UCD Michael Smurfit Graduate Business School

Generative AI based Learning App for Kids- Prototype

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Foreword

It is our vision to change how children learn, so we embark on this journey to further the integration of generative AI in educational applications. This has been motivated and powered by deep belief in the transformational power of technology in education, as well as a realization of the personal commitment to improving access to and the effectiveness of learning through innovation.

Generative AI—powered, dynamic, and personalized content holds much promise in solving most of these education challenges. That is how that sort of technology has the potential to tailor educational materials to the unique needs of learners—a matter of academic interest and a passion that each one of our team members is eager to share. We are particularly interested in how far we can make learning more enjoyable for children, who have been inadequately catered to so far by conventional educational resources.

This capstone project serves to stand for something much more than an academic requirement: how we actually apply what we learned throughout the coursework toward a real-world problem affecting millions of lives. It is also, really, an homage to the innovative spirit that characterizes the field of Business Analytics, one that we hope to emulate as each of us makes our contribution to this changing environment of educational technology.

Through this project, we not only intend to achieve our academic objectives but also make a difference in a positive way in the way young children deliver and experience educational content. We hope this work shall be just a stepping stone towards further developments that continue making learning more accessible, enjoyable, and effective for children across the globe.

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This work would not have been possible without the support and contributions of these individuals and institutions, and we are sincerely thankful for their involvement in this journey.

Executive Summary

This capstone project, a part of the Master of Science in Business Analytics program at University College Dublin, explores the feasibility of using generative artificial intelligence (AI) and Large Language Models (LLMs) to deliver educational content to children. The study led to the development of a comprehensive web and mobile platform featuring captivating, child-friendly educational materials. This includes interactive books and quizzes crafted by Large Language Models, designed to enhance the learning experience for young users.

Our critical innovation will be an advanced content filtration system. This tool will adapt and guarantee the level of appropriateness of the AI-generated content; it is educationally and age-premised appropriate. In the case of unsuitable content, it will trigger refinement from LLM and maintain a secure and supportive learning environment for our young users.

The result of the learning app's effectiveness was measured with user feedback from parents and teachers upon using our app. We have also explained what other functionalities this app could provide.

Our findings were that generative AI could make a real difference in the personalization of educational content, increasing its engagement rate, and making learning accessible and enjoyable for kids. The suitability of all content regarding age and educational value will be assured through an inbuilt filtering mechanism, thus reaffirming commitment to safety in the learning environment.

List of important abbreviations

1. AI- Artificial intelligence
2. API- Application Programming Interface
3. AWS- Amazon Web Services
4. AWS EC2- Amazon Elastic Cloud Compute
5. AWS S3- Amazon Simplified Storage Service
6. CRM- Customer Relationship Management
7. GenAI- Generative AI
8. GPT- Generative Pre-trained Transformers
9. LLM- Large Language Models

Chapter 1 - Introduction

The global education technology market has seen substantial growth in recent years, with the market size estimated at USD 142.37 billion in 2023. This market encompasses both hardware and software technologies designed to enhance learning experiences and outcomes through virtual education platforms (Grand View Research 2023). The sector is projected to continue its upward trajectory, with a compound annual growth rate (CAGR) of 13.4% from 2024 to 2030, indicating sustained demand and innovation in educational technologies.

Within this broader market, the segment of educational technology applications specifically aimed at children under eight years old has emerged as a significant area of interest. According to Blinc Invest, this segment alone represents a market size of approximately USD 9.5 billion, having grown at a CAGR of 17% over the past decade. This rapid growth highlights the increasing recognition of the importance of early childhood education and the role that digital tools can play in supporting the development of young learners (Blinc Invest 2021).

These trends underline the critical role of innovative educational technologies, such as the generative AI-powered learning app developed in this project, in shaping the future of education across various age groups.

The EdTech domain is undergoing significant revolutions at the moment, as it has begun incorporating Artificial Intelligence. More specifically, the creation and application of Generative AI and Large Language Models (LLMs) are set to transform the customization and provision of learning material on digital platforms. The rollout of technologies like OpenAI's ChatGPT, DALL·E, and Midjourney has further accelerated this transformation, enabling more personalized, interactive, and creative learning experiences. These advancements are not only enhancing the way educational content is delivered but are also expanding the possibilities for how students engage with and absorb new information.

This project at University College Dublin will critically investigate the potential of generative artificial intelligence to innovate educational content delivery through a tailored web and mobile platform for children, with regard to the capability of AI to personalise learning experiences according to the requirements of each individual learner.

Generative AI can generate interactive books, adaptive quizzes, and many more along this line of educational materials from large datasets. This tech can tailor content to the very unique learning styles and paces of the individual learner; therefore, not only will it increase engagement, but it will really raise the bar for efficacy in terms of educational interventions. At the very core of our investigation is the implementation of a very advanced system that filters content and tests whether AI-generated content is appropriate for young learners vis-à-vis educational standards. In case the content does not attain this standard, the setting is for the system to have the AI refine its outputs, thus ensuring age appropriateness and pedagogical soundness in all materials.

Empirically, AI-enhanced personalized learning environments have demonstrated a significant impact on student engagement, comprehension, and retention of information. Research by Brown and Riel (2020) illustrates that

AI-powered tools can dramatically improve reading comprehension, showcasing the potential of AI in educational settings. Similarly, Roschelle et al. (2000) highlights the transformative potential of computer-based technologies in educational content and methodologies, advocating for their seamless integration into learning environments to support effective learning.

However, the deployment of Large Language Models (LLMs) in educational settings, particularly in institutions focused on children, presents challenges related to the appropriateness of the generated content. While LLMs can create highly personalized learning experiences through the generation of diverse educational materials, there is a significant risk associated with content suitability. The autonomy of these models, derived from extensive datasets, could lead to the inadvertent generation of inappropriate language or toxic elements, which are unsuitable for young learners or family-friendly learning environments.

As the World Economic Forum (2024) report points out, it is critical to acknowledge the potential risks of deploying generative AI in education without implementing proper planning, safety measures, governance structures, and equity frameworks. Although AI systems often outperform traditional educational technologies, they also introduce new risks that must be carefully managed. These concerns are shared widely among parents, educators, and leaders. A global survey of more than 17,000 people in 2023 found that 61% of respondents are either ambivalent or unwilling to trust AI systems, with 71% expressing concern about potential risks, particularly in relation to the analysis of content and the adverse consequences of false information (World Economic Forum, 2024).

In this context, the exercise would involve filtering out such content and calls for strong mechanisms to screen and edit LLM outputs. This involves not only the initial detection of potentially offensive speech, but also the dynamic fine-tuning of content in accordance with strict educational standards and societal norms. Because of the subtlety of language use nuances and the fineness of inappropriate content, standard tools for content moderation can sometimes be less effective than desired. Instead, more advanced AI-driven filtering systems have to be implemented in order to understand context, recognize subtle innuendos, and learn from continuous interactions to improve their filtering processes.

The challenge does not stop at simple filtration but extends to the need for re-presentation of the refined content in a manner that is engaging and educative. To ensure that the learning experience is not disrupted with moderation and enhancement of content, there should be an iterative process seamlessly integrated into the AI system so that all content coming through the platform is safe, educational, and contributes to a positive learning environment.

Resolving these challenges is very critical because, in Generative AI-based educational platforms, the integrity and safety of learning content alone drives trust and reliability as perceived by educators, parents, and young learners. The present project will, therefore, exploit the capabilities of generative AI in order to tailor educational content but, more importantly, to further continuously refine and optimize the learning process to ensure maximal

educational outcomes for each child. In the following chapters, a description of the methodologies to create an AI and LLM powered learning app will be presented together with the development process of the platform.

Chapter 2 - Purpose of the Study

This chapter frames some of the key goals of our capstone project: to make effective use of Generative AI and Large Language Models in developing an innovation-driven educational platform with access via web and mobile devices. More precisely, it will provide a child-friendly environment that will drive increasing user engagement through the provision of personalized educational content while ensuring safety concerned with the material provided. It tries to meet children's developmental needs by providing personalized educational experiences that are engaging yet safe.

Objective 1: Develop a proof of concept

Our research project focused on establishing a proof of concept for a web and mobile application that would play off Generative AI and Large Language Models in an early childhood education context. The novel application that is described here is set to alter the way young learners' interface with educational content through innovations introduced to audio book narration, engaging fact presentation, and audio-assisted vocabulary support.

Recent research by Kim, Lee, and Thomas (2021) underscores the significance of personalized learning experiences in enhancing user engagement and fostering deeper connections with educational material. This personalization is particularly crucial in the cognitive and linguistic development of young learners, as it accommodates individual learning paces and styles (Zhang, Zhao, and Wang, 2020). By adapting to each child's unique needs, our application seeks to create a more tailored educational experience, potentially increasing motivation and focus among young users.

Our application also aims at providing an entertaining and educationally stimulating setting. The interactive modules make learning into an active process rather than a passive one with the use of audio-aided reading and dynamic statements of facts. Such interactivity is considered basic in early childhood education, as it encourages children to explore new concepts, ask questions, and evolve critical thinking skills at the most formative age.

