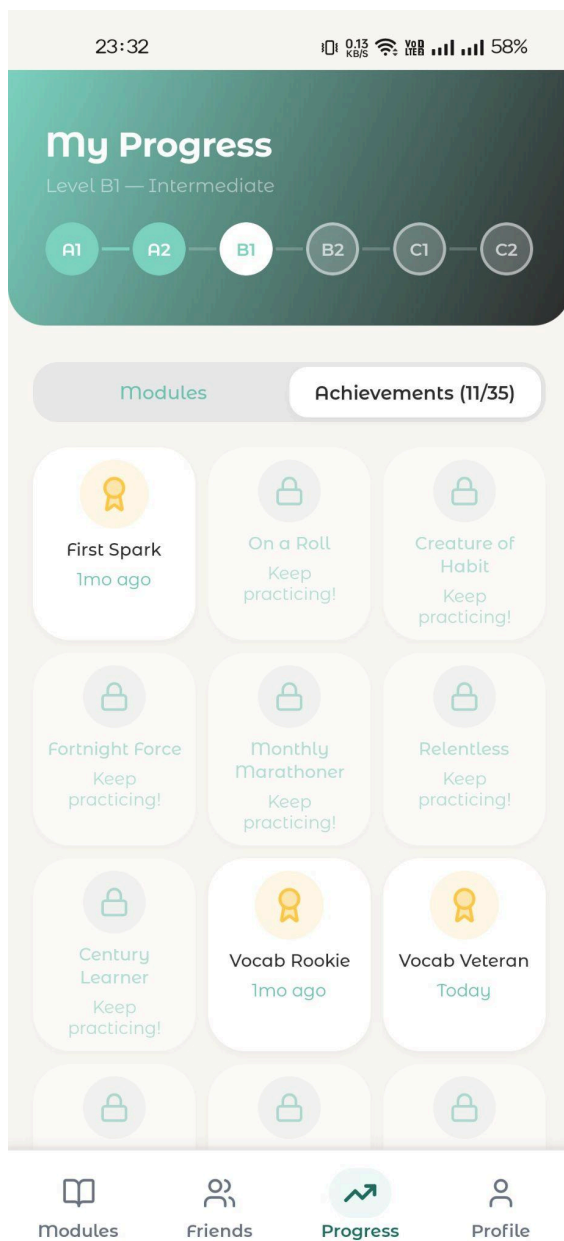


Figure 4.86: Progress Screen 02

Figure 4.87 and Figure 4.88 show the user profile and rules for the level-up assessment.

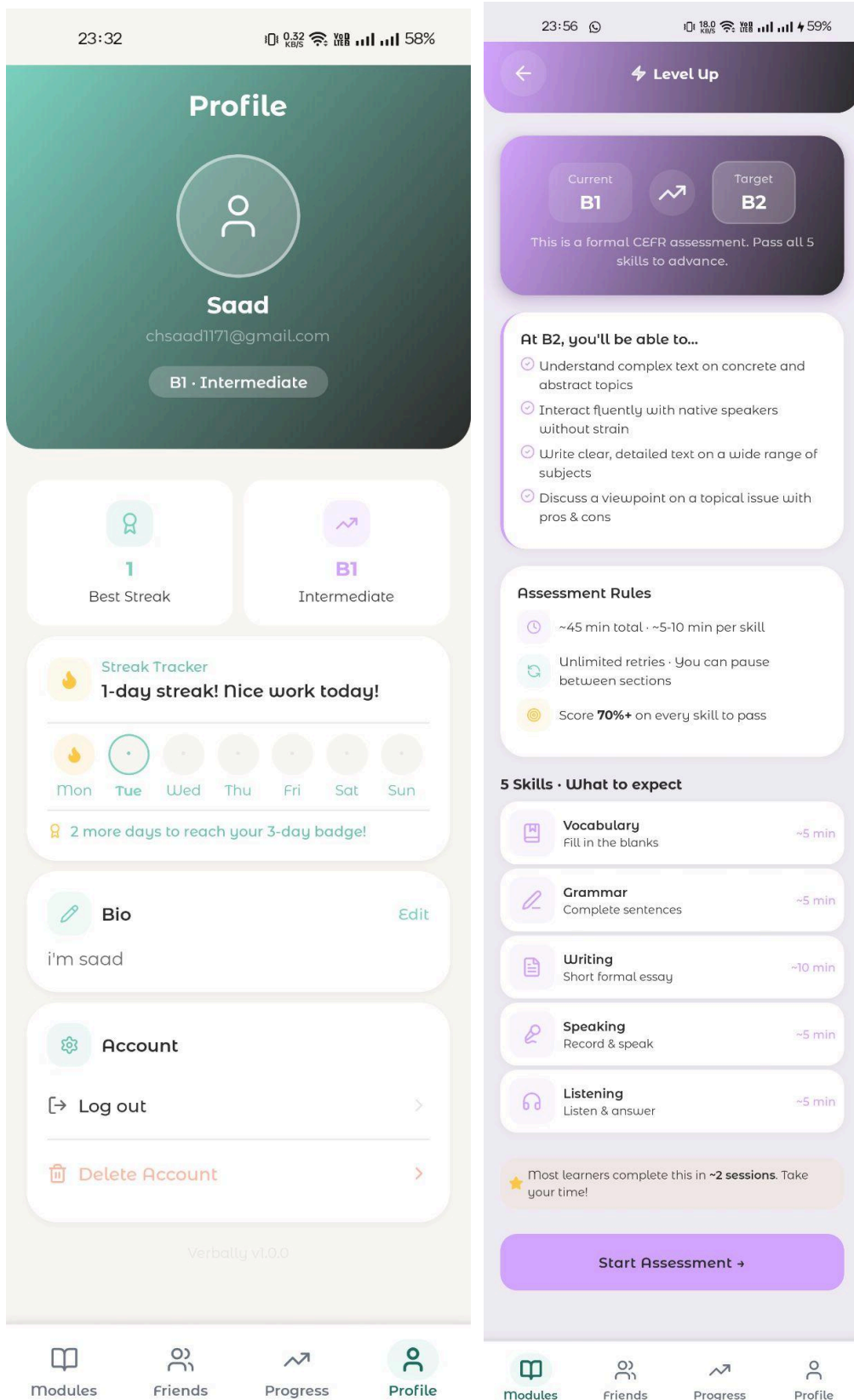


Figure 4.87: Profile Screen      Figure 4.88: Level up Overview Screen

Figure 4.89 and Figure 4.90 the vocabulary and grammar sections of the level-up module.