Usability and accessibility of the application across different devices—this is one of the important focuses in our proof of concept. Of importance in regard to this is the fact that increased functionality will bridge the gap of the digital divide, ensuring cutting-edge educational tools are available to every child, be it hardware-preferred or hardware-limited.

Development of this proof of concept does not only help us in designing an educational tool but probably lays the foundation for sowing a love of learning in learners for life. Our app will try to provide education in such a way that it's interactive, personalized, and fun so it lays a really strong foundation for educational curiosity and future academic success in young learners.

The project thus serves two purposes: to test the feasibility of applying Gen AI and LLMs in educational settings and to explore the transformative potential for reshaping the landscape of early childhood education. We believe

that moving forward, the lessons learned from this proof of concept will deeply influence the continuous discussion about technology-enhanced learning within early childhood education.

Objective 2: Ensuring Content Safety for Text

Another important consideration in this project is to ensure the safety and appropriateness of the content generated by the LLMs. This was solved by developing a sophisticated filtration system that tests appropriateness or otherwise in the text produced by the LLM. The need for that system was two-fold: it could detect potential problems in the content but also would prompt the LLM to adjust appropriately to align with the safety standards in place. This filtration system was designed in consideration of the research by Bender et al. (2021), which details the intrinsic risks of biases and inappropriate output productivity of AI-driven content. These risks are very serious within an educational setting because of the formative effect it will have on young learners. Inappropriate content, either due to bias or error, may misinform or offend, leading to a setback or even harm in learning. This is in line with our filtration system, which tests the generated content using appropriate indicators: language use, tone, and presence of culturally sensitive material, all checked against sophisticated algorithms.

Content safety is at the core of our mission to provide a safe and trusted learning environment. This commitment does not stop at mere filtration and correction of outputs, but involves a continuous cycle of learning and improvement for our AI models. We ensured that feedback from the filtration system is used to further train the models so that the chances of repetition of mistakes are drastically reduced in the future, hence making the entire system more reliable. Moreover, we consulted with educational professionals and linguists to define the parameters of our filtering system—to keep our product current with the standards of education and social norms. By building in these strong controls, we continue to provide not only a richer learning environment for learners but also sustain the needs of educators and parents through the sustenance of a trusted platform. Our content safety processes empower students, teachers, and parents to have faith in the integrity and validity of the educational content provided therein. We therefore directly align with and further our mission of using technology to transform education while keeping all those that use it safe and secure.

Objective 3: Track Kids Learning/Quiz Performance

The third aim of our project, therefore, is to create sophisticated tools that will enable parents and teachers to design flexible quizzes and effectively alter the level of challenge based on the children's learning rate. This is an indispensable feature of our work, as Brown and Riel (2020) proposed in their paper last year on 'various important components of adaptive learning environments that have been proven to be effective.' These tools thus personalize learning, ensuring each child receives learning that best suits his pace and learning style.

Ours is not just a quiz performance tracking system but far more advanced, bringing in analytics to get the right insight into the learning journey of a child. It can monitor the responses to the quizzes to check the proficiency level in various subjects, which can help in finding patterns in the answers that could reflect strengths and weaknesses of a child. Because of that, we are now able to recommend actionable educational interventions,

which actually support an understanding of not just what but how children learn and hence powerfully contribute to the continuous feedback and improvement of the entire learning process for both teachers and parents in simplicity and effectiveness.

Furthermore, it is integrated with features through which further tweaking of the learning contents based on the performance of the child is possible. For instance, in the event that a child makes errors in a particular subject all the time or has a perfect score in, say, another one, then it is automatic that the system makes recommendations towards changing the content to suit his needs. Learning, as a result, continues to be challenging yet within reach; this keeps a student engaged and provides effective learning results.

In addition, the comprehensive performance metrics and progress reports from the tool are displayed in a manner that both educators and parents will find easy to access. The reports come with graphics of progression and areas to improve upon, so it is easy to observe education growth. Our tool will therefore not only improve the educational experience but will also support children in the constant development of skills and knowledge by offering these insights.

This is in furtherance of using technology to make education more effective, engaging, and tailored. Our objective is to change the method of monitoring and enhancing educational progress. We are providing the tools that adapt to the educational needs of each child to enable an environment where personalized education is not only a concept but a realizable idea.

Objective 4: Gather User Feedback to Measure the Usefulness of the App

In addition to developing a proof of concept, ensuring content safety, and tracking children's learning and quiz performance, we sought to measure the app's effectiveness through user feedback. This fourth objective aimed to collect qualitative and quantitative feedback from parents and teachers, the primary users, to understand their perceptions of the app's usefulness. User feedback was gathered through structured surveys and interviews, focusing on the app's ease of use, its ability to meet educational goals, and the effectiveness of its content safety measures.

The feedback process involved asking parents and teachers to evaluate several aspects of the app, such as how well it engaged children, its educational value, and whether it adequately safeguarded against inappropriate content. This data was essential for assessing how the app was perceived in real-world educational settings, enabling us to make informed decisions about future enhancements. By including the voices of parents and teachers in the evaluation process, we ensured that the app's development was aligned with the actual needs and expectations of its users, thus increasing the likelihood of adoption and long-term success in educational environments.

Chapter 3 - Literature Review

Adoption of generative AI and LLM in educational settings has opened up new avenues for personalization of learning experiences and is touted to truly revolutionize pedagogies. However, this huge change of technological evolution comes with serious issues on equity, ethics, and effectiveness.

3.1 Impact of Generative AI on Personalized Learning

Generative AI is touted as a game changer for education, basically changing the way educational content is created, circulated, and consumed. This technology enables personalized learning—through dynamic adjustment of educational content in real time, based on the needs of each learner—and has been proven to engage learners much more than the traditional approach does, through attending to different learning preferences and paces. According to Bavelier et al. (2010), this kind of tailored digital environment can substantially improve certain higher-level cognitive skills like attention and problem-solving ability. It not only keeps learners engaged but allows for deeper educational interactions, all pegged on individual learning curves.

In their article, Higgins et al. (2012) describe at length the huge reverberations of digital technology on learner outcome. Their work presented customized content because it is powered by very sophisticated algorithms that adapt in real-time and respond to learners' responses, promoting deeper engagement and more effective learning. This adaptive learning environment becomes very critical in covering a range of styles and abilities, hence making education inclusive and effective.

Going further with the capabilities of Generative AI, Kim, Lee, and Thomas (2021) showed that AI can further enhance storytelling into an interactive experience that enhances material connection substantially. This interaction not only makes it more interesting for children to learn things but also helps them in retaining knowledge and improving their critical thinking skills. AI-enabled interactive storytelling will succeed in explaining complex ideas in very simple ways, which will also instil a good attitude toward learning.

Despite these developments, huge challenges persist for making sure that the benefits coming out of AI-driven personalized learning are operationalized for all. Flewitt, Messer, and Kucirkova (2014) inform that if there is not an equal share of these, then advantages of such approaches, taken for personalization, might fail to reach out to all. This might not only create but also exacerbate educational inequalities in most cases because it is the socioeconomic factors and geographic disparities that will dictate the availability and quality of technological resources. There is, hence, a need to ensure that policies and investments in deploying education technologies are done having in mind accessibility.

The necessity of strong frameworks so that these technologies do not further widen unintentionally the educational divide is indicated by Zhang, Zhao, and Wang (2020). Since AI systems are heavy consumers of data, biases carried through in the data may fall to the learning models, and they can further accentuate educational inequities. Therefore, these emerging frameworks do more than adjust technical parameters of fairness and

transparency in AI algorithms; rather, they institute broader policy decision-making to regulate and guide the use of AI in education.

Apart from the technical and accessibility issues, there's also the question of data privacy and security. Given the amount of sensitive data collected by any educational platform on students' learning patterns, preferences, and performance, it becomes very important to ensure the security of that data. This calls for state-of-the-art security measures in backing up data governance policies at the highest level, hence protecting this information from unauthorized access, and ensuring that trust between educational institutions and learners is upheld.

This section is concluded by the fact that while generative AI has huge promise to revolutionize educational practices through personalization in learning, this will have to be done with much reflection on issues of accessibility, ethical implications, and data security. By doing so, it creates a collaborative opportunity for educators and technologists to create learning environments that are innovative, engaging, inclusive, and secure.

3.2 Effectiveness of AI-Driven Educational Tools

The next generation of AI-driven education tools not only serves as a tool for learning but creates the landscape in which learning occurs. These are dynamic, living, interactive environments that assist students with all their disparate needs. The latest advancement in artificial intelligence provides more engaging and tailored-made learning experiences. According to Brown and Riel (2020), AI can enhance reading comprehension by adapting learning techniques. These systems automatically adapt the level of difficulty and how the material is presented based on a learner's responses, thereby making sure that each student accesses the material in this learning environment at a pace and level appropriate for him or her.

A significant contribution to individualized support in STEM subjects has recently been shown by Chen et al. (2021): AI-powered virtual tutors. Artificially intelligent tutors are able to simulate one-on-one interaction, explanation, problem-solving guidance, and feedback that can be personally relevant to learners' learning dynamics. This kind of personalization not only sustains understanding and retention but also fosters further interest in the subject under study.

On a larger scale, Roschelle et al. (2000) focus on the transformative potential of technologies. They state that educational technologies based on computers can dramatically change both the content and the practice of education to make learning at schools more accessible and effective. This transformation is found in the capacity of educational content now to be dynamic in response to students' learning curves and provide a learning experience much more aligned with personal educational journeys.

While there are evident benefits that AI-driven tools bring in order to improve educational outcomes, there are relevant challenges that need to be dealt with in order to establish an effective implementation of these tools. Li and Tsai (2021) raise concerns about data privacy and integrity with algorithms used in these systems. AI working out in education depends on the accuracy and fairness of the algorithms. Unless these algorithms are unbiased

and faultless, they might actually increase rather than alleviate existing educational inequities. It is on these grounds that AI tools must be created with a really robust ethical framework respecting privacy and the autonomy of the learners.

On this point, Davis et al. (2022) stress that the development and implementation of AI tools into the school environment have to proceed according to strict standards to avoid potential improper leaks of sensitive data. Educational platforms store enormous personal data about students' learning patterns, preferences, and performance. Protection from unauthorized access and making sure that these data are utilized respectfully towards student privacy are not the least concerns.

Further still, AI implemented into education begs questions concerning the role of a teacher within that very learning environment. Of course, there is no denying that AI does bring forward personalized content, but where teaching is concerned, it cannot replace the human feature of a teacher. Teachers have been, and always will be, crucial in motivating students, keeping up classroom dynamics, and offering emotional and social support that no AI can give. In this respect, AI tools should not be deemed as a replacement for traditional ways of teaching, but rather enhance them.

In final thought to this section, a last word is given to the fact that although AI-driven educational tools proffer promising enhancements to educational practices, their successful operation and sustainability depend on careful considerations of ethics, technology, and pedagogy. Guaranteeing responsible and efficient usage of these tools requires continuous research, development, and debate by educators, technologists, and policymakers. It is only through solving these challenges that AI can live up to its potential as a game-changing tool for learning benefits extending beyond the classroom to foster whole and lifelong learners.

3.3 Ethical Considerations of AI in Educational Settings

The integration of AI in educational settings involves great ethical concerns that must be charted in very small steps so that the related benefits may be gained without harm. Particular concerns will be data privacy, bias, and accessibility issues, all at the heart of the ethical deployment of new technologies. Crucial for educational processes will be the assurance that AI systems, once integrated, are compliant with these ethical standards.

Selwyn (2012) provides a view of challenges in integrating technology into education globally, with an emphasis on the fact that ethical considerations should always remain at the forefront of educational innovation. Use of AI tools must be based on a framework that considers efficiency, effectiveness, fairness, and respect for learners' rights. This involves protection of sensitive data of students and ensuring that applications of AI do not perpetuate or amplify the already existing educational inequalities.

Jones and Kahn (2017) then discuss how digital tools impact social, emotional, and academic development, identifying a need for ethical frames through which the holistic well-being of students is to be fronted. These frameworks should ensure that AI tools support constructive educational practices that provide for the nurture of

students' emotional and social skills alongside their academic abilities. Use of AI in education should, therefore, not be solely aimed at attaining academic excellence but create an environment that fosters overall development in a child.

Wu et al. (2020) contribute to the associated ethical dimensions around the use of AI to support bilingual education, underlining the many challenges and opportunities brought about by the situation. AI can provide individually tailored linguistic exercises that are calibrated for every student based on their level of proficiency and pace of learning, enhancing language learning significantly. These technologies need to be deployed with acute regard for cultural sensitivity and avoidance of linguistic bias that otherwise would disenfranchise students from minorities or other cultural backgrounds.

These ethical concerns do not stop at student-to-student level interactions but further affect the larger community of education. One major problem is the accessibility of AI-driven tools; this might ensure that advanced technologies turn into gatekeepers who preserve social and economic imbalances. This makes fair access to AI resources very important, so as not to create a digital divide that will worsen educational inequalities between socioeconomic groups.

Data privacy remains one of the thorniest issues in ethics related to AI use in education. In view of large amounts of personal information being fed through AI systems to tailor learning experiences, strong data protection measures are required to ensure that student information does not fall prey to breaches and misuse. This not only includes technological solutions but comprehensive policies regulating data use and bringing transparency and accountability into how student data is handled.

The ethical considerations of applying AI within educational settings should be addressed in their entirety, with sound regulatory frameworks and strong oversight mechanisms in place for its application to uphold fairness, respect for privacy, and human dignity among all learners. The second step to be taken by educators and technologists is to be aware of ethical considerations to ensure that AI-based educational environments are at once both innovative and effective, fair and safe. Only in this way can the contribution that AI in education will make be an incrementally positive factor in the educational landscape, heading toward inclusivity and equity for very diverse learning communities.

3.3.1 Additional Ethical Considerations of AI in Educational Settings

Another important ethical issue in the area of the application of AI in an educational context is the control over appropriateness in AI-generated content. AI, even though it is a potent tool with the potential to personalize and engage, at times builds profane or biased content due to its inner biases shared in training data or algorithms themselves. This issue shows that there is an essential need for close content moderation systems and continuous update of AI models to ensure the suitability of the educational content delivered to all age categories and cultural contexts involved (Bender et al., 2021).

These are issues that point to deeper problems of bias in data: AI systems learn from and perpetuate biases in their training datasets. With poor control, this will lead to generating inappropriate and harmful content, reinforcing stereotypes or giving biased perspectives as fact. It is, therefore, important to have robust mechanisms for filtering and reviewing such content before it reaches learners.

Moreover, AI and machine learning models are dynamic by nature and hence have to be maintained further with regular updates in order to ensure their continuous accuracy and appropriateness. This cannot be restrictively associated with only technical updates but is also a continuous review in their content toward alignment with evolving educational standards and ethical norms.

While there is a general lack of studies on the use of swearwords and toxicity in educational AI, several valuable lessons can be drawn from the broader discourses on AI content moderation. It sets the stage for newer ways in natural language processing and machine learning that detect and correct biased or inappropriate generation of content. Such advanced technologies require cross-disciplinarity in their application—that is, bringing in adequate expertise from education, ethics, and computational sciences to come up with effective AI tools that are ethically sound.

In case such problems are dealt with in advance, AI tools will make the educational process still more perfect without compromising on ethical standards, thus safeguarding the integrity of educational content and promoting safe and inclusive learning environments.

3.3.2 Summary

In other words, the continuous integration of AI into educational settings definitely needs a balanced approach to exploring the capabilities and limitations. That means sustained research and dialogue among educators, technologists, and policymakers will help them reap maximum benefits while reducing ethical and practical challenges. This literature review thus takes part in the on-going dialogue, offering a broad overview of where AI in education stands today, and pointing to both the transformative potential of these technologies and the considerable obstacles that will have to be overcome.

Chapter 4 - Methodology

The methodology of this endeavour involved various different tools and technologies to create a single coherent system that made it possible to create an application that allows anyone to interact with a Large Language model with a single click while being really fast and efficient. The technologies that we used ranged from computing and infrastructure services like Amazon EC2 and docker to Frameworks such as Angular, Flutter and FastAPI. A variety of AI services were also considered and we finalized ChatGPT3.5 for text generation, Midjourney for Image generation and Amazon Polly for audio generation. User authentication is done using Amazon Cognito user management service that also ensures safety and security and PostgreSQL database is the application's primary data source to read and save users chat history data. Other tools and technologies involved Git and GitHub for version control and CI/CD pipeline, Bootstrap for UI/UX design, CloudFront for IP configuration and routing, Amazon route 53 to buy the domain name for the web application.

Prompt engineering is extensively used in this application primarily to generate text and images. AI services are instructed to act as a tutor to 3–5-year-olds to generate content which ensures a level of safety in the text and image being generated. The response of the AI is structured in a JSON format which ensures integration of AI services through Amazon S3 and FastAPI directly to the client facing application. Overall, the number of tools and technologies may seem like a lot and quite complex, the next section showing the architecture will make it quite easy to understand the flow of services which will paint a clearer picture.

4.1 Architecture

The primary objective of building this architecture is to find a way to combine the three different AI services (text, image and audio) into a single system seamlessly. We used FastAPI framework and Amazon S3 bucket service to achieve the integration. The FastAPI receives the instructions from the client and redirects them to the required AI services to get the prompt response, If the response is from Midjourney or Amazon Polly, the image and text file are stored in Amazon S3 buckets and then are called by FastAPI to be shown in the Frontend. The text generated by ChatGPT is first stored in PostgreSQL database from FastAPI and then is shown in the frontend. The Frontend applications namely Flutter Mobile application and Angular web application only gave instructions to the FastAPI backend for interacting with the AI service and calling the Amazon Cognito service for user management. Angular web application is deployed in S3 buckets and the Flutter Mobile application is available in the Apple app store to be downloaded.

An instance of PostgreSQL database and the FastAPI backend is containerized using docker and then deployed to two different Amazon EC2 instances. The deployment of FastAPI backend is achieved using docker hub where we first containerized the service in our local systems and then uploaded the docker hub and then pulled in the EC2 instance and run at a specific port using docker command to be consumed by other services.