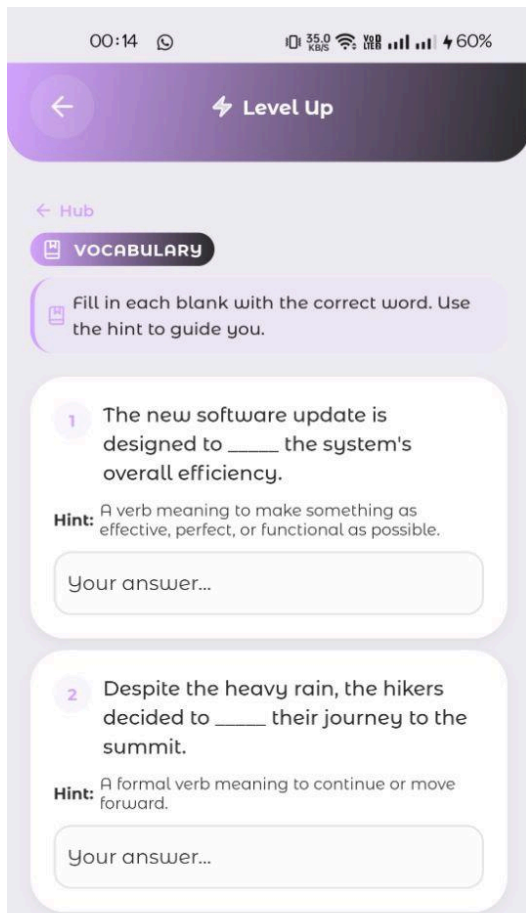


Figure 4.89: Level up vocab screen

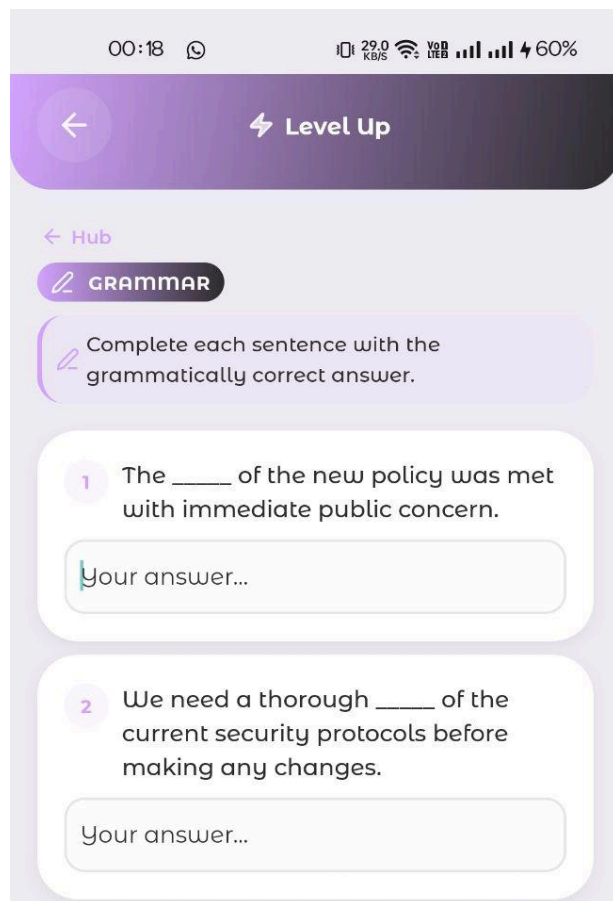


Figure 4.90:Level up Grammar Screen

Figure 4.91 and Figure 4.92 show the writing and speaking sections of the level-up module.

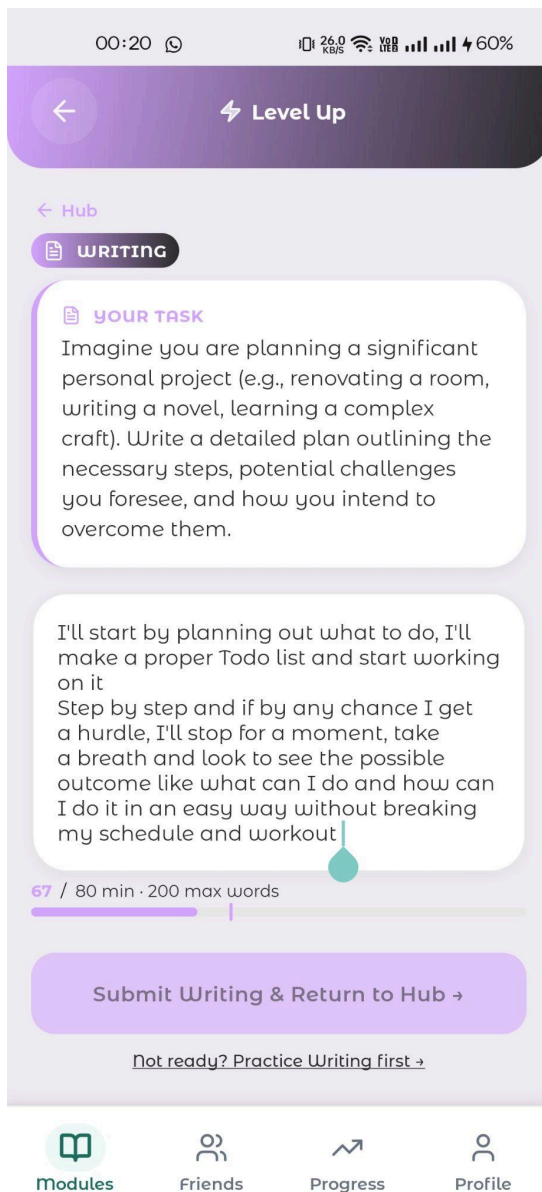


Figure 4.91: Level up Writing Screen

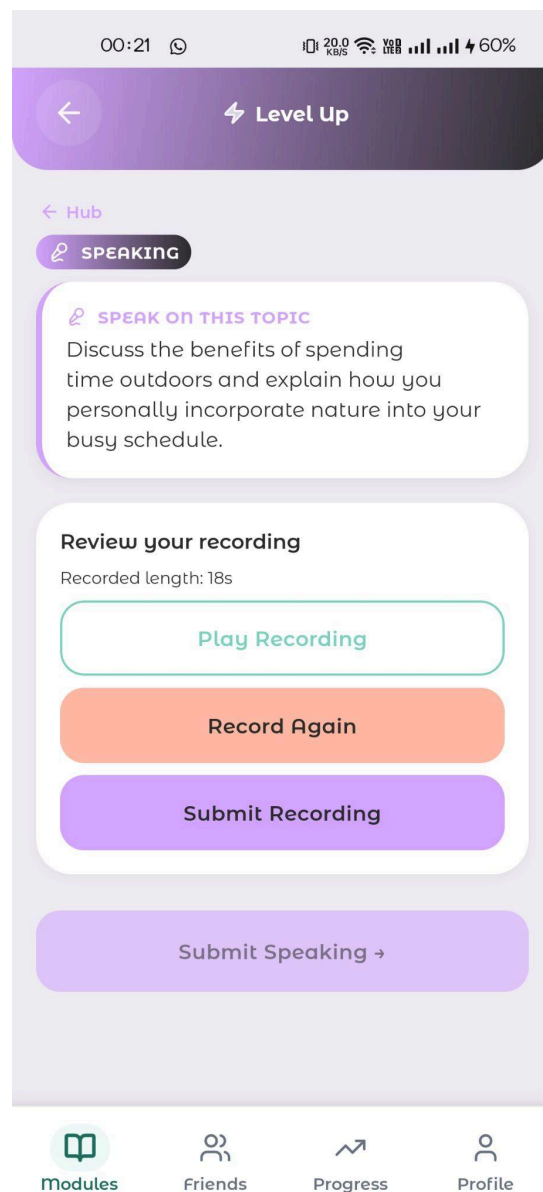


Figure 4.92: Level up Speaking Screen

Figure 4.93 and Figure 4.94 show the listening section and the result of the level-up module with section breakdown.