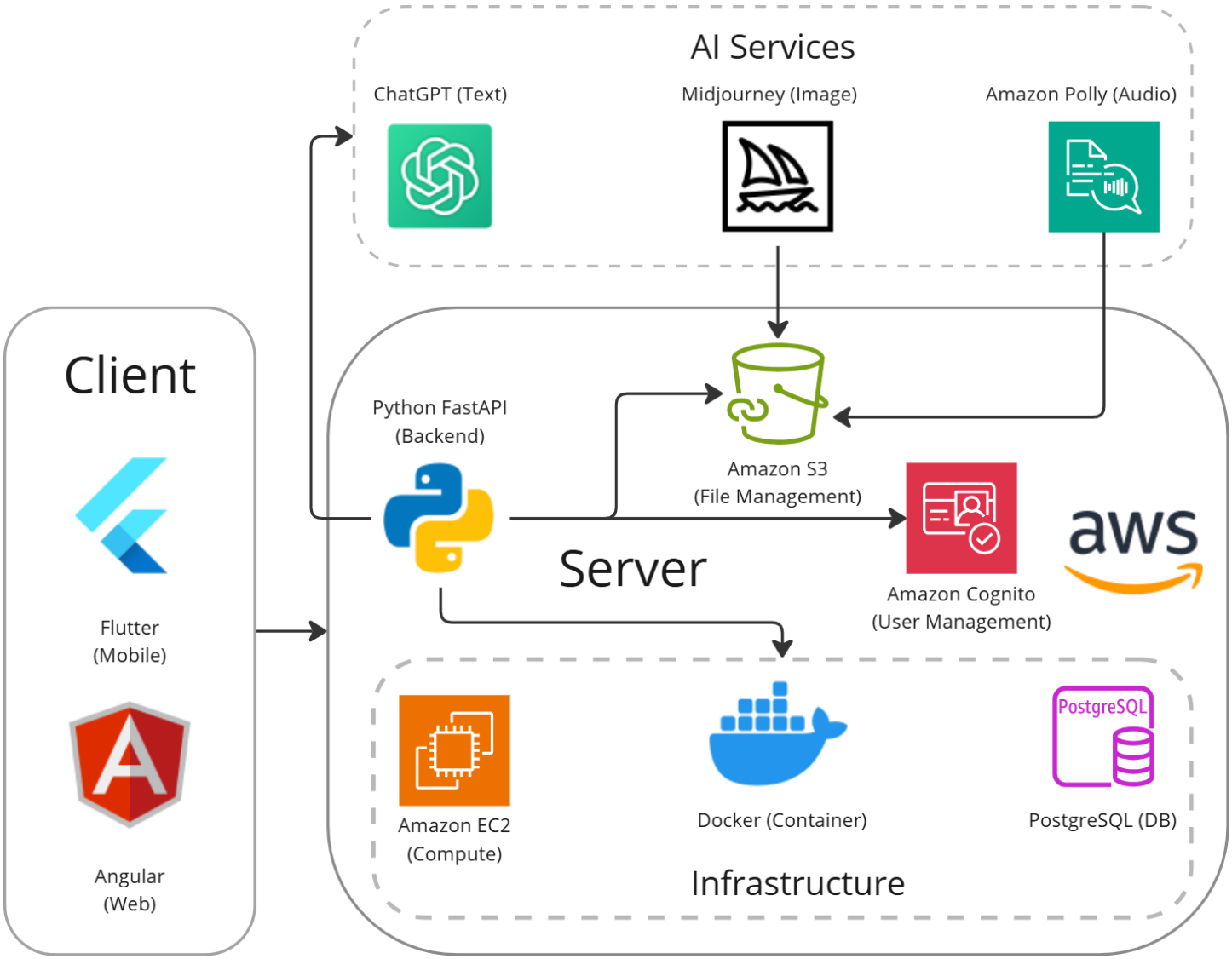

Fig 1: Complete Architecture of the application

Fig 1 depicts the client-server architecture used to create the application. The reason to select this architecture is it simplifies or facilitates integration with various other services, which was needed in our case as we wanted to integrate three different Generative AI Services - ChatGPT (text), Midjourney (image), Amazon Polly (audio), as depicted in the above region of Fig 1. This architecture is beneficial due to its scalability, flexibility, and the ability to manage multiple services efficiently (Sharanagowda, 2022). Additionally, client-server architecture enhances the security and control over data transactions and simplifies maintenance and updates, making it an ideal choice for complex applications (Duchessi and Chengalur-Smith, 1998).

We chose to build the backend in the cloud due to the numerous advantages it offers. Cloud platforms, such as AWS, provide high availability and reliability, ensuring that the application can handle traffic spikes and remain operational even in the case of hardware failures. They also offer automatic scaling, which allows resources to be adjusted dynamically based on the current load, thus optimizing performance and cost-efficiency (Amazon Web Services, 2023). Furthermore, the pay-as-you-go model of cloud computing reduces upfront infrastructure

costs and allows for better budgeting and financial management. Implementing proper methods for dynamically allocating resources based on application

The entire backend (server) architecture was built using AWS as it simplifies access to crucial services like S3 buckets, Elastic Compute 2 (EC2) Engines, Cognito. The backend logic is built using the FastAPI framework in python as it is much better and faster than other frameworks when it comes to integrating with AI services. The backend FastAPI service is first dockerized and is hosted in an EC2 instance which also contains the PostgreSQL database to save and store various data needed for the proper functioning of the application.

The images generated by Midjourney, Audio generated by Amazon Polly and long text generated from OpenAI's ChatGPT were stored in the cloud using the AWS S3 storage service. Additionally, S3 buckets also host the frontend web application built using Angular. The reason to select angular is it is really fast for applications that contain complex logic and easy to style using Angular materials and simple integration with frameworks like bootstrap.

The mobile application is built using Flutter as it is platform independent meaning the same source code is used to build android as well as iOS application. It also has simple integration with Flutter Flow which is a low-code/no-code development platform which simplifies development even further.

4.2 Generative AI Services

The table below shows the various Generative AI services that we used in our project and why they were selected. Most of the selections were based on accuracy and latency but cost of using the service also played a major role for instance GPT4 is very costly for text and image generation and GCP and Azure are very costly for audio generation, hence Midjourney, ChatGPT3.5 turbo and Amazon Polly are good options when it comes to cost as they are really cheap.

Service	Description
ChatGPT (Text) 	Our primary chat service that we called using our FastAPI service. We tested our application with various models like GPT3.5, GPT4o, GPT4 but for our purposes, GPT3.5 turbo performed exceptionally well as it is really fast and accurate.
Midjourney (Image) 	For image generation we tested various services like GPT4, Dalle, Co-piolet but most of them were not accurate enough or did not understand the prompt clearly. Midjourney performed the best as it is really accurate and generated beautiful and colorful images.

Amazon Polly (Audio) 	The three primary services for audio were offered by Azure, GCP and AWS and since our infrastructure is based on AWS, we went with Amazon polly. It also generated captions with word level timings which helped us implement text level highlighting.

Table 1: Various AI services used

READIFYAI_Python_Backend > server.py > get_word_meaning

```python
@app.post("/api/short-stories-get-meaning")
async def get_word_meaning(word_details: WordPayload):

    # Use the payload data to generate a response
    title = word_details.title
    word = word_details.word
    context = word_details.context

    prompt1 = f"The current story being read is {title}."
    prompt2 = f" What does this word mean- {word}? "
    prompt3 = f"This is the context- {context}"
    prompt = prompt1 + prompt2 + prompt3

    response = openai.chat.completions.create(
        model="gpt-3.5-turbo",
        messages=[
            {"role": "system", "content": "You are a supportive AI tutor who is helping a student with reading book and helping build their comprehension skills,
            {"role": "user", "content": prompt},
        ],
        max_tokens=150,
        temperature=0.2,
    )
    print(response)
    open_ai_response = response.choices[0].message.content.strip()

    output = {"word_meaning": open_ai_response}

    word_meaning_audio_url = generate_audio_with_polly(
        aws_bucket_name, open_ai_response, title, "")

    output['word_meaning_audio_url'] = word_meaning_audio_url

    print(output)
    print(type(output))

    return output
```

Fig 2: Python function that uses Amazon Polly as well as ChatGPT to get a meaning of a word

The above figure is a small part of the entire Python FastAPI service and it gets the meaning of a word by first asking GPT3.5 turbo after a lot of prompt engineering and then generating audio using Amazon Polly of the text generated by GPT3.5. The audio is then stored in mp3 format in S3 buckets and the URL of the audio is sent as an output.

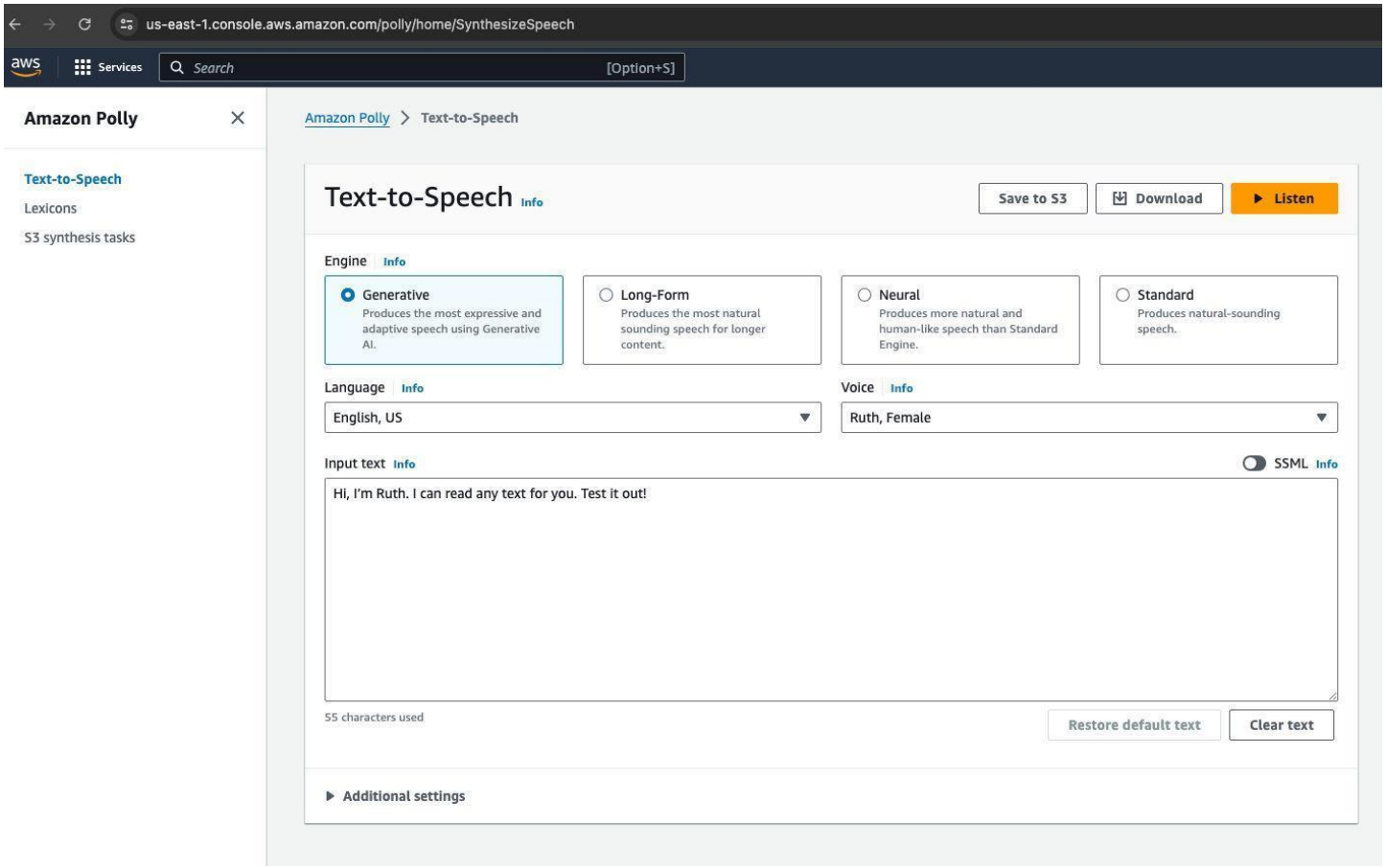

Fig 3: Amazon Polly dashboard to convert text to speech

4.3 Prompt Engineering:

One of the significant challenges in building applications that use Large Language Models (LLMs) is the variability in the output, which is always in the form of text or strings. Due to the inherent randomness in transformer models, the structure of the generated text can change with each execution. This variability poses significant challenges in developing complex applications where structured or semi-structured output is expected. Ensuring consistency and reliability in such outputs necessitates advanced prompt engineering techniques, which involve carefully designing and tuning input prompts to guide the model towards producing more predictable and useful results (Acher et al., 2023).

For instance, in a customer support chatbot, consistent and structured responses are crucial for maintaining user trust and providing accurate information. Variability in the responses can lead to confusion and reduce the effectiveness of the support provided. Another critical example is when LLM outputs are used to fill in forms or add records into databases. If the model generates inconsistent or improperly structured data, it can cause issues such as incorrect data entry, which may corrupt the database or lead to incomplete records. For example, when automating the input of customer information into a CRM system, the LLM needs to consistently follow the expected format for names, addresses, and contact details. Any deviation from the standard format can result in invalid entries, making it difficult to retrieve and utilize the information later. This not only increases the

workload for data verification and correction but also can lead to loss of crucial data, impacting business operations.

Prompt engineering involves several strategies to mitigate these issues. These include using precise and context-rich prompts, incorporating example completions, employing fine-tuning on domain-specific datasets, and utilizing post-processing techniques to normalize outputs. By refining the way prompts are crafted and understanding the model's behavior, developers can significantly improve the consistency and reliability of LLM outputs, thus enhancing the overall performance and user experience of the application.

To ensure the LLM outputs are in a specified format, we used LangChain's Response Schema and StructuredOutputParser modules. These modules allow us to define the expected structure of the output and parse the LLM responses accordingly. The following code snippet illustrates how we implemented this to get response in a specific format:

```
from langchain.output_parsers import ResponseSchema
from langchain.output_parsers import StructuredOutputParser


def gen_short_stroies_fun_facts(stroy_details):
    fun_fact_schema = ResponseSchema(name='fun_fact', description='Fun Facts')
    follow_up_question_schema_1 = ResponseSchema(
        name="follow_up_question_1", description="Follow up question 1")
    follow_up_question_schema_2 = ResponseSchema(
        name="follow_up_question_2", description="Follow up question 2")

    response_schema = [fun_fact_schema, follow_up_question_schema_1,
                       follow_up_question_schema_2]

    output_parser = StructuredOutputParser.from_response_schemas(
        response_schema)

    format_instructions = output_parser.get_format_instructions()

    title = stroy_details['title']
    page_detail = stroy_details['page_detail']
    timestamp = datetime.now().strftime("%Y-%m-%d %H:%M:%S")

    general_instruction = f'You are an AI Teaching App helping kids under the age to six.\nCurrently they are reading a famous short story and\
        the title is {title}.\nThis is the page text that is currently being read: {page_detail}. The current date and time is {timestamp}.'

    additional_instruction = random.choice([
        "Make sure to provide a new fun fact that hasn't been mentioned before. First look at the page text and generate a fun fact based on that. If you can't find
        anything in the page text, then generate a fun fact based on the title of the story.",
        "Provide a fun fact that is unique and not repetitive. First look at the page text and generate a fun fact based on that. If you can't find anything in the
        page text, then generate a fun fact based on the title of the story.",
        "Generate a fun fact and ensure it's different from previous ones. First look at the page text and generate a fun fact based on that. If you can't find
        anything in the page text, then generate a fun fact based on the title of the story."
    ])

    template_string = f'{general_instruction} {additional_instruction} You need to generate one fun fact followed by which generate 2\
    follow up questions on topic related to page text or fun fact.\n \
    Start fun fact with phrase [Did you know ] If the story or page text mentions particular animal or place or nouns\
    then get fun facts and follow up questions about fun facts. \
    Donot discuss about the original version of story as they could be dark and not appropriate of kids.\
    IMPORTANT: Generate fun facts that would be appropriate for kids age and interesting to kids, is informational and builds there general knowlegde.\
    IMPORTANT: Please follow the schema instructions for generating the response. If not then downstream will error out.\
    \n{format_instructions}'

    output = conversation_with_summary.predict(input=template_string)
```

Fig 4: Prompt for ChatGPT to generate Fun facts regarding a short story

```python
def quiz_mcq_creation(topic, additional_info, quiztype, agelevel, numquestions, userid):

    topic = topic
    additional_info = additional_info
    if len(additional_info) == 0:
        additional_info = "None"
    quiz_type = quiztype
    age_level = agelevel
    number_of_question = numquestions
    userid = userid

    now = datetime.now()
    current_time = now.strftime("%d_%m_%y_%H_%M_%S_")

    create_session_id = current_time + userid

    chat = ChatOpenAI(openai_api_key=OpenAI_API_KEY, temperature=0)

    # Define the response schema
    question_number_schema = ResponseSchema(
        name="question number", description="Question number in the quiz set")
    question_schema = ResponseSchema(name="question", description="Question")
    choice_1_schema = ResponseSchema(name="choice 1", description="Option one")
    choice_2_schema = ResponseSchema(name="choice 2", description="Option two")
    choice_3_schema = ResponseSchema(
        name="choice 3", description="Option three")
    choice_4_schema = ResponseSchema(
        name="choice 4", description="Option four")
    answer_schema = ResponseSchema(name="answer", description="Answer")

    response_schema = [question_number_schema, question_schema, choice_1_schema,
                       choice_2_schema, choice_3_schema, choice_4_schema, answer_schema]

    output_parser = StructuredOutputParser.from_response_schemas(
        response_schema)

    format_instructions = output_parser.get_format_instructions()

    print(format_instructions)
```