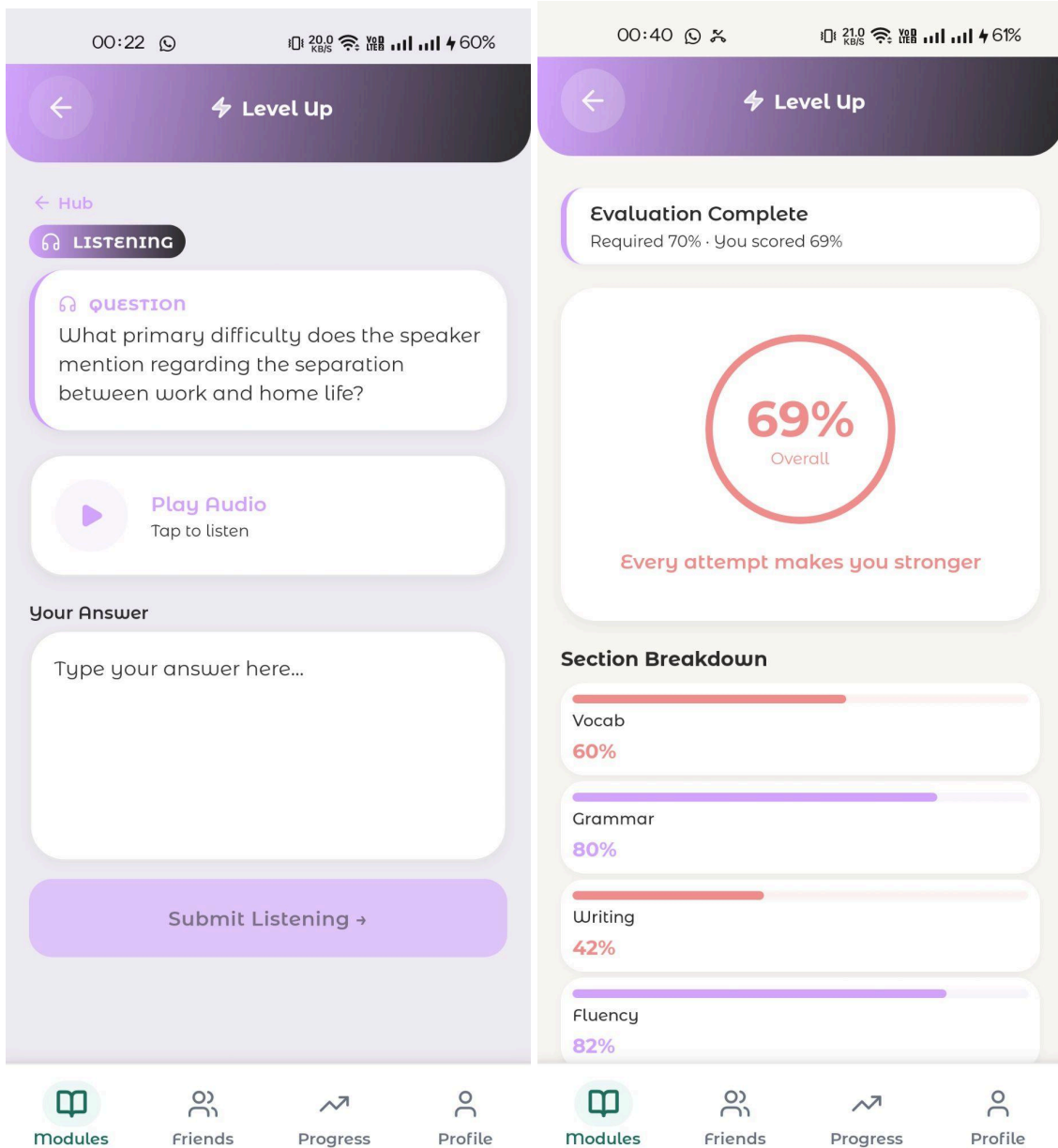


Figure 4.93: Level up Listening screen

Figure 4.94: Level up Evaluation Screen 01

Figure 4.95 and Figure 4.96 show detailed feedback of the level-up module.