Fig 5: Quiz creation function creating the response structure for ChatGPT

By leveraging LangChain's tools, we were able to define strict output schemas and ensure the generated content adhered to these structures, thereby improving the application's reliability and user experience. Response Schema and StructuredOutputParser modules are really powerful tools to specify the response structure of the output of the LLM which facilitates integration with various other services whether it be frontend or backend. Fig above shows how we used these two modules by first using Response Schema to define the structure of the quiz that we want the LLM to generate and then using StructuredOutputParser to get the raw response from the LLM and structure it according to the schema defined in the Response Schema.

src > app > models > TS question-true-false.model.ts > ...

```typescript
export interface TrueFalseQuestion {

  answer: string;

  question: string;

  'question number': string;
}
```

src > app > models > TS question-mcq.model.ts > ...

```typescript
export interface MCQQuestion {
  answer: string;
  'choice 1': string;
  'choice 2': string;
  'choice 3': string;
  'choice 4': string;
  question: string;
  'question number': string;
}
```

Fig 6: Response formats for prompt generated by ChatGPT

Fig shows two different response formats created for ChatGPT in the Frontend to generate quiz questions and options to be consumed in the Angular web application written in TypeScript. The first figure is the structure for True and False questions which contains ‘answer’, ‘questions’ and ‘question number’ as attributes. The second figure shows the structure for MCQ questions with ‘answer’, 4 different choices, ‘question’, and ‘question number’ as attributes defined in the backend.

4.4 Frontend Applications (Client)

To achieve our targets in the frontend side of the application, angular and flutter were the primary consideration for developing the web and mobile applications. The development first started with the use of angular to build the web application and after finding success, we also employed Flutter to build the mobile application.

4.4.1 Angular Web Application

To build the web application, the framework Angular is used due to its high scalability, easy to integrate with node packages and other frameworks and its wide user base and community give us access to tons of content to do our development. Two of the primary styling tools that we used for the application are Angular materials and bootstrap both of which have really easy integration with Angular, they are very easy to use and offer a variety of beautiful themes and UI elements to work with.

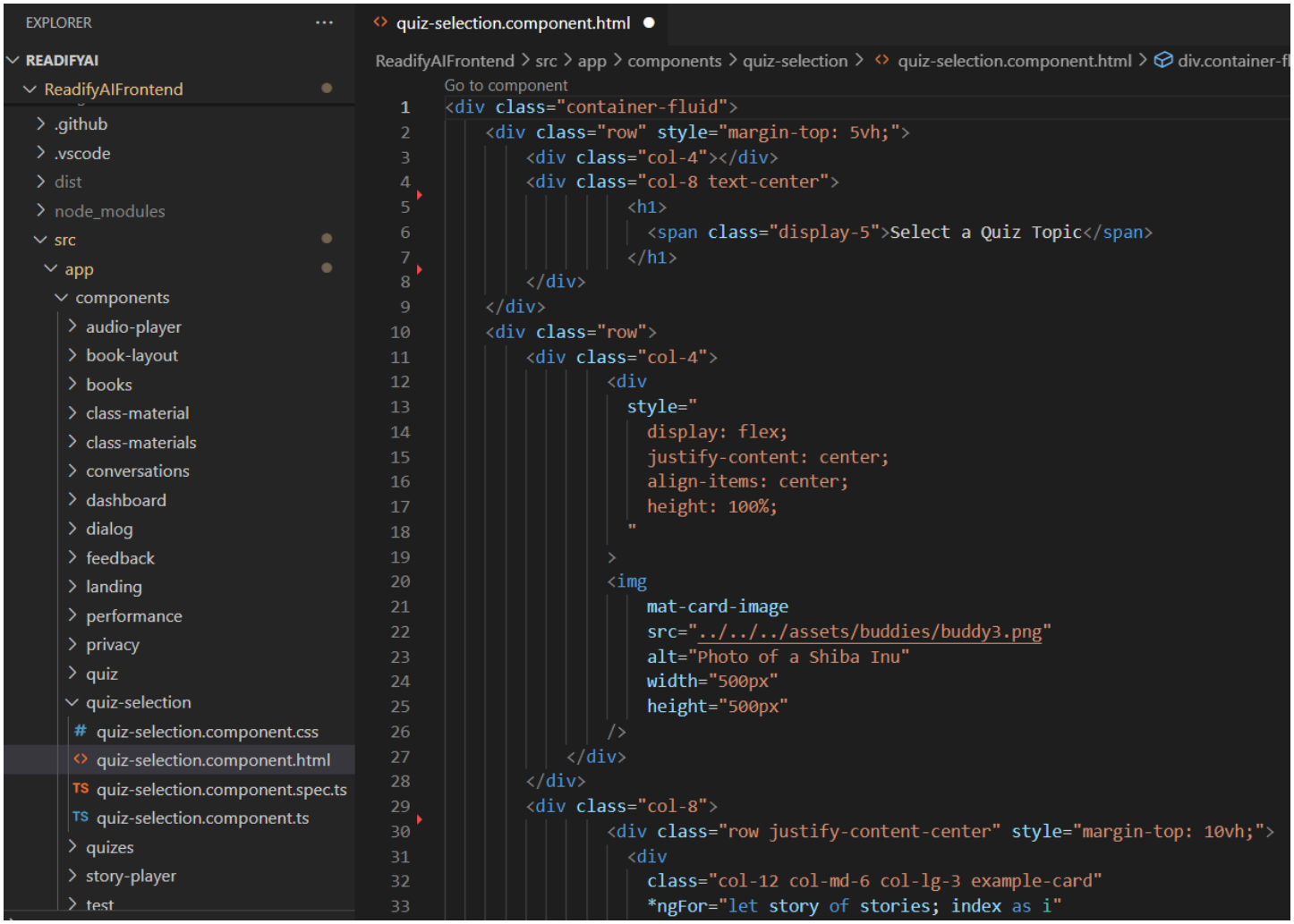

Fig 7: Angular file structure and quiz component in VS Code

4.4.2 Flutter Mobile Application

To build the mobile application, Flutter framework is used as it is platform independent meaning one code can be deployed for both android and iOS. The UI designs were first created in the web application and then were recreated in the mobile application as well. Android studio is the IDE that we used to build the application and it contains emulators to test the application on virtual mobile devices on PC.