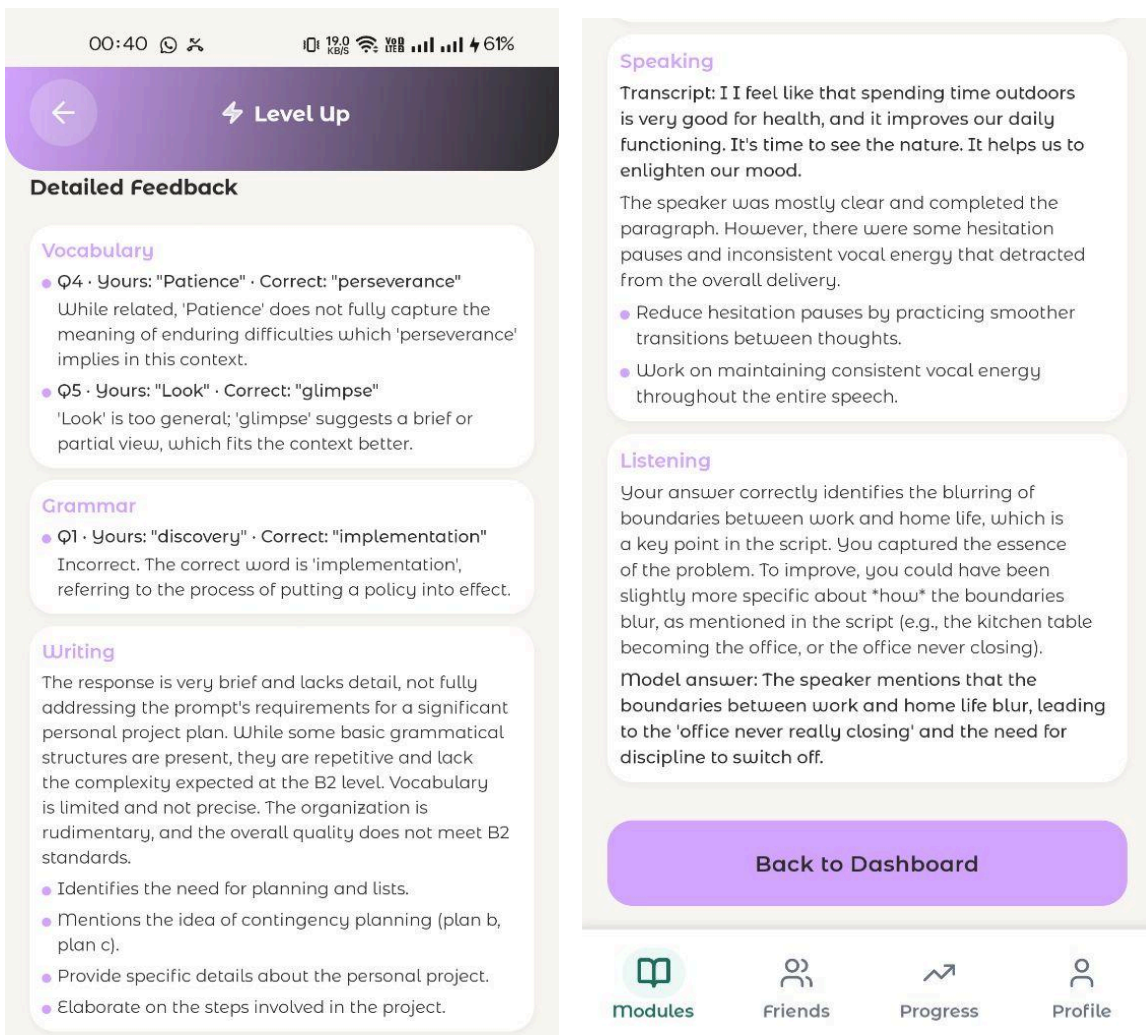


Fig 4.95: Level Up Evaluation Screen02 Fig 4.96:Level Up Evaluation Screen 03

## Chapter 5

### System Implementation

This chapter describes tools and techniques used during the implementation phase of Verbally. Verbally provides an AI powered platform to innovate English language learning. This platform tests skills in speaking, listening, writing, vocabulary, and grammar. Core functionality includes personalized, CEFR-aligned assessments, real-time accent-specific speech analysis, AI-generated content, and progress tracking.

#### 5.1 Strategy:

Verbally was implemented using Incremental Model and Agile Development Methodology. The development began with core modules like User Authentication and CEFR-based Onboarding. It was extended to subsequent features like the Speaking, Listening, Writing, and Grammar modules, as well as Progress Tracking and the Real-Time Chat feature in iterative cycles. Initially, the basic user flow was implemented, it covered user registration and login. This was followed by the AI-Driven CEFR Placement and Progression module. After confirming stable functionality, the core learning features, including the accent-specific speech analysis module and AI content generation (lessons/quizzes), were integrated. The final iterations was focused on the real-time chat feature, progress report generation, achievement tracking, and comprehensive user interface styling. Each iteration included testing, feedback incorporation, and refinement that allowed us to develop a flexible and responsive system that meets real-world language learning requirements.

#### 5.2 Tools and Technologies:

Verbally utilized a hybrid stack of professional development tools, modern web technologies, specialized AI models, and cloud deployment platforms, as detailed in the tables below.

**Table 5.1: Tools Used in Verbally System Implementation**

Tools	Version	Rationale
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Visual Studio Code	1.86	Chosen as the primary IDE for coding due to its lightweight interface, rich extension support, and integrated terminal.
Git & GitHub	Latest	Enabled version control and collaboration, allowing team members to track code changes, review pull requests, and manage branches.
Postman	Latest	An API testing tool used to validate RESTful endpoints developed using NestJS and FastAPI. It helps ensure data integrity, authorization, and response handling.
Figma	Web-Based	A web-based collaborative UI/UX design tool that was used to create wireframes, prototypes, and visual mockups for the frontend interface.

**Table 5.2: Technologies Used in Verbally System Implementation**

<b>Technologies</b>	<b>Version</b>	<b>Rationale</b>
React Native (Expo)	Latest	Used for developing the cross-platform application (mobile and web) for the Presentation Layer.
NestJS	Latest	Built the primary backend logic, RESTful APIs, and server-side operations (e.g., authentication, assessment management).
FastAPI (Python)	Latest	Used to build the dedicated Speech Analysis Microservice for computationally intensive tasks.

PostgreSQL	Latest	A relational database used to store structured data like user information, session logs, assessment results, and question banks.
TypeScript	Latest	Used across the NestJS backend and React frontend to ensure type-safety and improve code reliability.
Gemini API	Latest	The Generative AI model used to dynamically create level-appropriate content, writing prompts, quizzes, and to evaluate text-based and fluency responses.
Montreal Forced Aligner	Latest	Used within the Python Microservice for precise phoneme-level analysis and accent-specific speech assessment.
Deepgram	Latest	Used for high-accuracy audio transcription (speech-to-text) during speaking practice modules.
Google TTS	Latest	An AI model used to generate natural-sounding audio clips for the Listening module.
WebSockets	Latest	Enabled real-time communication for the chat feature and instantaneous updates.
Vercel	Latest	Deployment platform for the React Native/Web Frontend Client.
Railway	Latest	Deployment platform for the NestJS API and FastAPI Speech Microservice.

Aiven	Latest	Managed hosting solution for the scalable PostgreSQL Data Layer.
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### 5.2.1 Explanation:

#### 1. Visual Studio Code, Git & GitHub, Postman and Figma:

We used visual studio code to code. Git and GitHub came to the rescue to control codebase and user collaboration across codebases and to maintain a record of changes on the code and to be able to manage various branches. On the other hand, we went with Postman to test and validate API endpoints. Figma was the main tool to design UI/UX, wireframe and visual mockups.

#### 2. React, React native (Expo) + TypeScript:

React.js was also used as tech stack to develop the dynamic codebase in case of web app development. However, React Native with expo was chosen to be used in mobile application. TypeScript was type safe, and reduced runtime errors.

#### 3. NestJS + FastAPI:

We developed backend by using a hybrid architecture.. The main Modular Monolith API that was managed by NestJS managed authentication, communication and core business logic. We used a microservice with FastAPI to be able to perform heavy and speech-related processing.

#### 4. PostgreSQL + Aiven:

To store structure data, we chose postgresQL which is a robust relational database. It provides a good degree of data integrity and reliability to guarantee finer tracking of progress and CEFR level management.. It ensures reliable data integrity and consistency for detailed progress tracking and CEFR level management. We employed Aiven as hosting solution to achieve high availability and easy scaling.

#### 5. Gemini API + Deepgram + Google TTS:

The Generative AI model is the Gemini API, which creates all the content of an appropriate level (lessons, quizzes, writing prompts). It also generates a comprehensive feedback for modules. Deepgram will give proper speech-to-text accuracy of all speech recorded. In this case of Listening module practices we used Google TTS to create audio that reads naturally.

#### **6. Montreal Forced Aligner (MFA):**

MFA is a speech processing that we implemented into the microservice FastAPI. It does forced alignment of transcribed text to the audio record to examine phonemes. That is why Verbally can give more precise and accent-oriented feedback on pronunciation, distinctive compared to other systems.

#### **7. WebSockets:**

We used webSockets to provide a bi-directional communication channel in relation to social features of this platform. It allows real time chatting and immediate notification among individuals connected to it.

### **5.3 Conclusion:**

Verbally was written with a modern, distributed architecture based on NestJS modular monolith, a React Web Application and a React Native mobile client and a python based microservice.. The development of each module was performed in an iterative way with the Agile approach to guarantee stability and functionality to the users. The system is now able to create and analyze AI-driven English language tests, provide real-time feedback on accent pronunciation. Which is proven to improve proficiency of the users in all the core-English skills.

## Chapter 6

### System Testing & Evaluation

In this chapter, we will evaluate the system and its components per the anticipated results. We will test each scenario against its expected outcome and results. Testing is the process that requires completing the software life cycle to ensure that the software is error-free and acquires high quality.

#### 6.1 Test Strategy

Every software needs to be tested before deployment to ensure whether the software platform is as intended. It also secures the reliability and usability of the system by unearthing the bugs. Testing guarantees that as many bugs as possible are diagnosed in the system.

To test our system, we followed the code, implement and test strategy, initially we code a module and perform a test on it to ensure that the module work as per intention. We then implement the module in the overall system and perform more rigorous tests to ensure its functionality is optional when used with the overall system. To test, we performed different tests based on the module's timing and nature.

#### 6.2 Component Testing

Component testing is a phase of testing in which the individual components or modules of a program or system are tested independently. Component testing for Verbally focuses on verifying the functionality of individual modules such as user authentication, AI-powered content generation (lessons, quizzes), CEFR-level progression logic, speech analysis (fluency and accent), real-time chat, and progress assessment. We tested each component independently to ensure it behaves as expected, with mock data or stubs used where necessary to isolate dependencies.

#### 6.3 Unit Testing

The first testing process in software testing is unit testing. Verbal Unit testing entails testing isolated units of the system, i.e., individual functions, classes and methods to assure that each unit of the system is working properly. Some of the key units to be tested are:

- The API access to Gemini-created content, feedback, and progress reports.

- Audio recording/upload and Google Text-to-Speech (TTS) conversion functions.
- The speech assessment logic at phoneme level through the Montreal Forced Aligner.
- Registering of users, logging in and managing of sessions.
- Database functions to store and retrieve user information (e.g., UserAssessments, UserVocabulary, Achievements).

The mock data and automated test scripts are used to test each unit to ensure the input/output behavior and edge cases are taken care of. This assists in the reliability of the code as well as making debugging easier when integrating.

## 6.4 Integration Testing

Integration testing in Verbally involves assuring the interaction of various modules and elements of the system when integrated. This involves testing flow of data and control between:

- The NestJS API (Primary Backend) through RESTful APIs and frontend (React Native/Web).
- Logic and PostgreSQL database to save and retrieve data.
- Embedding of external APIs: Gemini API to generate content and receive feedback, Deepgram API to transcribe, and Google TTS.
- The main backend and Python-based Speech Analysis Microservice (FastAPI) to score resources-intensive.
- WebSocket communication of the real-time chat feature.

The purpose of test cases is to make sure that the integrated components operate properly, data is transferred correctly between interfaces, and the system can respond to real-time properly. This testing assists in discovering problems in the interactions between modules early in the development process.

## 6.5 System Testing

Verbally checks the entire and integrated system by system testing with regard to the specified requirements. It ensures that the overall application between the user interface and back-end application as well as integration with external applications is functional in real world scenarios. Major areas to be tested are:

Complete Level-Up module evaluation process (vocabulary, grammar, writing, listening, speaking parts).

- AI-driven level of assessment and advancement of CEFR.
- Live speaking and phoneme analysis of accents and generation of feedback.
- Registering of users, logging in and managing of sessions.
- Friend connection and real time delivery of messages.
- Generation of progress report with regard to user activity in all six learning modules.

## 6.6 Use case Testing

### 6.1.1 Login and Signup

**Test Case 01:** The table below shows a test-case where the user logs into their account with valid credentials.

**Table 6.1: Test Case of Learner Authentication**

<b>Test Case ID</b>	1
<b>Objective</b>	Authenticate Learner with valid credentials
<b>Pre-Condition</b>	The User must be registered.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User enters their valid username and password in the relevant fields.</li> <li>2. The User clicks on the ‘Login’ button.</li> <li>3. The system verifies the credentials.</li> </ol>
<b>Expected Output</b>	The User is successfully logged in and redirected to the Home Page.
<b>Actual Output</b>	The User is successfully logged in and redirected to the Home Page.

<b>Status</b>	The Test Was Successfully Performed
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**Test Case 02:** The table below shows a test-case where the user tries to log into their account with invalid credentials.

**Table 6.2: Test Case of Learner Authentication with Invalid Credentials**

<b>Test Case ID</b>	2
<b>Objective</b>	Authenticate Learner with invalid credentials
<b>Pre-Condition</b>	The User is on the login page.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User enters invalid credentials.</li> <li>2. The User clicks on the 'Login' button.</li> </ol>
<b>Expected Output</b>	A clear error message is displayed and the user is not logged in.
<b>Actual Output</b>	A clear error message is displayed and the user is not logged in.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 03:** The table below shows a test-case where the user tries to log into their account without entering their credentials.

**Table 6.3: Test Case of Learner Authentication with Empty Fields**

<b>Test Case ID</b>	3
<b>Objective</b>	Authenticate Learner with empty fields
<b>Pre-Condition</b>	The User is on the login page.
<b>Flow</b>	1. The User leaves the username and password fields empty. 2. The User clicks on the 'Login' button.
<b>Expected Output</b>	The User is asked to fill in the form fields.
<b>Actual Output</b>	The User is asked to fill in the form fields.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 04:** The table below shows a test-case where the user makes a new account.

**Table 6.4: Test Case of Learner Signup**

<b>Test Case ID</b>	4
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<b>Objective</b>	Learner Signup with valid inputs
<b>Pre-Condition</b>	The User must not have an account with the same email.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User enters valid 'Full Name', 'Email', 'Password', and 'Confirm Password'.</li> <li>2. The User clicks on 'Signup'.</li> <li>3. The system validates inputs and shows a toast indicating successful signup.</li> <li>4. The user is then redirected to the 'Login' page</li> </ol>
<b>Expected Output</b>	User is shown a message indicating successful signup and redirected to 'Login' page
<b>Actual Output</b>	The user is shown a message indicating successful signup and redirected to the 'Login' page.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 05:** The table below shows a test-case where the user tries to make an account but the email has already been taken.

**Table 6.5: Test Case of Learner Signup with Duplicate Emails**

<b>Test Case ID</b>	5
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<b>Objective</b>	Learner Signup with existing email
<b>Pre-Condition</b>	An account with the intended email already exists in the system.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User enters their details, using an email address that is already taken.</li> <li>2. The User clicks on 'Signup'.</li> </ol>
<b>Expected Output</b>	A message is displayed showing that the email already exists.
<b>Actual Output</b>	A message is displayed showing that the email already exists.
<b>Status</b>	The Test Was Successfully Performed

### 6.1.2 User Onboarding

**Test Case 06:** The table below shows a test-case where the user completes their onboarding and receives their CEFR assessment result.

**Table 6.6: Test Case of Complete Onboarding Assessment**

<b>Test Case ID</b>	6
<b>Objective</b>	Complete Onboarding Evaluation successfully

<b>Pre-Condition</b>	The User must be authenticated and using their account for the first time.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User logs in and is redirected to a written assessment page.</li> <li>2. The User completes the written assessment and clicks ‘Submit Assessment’.</li> <li>3. The system determines CEFR level.</li> <li>4. The user clicks ‘Start Learning’.</li> </ol>
<b>Expected Output</b>	Users are assigned and shown their CEFR level, then redirected to the home page.
<b>Actual Output</b>	Users are assigned and shown their CEFR level, then redirected to the home page.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 07:** The table below shows a test-case where the user tries to complete their onboarding assessment but does not meet the word limit.