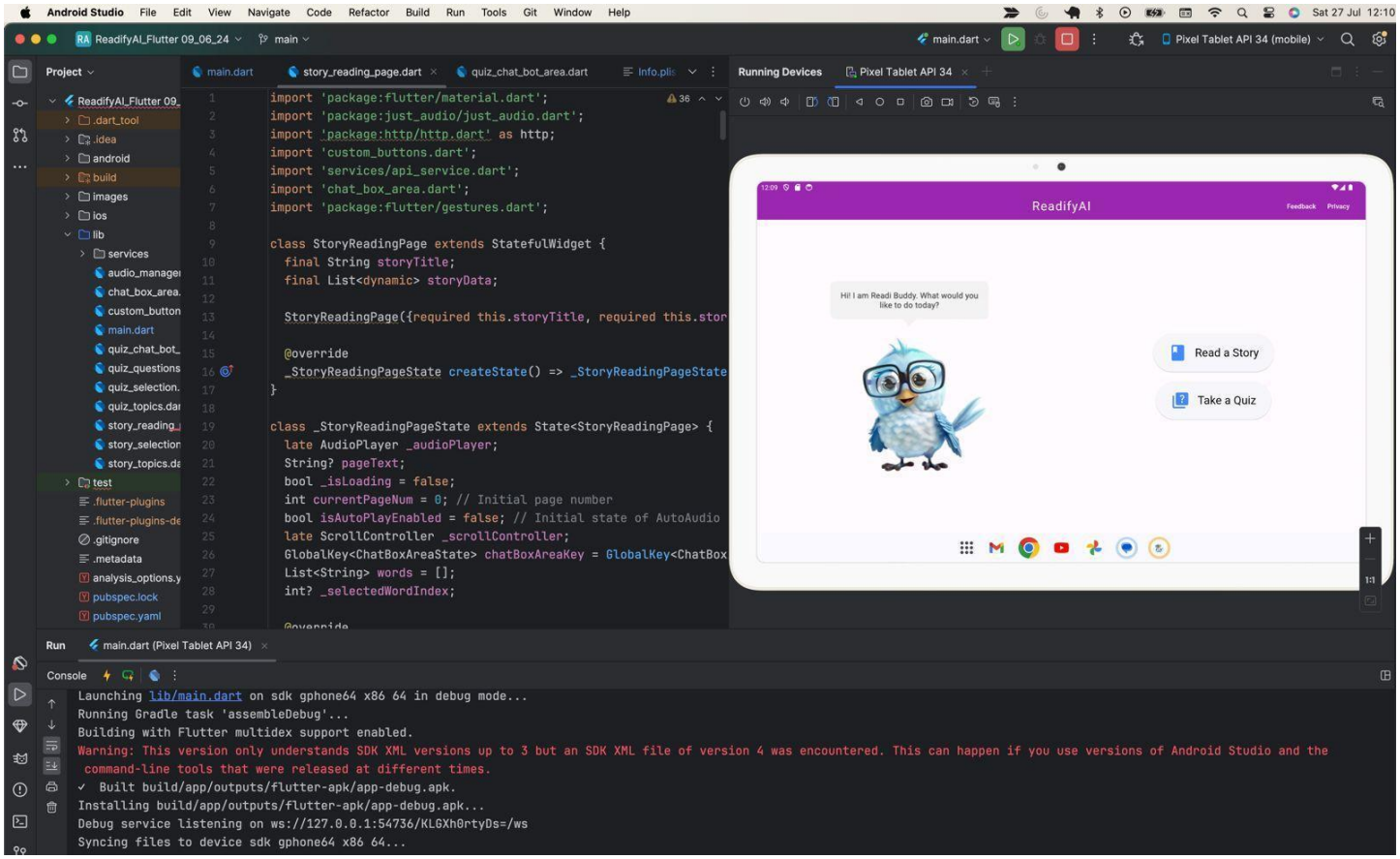

Fig 8: Flutter file structure, code and emulator in Android Studio

4.5 Backend Services (Server)

The backend services comprise various tools and technologies to achieve the target of building API's so that the frontend application has seamless connectivity with the AI service, database and the infrastructure. The development of these services was by far the most important and challenging part of the project as it is a bridge between user interface and complex technologies and this added layer of complexity simplifies technology for the average user and in this case, for children.

4.5.1 Python FastAPI Service

The primary backend service is built using the FastAPI framework for its high performance, ease of use, and efficient handling of asynchronous tasks. FastAPI is a modern web framework for building APIs with Python, known for its speed, ease of use, and automatic generation of interactive API documentation. It supports modern web practices with built-in request parsing, data validation, documentation, and security features. Combining FastAPI with Amazon EC2 brings added benefits like scalability, flexibility, reliability, high availability, enhanced security, and cost-effectiveness. Deploying the backend services within a Docker container on an EC2 instance secures the application environment and ensures consistent performance across development, testing, and production environments, highlighting a successful implementation and operation.

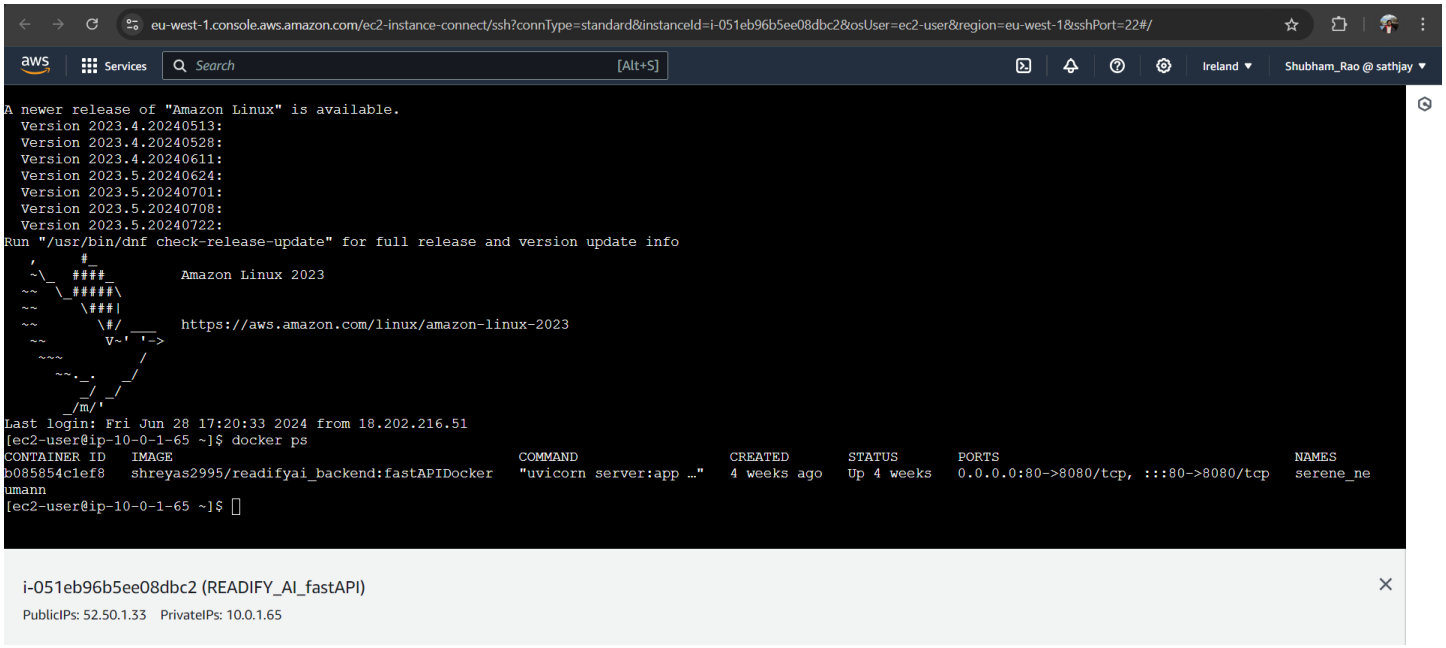

Fig 9: AWS EC2 instance running FastAPI service using docker container

4.5.2 Amazon Cognito

For managing user authentication and data security, the application uses Amazon Cognito, a service for handling user sign-up, sign-in, and access control. This integration ensures a secure and scalable user management system, supporting diverse needs. Amazon Cognito provides secure user authentication, protecting user data like course progress, quiz results, and personal settings with robust encryption. Its scalability allows the system to handle an increasing number of users without compromising performance or security. The Cognito dashboard simplifies user management, enabling administrators to manage user pools, configure sign-in options, and monitor activity easily. The integration has streamlined the user registration and login processes, making them user-friendly and secure, with positive feedback indicating high satisfaction and healthy engagement metrics.

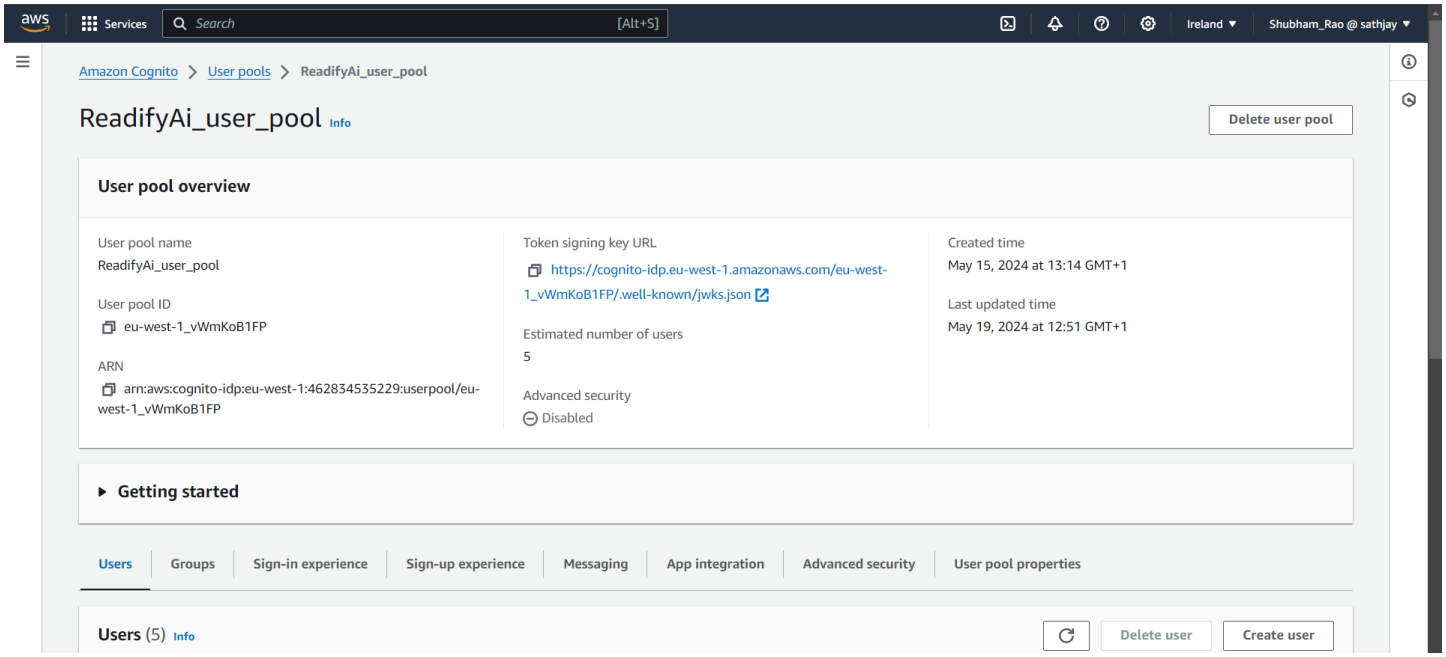

Fig 10: Amazon Cognito dashboard

4.5.3 Amazon S3 buckets

Amazon S3 was chosen for our application's storage due to its reliable security, high availability, low cost, ease of migration, and simplicity of management. S3 buckets are accessible only by the identity that created them, with IAM policies allowing detailed access control, preventing unauthorized data access. It provides access to a scalable, reliable, and fast data storage infrastructure, with S3 Standard offering 99.99% availability and Standard-IA 99.9%, both backed by strict service level agreements. Cost efficiency is another key benefit, as users only pay for the data used, with low prices of $0.022 per GB and $0.0125 per GB for infrequent access, and even lower costs with Amazon Glacier. Migration is straightforward with multiple options for data transfer and the ability to import/export data to any device or network. S3's user-friendly web interface simplifies security maintenance, storage optimization, data transfer management, lifecycle policy definition, replication rule configuration, and storage usage analysis (Blazeclan).