**Table 6.7: Test Case of Onboarding Assessment with Word Limit Problem**

<b>Test Case ID</b>	7
<b>Objective</b>	Onboarding Evaluation - Word limit not met

<b>Pre-Condition</b>	The User is on the onboarding assessment page.
<b>Flow</b>	1. The User writes an assessment response that does not meet the word limit.  2. The User clicks 'Submit Assessment'.
<b>Expected Output</b>	The system asks the user to write more.
<b>Actual Output</b>	The system asks the user to write more.
<b>Status</b>	The Test Was Successfully Performed

### 6.1.3 Verbally Dashboard

**Test Case 08:** The table below shows a test-case where the user tries to view the word of the day.

**Table 6.8: Test Case of View Word of the Day**

<b>Test Case ID</b>	8
<b>Objective</b>	View Word of the Day
<b>Pre-Condition</b>	The User must be authenticated and using their account.
<b>Flow</b>	1. The User visits the modules page.

	2. The system fetches a word.
<b>Expected Output</b>	The User views the word of the day with its details.
<b>Actual Output</b>	The User views the word of the day with its details.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 09:** The table below shows a test-case where the user tries to save the word of the day.

**Table 6.9: Test Case of Save Word of the Day**

<b>Test Case ID</b>	9
<b>Objective</b>	Save Vocabulary Word
<b>Pre-Condition</b>	The User must be authenticated and on the modules page.
<b>Flow</b>	1. The User views the 'word of the day' card. 2. The User clicks on the save icon button.
<b>Expected Output</b>	A message is displayed showing that the word has been saved successfully.

<b>Actual Output</b>	A message is displayed showing that the word has been saved successfully.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 10:** The table below shows a test-case where the user tries to take a vocabulary quiz.

**Table 6.10: Test Case of Practice Vocabulary Quiz**

<b>Test Case ID</b>	10
<b>Objective</b>	Practice Vocabulary - Complete Quiz (Basic Flow)
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks on 'Start Quiz' under the Vocabulary Section.</li> <li>2. GenAI generates a quiz based on the 'word of the day'.</li> <li>3. The User completes the five multiple-choice questions.</li> </ol>
<b>Expected Output</b>	The system gives the result and feedback from GenAI.
<b>Actual Output</b>	The system gives the result and feedback from GenAI.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 11:** The table below shows a test-case where the user leaves the vocabulary quiz without completing it.

**Table 6.11: Test Case of Practice Vocabulary Quiz (Incomplete)**

<b>Test Case ID</b>	11
<b>Objective</b>	Practice Vocabulary - Leave quiz early (Alternative Flow)
<b>Pre-Condition</b>	The User has started a Vocabulary quiz.
<b>Flow</b>	1. The User starts the quiz but leaves the page without completing it.
<b>Expected Output</b>	The quiz is not completed, progress is lost, and no feedback is generated.
<b>Actual Output</b>	The quiz is not completed, progress is lost, and no feedback is generated.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 12:** The table below shows a test-case where the user tries to view the grammar lesson.

**Table 6.12: Test Case of View Grammar Lesson**

<b>Test Case ID</b>	12
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<b>Objective</b>	View Grammar Lesson
<b>Pre-Condition</b>	The User must be authenticated and on the modules page.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The system fetches a grammar lesson.</li> <li>2. The User clicks 'see more' on the grammar lesson card.</li> </ol>
<b>Expected Output</b>	The complete grammar lesson is shown in a modal dialog box.
<b>Actual Output</b>	The complete grammar lesson is shown in a modal dialog box.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 13:** The table below shows a test-case where the user tries a grammar quiz.

**Table 6.13: Test Case of Practice Grammar Quiz**

<b>Test Case ID</b>	13
<b>Objective</b>	Practice Grammar - Complete Quiz
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.

<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks on ‘Start Quiz’ under the Grammar Section.</li> <li>2. The User completes the five multiple-choice questions generated by GenAI.</li> </ol>
<b>Expected Output</b>	The system gives the result and feedback from GenAI.
<b>Actual Output</b>	The system gives the result and feedback from GenAI.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 14:** The table below shows a test-case where the user tries to view the speaking tip.

**Table 6.14: Test Case of View Speaking Tip**

<b>Test Case ID</b>	14
<b>Objective</b>	View Speaking Tip (Basic Flow)
<b>Pre-Condition</b>	The User must be authenticated and on the modules page.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User scrolls to the speaking section.</li> <li>2. The system generates a random speaking tip based on the CEFR level.</li> </ol>

<b>Expected Output</b>	The User sees the speaking tip inside the ‘speaking tip’ card.
<b>Actual Output</b>	The User sees the speaking tip inside the ‘speaking tip’ card.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 15:** The table below shows a test-case where the user attempts the speaking fluency module and submits their audio recording.

**Table 6.15: Test Case of Practice Speaking Fluency (Submit Recording)**

<b>Test Case ID</b>	15
<b>Objective</b>	Practice Speaking (Fluency) - Submit Recording
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks ‘Practice Now’ under the Speech section.</li> <li>2. The system provides a prompt via GenAI.</li> <li>3. The User clicks ‘Start Speaking’, speaks for &lt; 1 min, and clicks ‘Finish Recording’.</li> </ol>
<b>Expected Output</b>	The system provides fluency feedback.

<b>Actual Output</b>	The system provides fluency feedback.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 16:** The table below shows a test-case where the user tries to speak for a very long time in the speaking fluency module.

**Table 6.16: Test Case of Practice Speaking Fluency with Time Limit Exceeding**

<b>Test Case ID</b>	16
<b>Objective</b>	Practice Speaking (Fluency) - Time Limit Exceeded
<b>Pre-Condition</b>	The User is recording their fluency practice.
<b>Flow</b>	1. The User speaks for longer than the 1-minute time constraint.
<b>Expected Output</b>	The system automatically stops recording when the time limit is exceeded.
<b>Actual Output</b>	The system automatically stops recording when the time limit is exceeded.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 17:** The table below shows a test-case where the user tries the practice speaking accent module and submits their recording.

**Table 6.17: Test Case of Practice Speaking Accent (Submit Recording)**

<b>Test Case ID</b>	17
<b>Objective</b>	Practice Speaking (Accent) - Submit Recording
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	<ol style="list-style-type: none"><li>1. The User selects a goal accent and clicks 'Practice Now'.</li><li>2. The User clicks 'Start Speaking', recites the provided text, and clicks 'Finish Recording'.</li></ol>
<b>Expected Output</b>	The system gives feedback on current and preferred accents.
<b>Actual Output</b>	The system gives feedback on current and preferred accents.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 18:** The table below shows a test-case where the user tries the practice speaking accent module but recites sentences unrelated to the given text.

**Table 6.18: Test Case of Practice Speaking Accent (Unrelated Recitation)**

<b>Test Case ID</b>	18
<b>Objective</b>	Practice Speaking (Accent) - Unrelated recitation (Alternative Flow)

<b>Pre-Condition</b>	The User is recording their accent practice.
<b>Flow</b>	1. The User recites content completely unrelated to the given prompt text. 2. The User submits the recording.
<b>Expected Output</b>	The system displays an error message informing the user that the recitation was unrelated.
<b>Actual Output</b>	The system displays an error message informing the user that the recitation was unrelated.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 19:** The table below shows a test-case where the user tries to view the writing tip.

**Table 6.19: Test Case of View Writing Tip**

<b>Test Case ID</b>	19
<b>Objective</b>	View Writing Tip (Basic Flow)
<b>Pre-Condition</b>	The User must be authenticated and on the modules page.
<b>Flow</b>	1. The system generates a writing tip. 2. The User looks at the writing section.

<b>Expected Output</b>	The User views the writing tip inside the ‘writing tip’ card.
<b>Actual Output</b>	The User views the writing tip inside the ‘writing tip’ card.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 20:** The table below shows a test-case where the user tries to practice writing through the writing assessment module.

**Table 6.20: Test Case of Practice Writing**

<b>Test Case ID</b>	20
<b>Objective</b>	Practice Writing - Complete successfully
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks ‘Start Practice’ under the Writing Section.</li> <li>2. The User writes a response to the GenAI prompt.</li> <li>3. The User clicks ‘Submit’.</li> </ol>
<b>Expected Output</b>	The system gives a result and feedback.
<b>Actual Output</b>	The system gives a result and feedback.

<b>Status</b>	The Test Was Successfully Performed
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**Test Case 21:** The table below shows a test-case where the user tries the writing assessment but their answer is unrelated to the given writing prompt.

**Table 6.21: Test Case of Practice Writing with Unrelated Answer**

<b>Test Case ID</b>	21
<b>Objective</b>	Practice Writing - Unrelated Content
<b>Pre-Condition</b>	The User is on the writing assessment page.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User writes content unrelated to the GenAI writing prompt.</li> <li>2. The User attempts to submit.</li> </ol>
<b>Expected Output</b>	The system shows an error message stating the writing does not match the prompt.
<b>Actual Output</b>	The system shows an error message stating the writing does not match the prompt.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 22:** The table below shows a test-case where the user tries to view the listening tip.

**Table 6.22: Test Case of View Listening Tip**

<b>Test Case ID</b>	22
<b>Objective</b>	View Listening Tip
<b>Pre-Condition</b>	The User must be authenticated and on the modules page.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The system generates a listening tip based on the CEFR level.</li> <li>2. The User looks at the listening section.</li> </ol>
<b>Expected Output</b>	The User views the listening tip inside the 'listening tip' card.
<b>Actual Output</b>	The User views the listening tip inside the 'listening tip' card.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 23:** The table below shows a test-case where the user tries to practice listening through the listening assessment module.

**Table 6.23: Test Case of Practice Listening**

<b>Test Case ID</b>	23
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<b>Objective</b>	Practice Listening - Complete successfully
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	1. The User clicks 'Start Practice' under the Listening Section. 2. The User listens to the audio clip and answers the question.
<b>Expected Output</b>	The system evaluates the answer and gives a result and feedback.
<b>Actual Output</b>	The system evaluates the answer and gives a result and feedback.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 24:** The table below shows a test-case where the user successfully attempts and completes the level-up module.

**Table 6.24: Test Case of Attempt level-Up Module (Successful)**

<b>Test Case ID</b>	24
<b>Objective</b>	Attempt Level-Up Module - Upgrade Level
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.

<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks 'Level-Up' and starts the assessment.</li> <li>2. The User sequentially solves vocabulary, grammar, writing, listening, and speaking assessments, clicking 'Next Section' after each.</li> <li>3. The User clicks 'Complete Assessment'.</li> </ol>
<b>Expected Output</b>	The system evaluates performance positively and upgrades the User's CEFR level, providing final feedback.
<b>Actual Output</b>	The system evaluates performance positively and upgrades the User's CEFR level, providing final feedback.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 25:** The table below shows a test-case where the user fails in some parts of the level-up module.

**Table 6.25: Test Case of Attempt level-Up Module (Unsuccessful)**

<b>Test Case ID</b>	25
<b>Objective</b>	Attempt Level-Up Module - Fail certain modules
<b>Pre-Condition</b>	The User is taking the Level-Up assessment.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User completes the assessments but provides incorrect answers to a failing degree.</li> </ol>

	2. The User clicks 'Complete Assessment'.
<b>Expected Output</b>	The System provides feedback but does not allow the user to level-up due to failure in certain modules.
<b>Actual Output</b>	The System provides feedback but does not allow the user to level-up due to failure in certain modules.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 26:** The table below shows a test-case where the user tries to view their progress.

**Table 6.26: Test Case of Track Progress**

<b>Test Case ID</b>	26
<b>Objective</b>	Track Progress
<b>Pre-Condition</b>	The User must be authenticated and using their account.
<b>Flow</b>	1. The User clicks on 'progress' in the navbar.
<b>Expected Output</b>	The system displays the User's progress in vocabulary, grammar, writing, etc.
<b>Actual Output</b>	The system displays the User's progress in vocabulary, grammar, writing, etc.

<b>Status</b>	The Test Was Successfully Performed
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**Test Case 27:** The table below shows a test-case where the user tries to view their achievements.

**Table 6.27: Test Case of View and Unlock Achievements**

<b>Test Case ID</b>	27
<b>Objective</b>	View and Unlock Achievements
<b>Pre-Condition</b>	The User must be authenticated and on the progress page.
<b>Flow</b>	1. The User scrolls down to the achievements section on the progress page.
<b>Expected Output</b>	The system displays unlocked badges clearly and locked badges as blurred out.
<b>Actual Output</b>	The system displays unlocked badges clearly and locked badges as blurred out.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 28:** The table below shows a test-case where the user creates a friend and chats with them.

**Table 6.28: Test Case of Real-Time Chatting (Successful)**

<b>Test Case ID</b>	28
<b>Objective</b>	Use Real-Time Chat
<b>Pre-Condition</b>	The User must be authenticated and have an initial CEFR level.
<b>Flow</b>	<ol style="list-style-type: none"> <li>1. The User clicks on 'Friends' in the navigation bar.</li> <li>2. The User clicks 'Add' on a suggested user to send a request.</li> <li>3. The target User accepts the request.</li> <li>4. The User sends a message to the new friend.</li> </ol>
<b>Expected Output</b>	The friend request is sent, accepted, and messages are successfully exchanged in real-time.
<b>Actual Output</b>	The friend request is sent, accepted, and messages are successfully exchanged in real-time.
<b>Status</b>	The Test Was Successfully Performed

### 6.1.1 Admin Management

**Test Case 29:** The table below shows a test-case where the user (admin) tries to view the admin dashboard.

**Table 6.29: Test Case of View Admin Dashboard**

<b>Test Case ID</b>	29
<b>Objective</b>	View Admin Dashboard
<b>Pre-Condition</b>	The User must be registered as an Admin in the system.
<b>Flow</b>	1. The Admin enters their valid username and password. 2. The Admin clicks the 'Login' button.
<b>Expected Output</b>	The system verifies credentials and redirects the Admin to the Admin Dashboard.
<b>Actual Output</b>	The system verifies credentials and redirects the Admin to the Admin Dashboard.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 30:** The table below shows a test-case where the user (admin) tries to view the admin dashboard but enters invalid credentials.

**Table 6.30:: Test Case of View Admin Dashboard (Invalid Credentials)**

<b>Test Case ID</b>	30
<b>Objective</b>	View Admin Dashboard - Invalid Credentials
<b>Pre-Condition</b>	The Admin is on the login screen.
<b>Flow</b>	1. The Admin enters invalid credentials. 2. The Admin clicks the 'Login' button.
<b>Expected Output</b>	A clear error message is displayed and access to the Admin Dashboard is denied.
<b>Actual Output</b>	A clear error message is displayed and access to the Admin Dashboard is denied.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 31:** The table below shows a test-case where the user (admin) tries to update user status.

**Table 6.31:: Test Case of Update User Status**

<b>Test Case ID</b>	31
---------------------	----

<b>Objective</b>	Update User Status
<b>Pre-Condition</b>	The User must be logged in as an Admin.
<b>Flow</b>	1. The Admin toggles the status of a specific User from 'Activate' to 'Deactivate' (or vice versa).
<b>Expected Output</b>	The system updates the user's status, either allowing or disallowing their access to the system.
<b>Actual Output</b>	The system updates the user's status, either allowing or disallowing their access to the system.
<b>Status</b>	The Test Was Successfully Performed

**Test Case 32:** The table below shows a test-case where the user (admin) tries to update the user role.

**Table 6.32: Test Case of Update User Role**

<b>Test Case ID</b>	32
<b>Objective</b>	Update User Role
<b>Pre-Condition</b>	The User must be logged in as an Admin.

<b>Flow</b>	1. The Admin toggles the role of a specific User from 'Learner' to 'Admin' (or vice versa).
<b>Expected Output</b>	The system successfully updates the user's permissions to reflect their new role as an Admin or Learner.
<b>Actual Output</b>	The system successfully updates the user's permissions to reflect their new role as an Admin or Learner.
<b>Status</b>	The Test Was Successfully Performed

## 6.7 Conclusion

In this chapter, we provide all the detailed information about the phases of testing that this project has been through. There was a total of three phases of testing i.e. Unit testing, component testing, and integration testing.

## Chapter 7

### Conclusion

Verbally - An AI-Powered Companion for Mastering English project successfully delivered an all in one platform that addresses the critical problem of switching between multiple language learning platforms and lack of personalized feedback in English language learning. By adding a multi-skilled learning path with advanced AI, Verbally has fulfilled all core objectives set out at the beginning of this project.

The system is built on a hybrid architecture, utilizing a NestJS modular monolith for core business logic and a FastAPI microservice for computationally intensive speech analysis, supported by PostgreSQL data layer. Through testing (Chapter 6), the system was validated to be secure and fully functional across all 32 test cases.

#### 7.1 Contributions

Effective construction of Verbally signifies some valuable work to the sphere of AI-assisted language learning connected with the tasks of projects:

- **A comprehensive Adaptive Learning Solution:** Verbally breaks the barriers of other options such as Duolingo and Elsa Speak by offering six learning modules (e.g. vocabulary, grammar, writing, listening etc.) in one single platform.. With Gemini API, each and every piece of content and assessment is personalised based on the current CEFR level of the user (A1, A2, B1, B2, C1 and C2) with the aim of creating a personalised learning experience.
- **Phoneme-Level Feedback:** An important technical input is the Speech Assessment Module. Using Deepgram to perform transcription and Montreal Forced Aligner (MFA) as a microservice in Python, it is possible to give a learner feedback on their pronunciation on a phoneme-by-phoneme level against the accent of which they would prefer to identify (e.g. American or British English).
- **Delivering Quality Education:** Verbally is a project that enables everyone to access high-quality and personalized learning in English, as long as they have access to the internet. This can be useful to individuals in areas where these resources are limited and English fluency is a motivator of employment.

- **Social Learning Environment:** Verbally can be used to provide motivation by including social networking features. The real-time chat and friend connection functionality made using WebSockets, turns learning into a community-based experience.

## **7.2 Reflections**

### **7.2.1 Strengths and Successes**

Verbally is strong in terms of scope and depth of technicality. The hybrid NestJS/FastAPI architecture was shown to be a successful choice and an ability to run computationally intensive speech analysis with Python microservice. Gemini, MFA, Deepgram The resulting successful integration of the various types of AI and speech applications (Gemini, MFA, Deepgram) offer a level of detail that outshines other commercial English Learning applications.

### **7.2.2 Weaknesses and Shortcomings**

Latency was one of the main technical deficiencies determined during the development. Following optimization and utilization of visual confirmation (loading spinners and skeletons) the reliance on numerous third-party APIs (particularly the Gemini API) to create the content and elaborate feedback created a performance challenge. This has led to 10 -15 seconds wait time by certain AI-based modules. The accent module, similar to the others, is also powerful, but only it has the limitation of being an American and British English module.

### **7.2.3 Impact**

Verbally's immediate impact is the provision of a structured and customizable learning environment. It can be used to assist learners in securing measurable improvement through the provision of CEFR scores and accent-specific remarks. This enhances their confidence and increases their educational and employment opportunities in the world.

## **7.3 Future work**

The following points are recommended for future work to extend Verbally:

- **Addition of Modules:** New modules such as a special Reading Comprehension or scenario-based conversational stimulus (e.g., job interviews) can be added..
- **Monetization and Gamified Progression:** Addition of a complete subscription or freemium model and a more detailed gamification system (e.g., leaderboards) would help strengthen user retention.

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# Appendix A: Glossary

<b>Term</b>	<b>Definition</b>
CEFR (Common European Framework of Reference for Languages)	An international standard used to describe language proficiency levels, ranging from A1 (beginner) to C2 (proficient).
Deepgram	A speech recognition and audio intelligence platform that converts spoken language into text and provides real-time transcription and analysis.
Gemini API	A generative AI API developed by Google that enables applications to generate text, analyze content, and simulate conversational responses.
Gemini TTS (Text-to-Speech)	A feature of Google’s Gemini platform that converts written text into natural-sounding spoken audio.
AI (Artificial Intelligence)	Technology that simulates human intelligence to perform tasks such as reasoning, learning, and decision-making.
ML (Machine Learning)	A subset of AI where systems learn from data and improve their performance without being explicitly programmed.
Phoneme	The smallest unit of sound in a language that distinguishes one word from another (e.g., /p/ and /b/ in “pat” vs “bat”).

Fluency

The ability to speak or write smoothly, accurately, and with proper flow in a language without unnecessary pauses or hesitation.

Accent

A distinctive way of pronouncing a language, often influenced by a speaker's regional or cultural background.

# Verbally\_

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