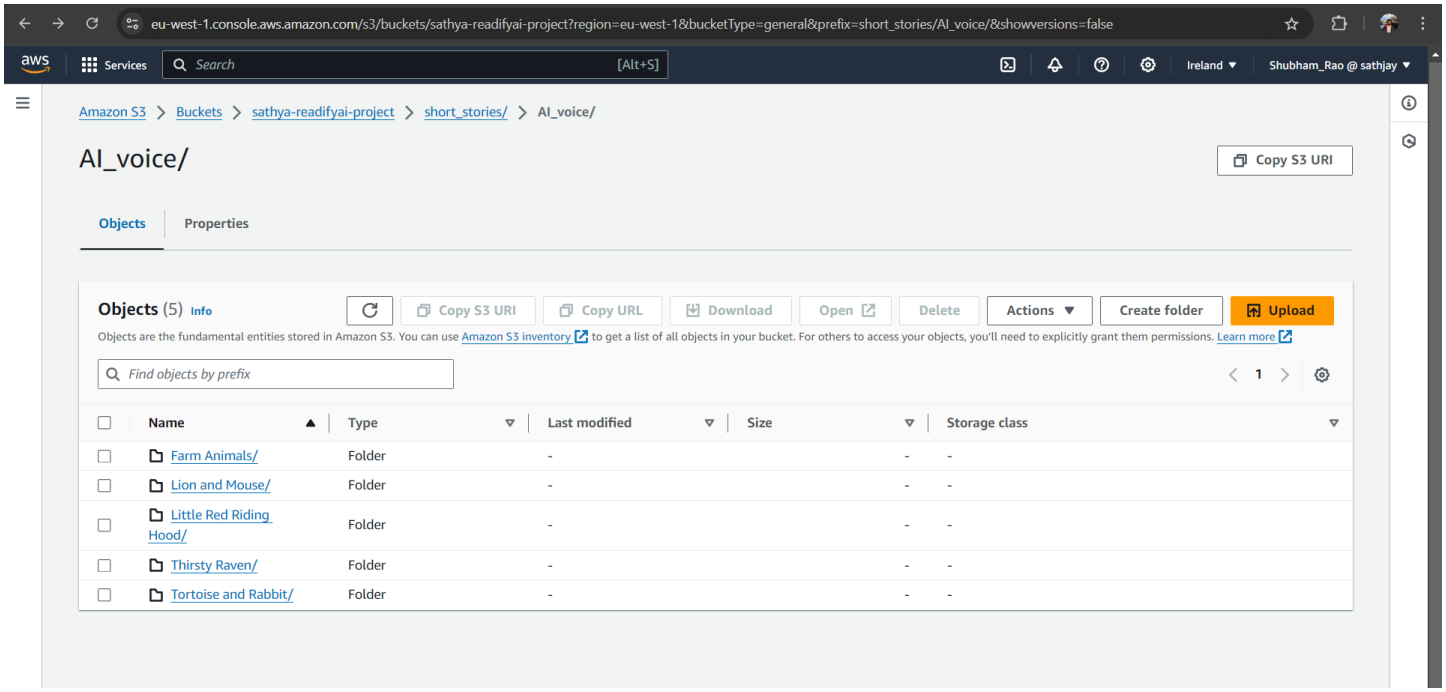

Fig 11: Amazon S3 bucket storing various audio files inside folders of separate short stories

4.6 Infrastructure

The application leverages a robust PostgreSQL database, deployed on Amazon EC2 instances using Docker containers. This setup provides a highly efficient, scalable, and secure environment for database management critical to supporting the application's data-intensive operations.

4.6.1 Rationale for Using PostgreSQL in Docker on Amazon EC2

- Flexibility and Portability: Running PostgreSQL within Docker containers on EC2 combines the benefits of containerization with robust cloud infrastructure. Docker provides a consistent environment for the database, ensuring that it runs the same way in development, testing, and production. This reduces conflicts between environments and simplifies deployment and scaling processes.
- Scalability and Performance: Amazon EC2 allows for dynamic scaling of resources to meet the demand of the application. This capability, paired with Docker's lightweight containerization technology, ensures that the database can handle varying loads with optimal performance.
- Security and Isolation: Docker containers encapsulate the PostgreSQL database, isolating it from other services. This isolation enhances security by limiting potential attack vectors. Amazon EC2 further secures the setup with network firewalls, encrypted storage, and compliance with global data security standards.

4.6.2 Implementation Details

- Amazon EC2 Instance: The EC2 instance runs the PostgreSQL database within a Docker container, as shown in the screenshot. This configuration allows for rapid provisioning and deployment, capitalizing on Docker's seamless ecosystem for managing container lifecycles.
- Docker Hub Repository: The PostgreSQL Docker image is maintained in a private repository on Docker Hub, ensuring that updates and patches to the database environment are centrally managed and consistently applied. The repository settings facilitate automated builds and updates, ensuring that the database environment remains up-to-date with the latest security patches and performance improvements.

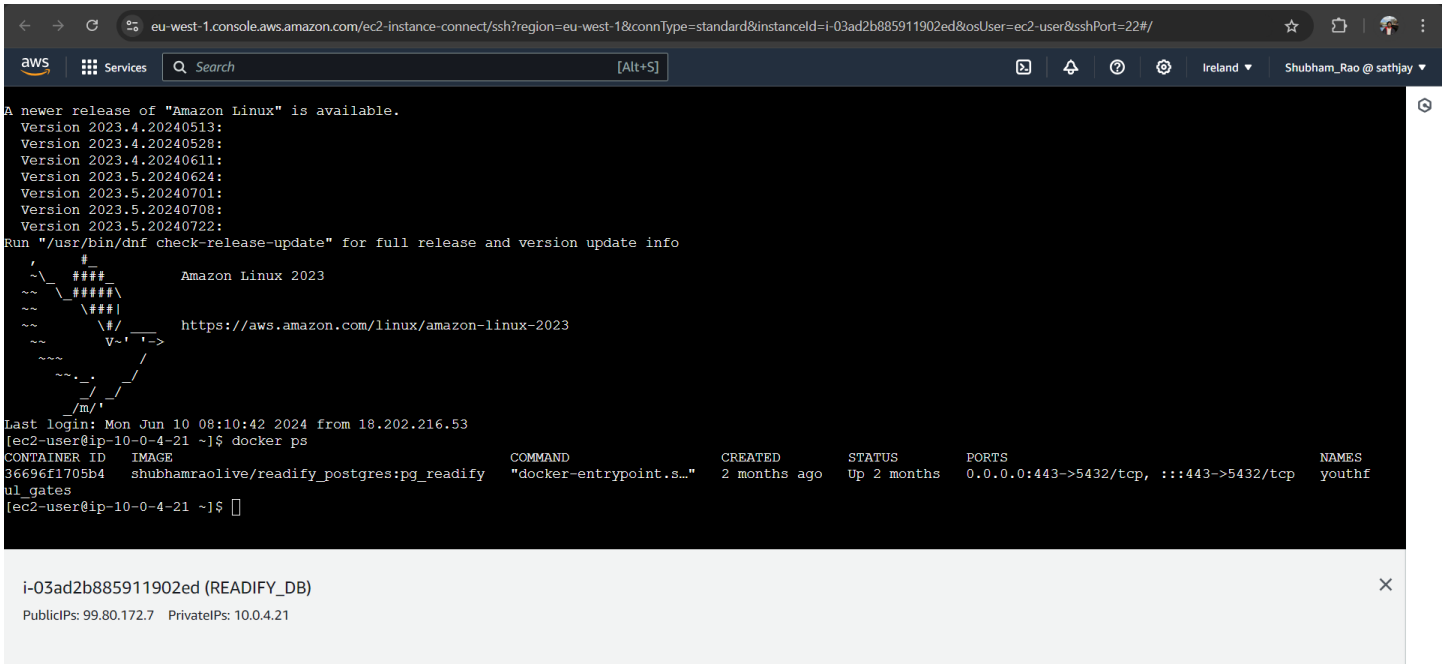

Fig 12: Amazon EC2 instance running Postgres DB using docker containers

4.6.3 Successful Deployment and Operation

The screenshots illustrate the operational status of the PostgreSQL database running on an EC2 instance, highlighting the successful deployment and integration within the infrastructure. This setup ensures that the application has a reliable and efficient data storage solution, critical for managing large volumes of educational content and user data.

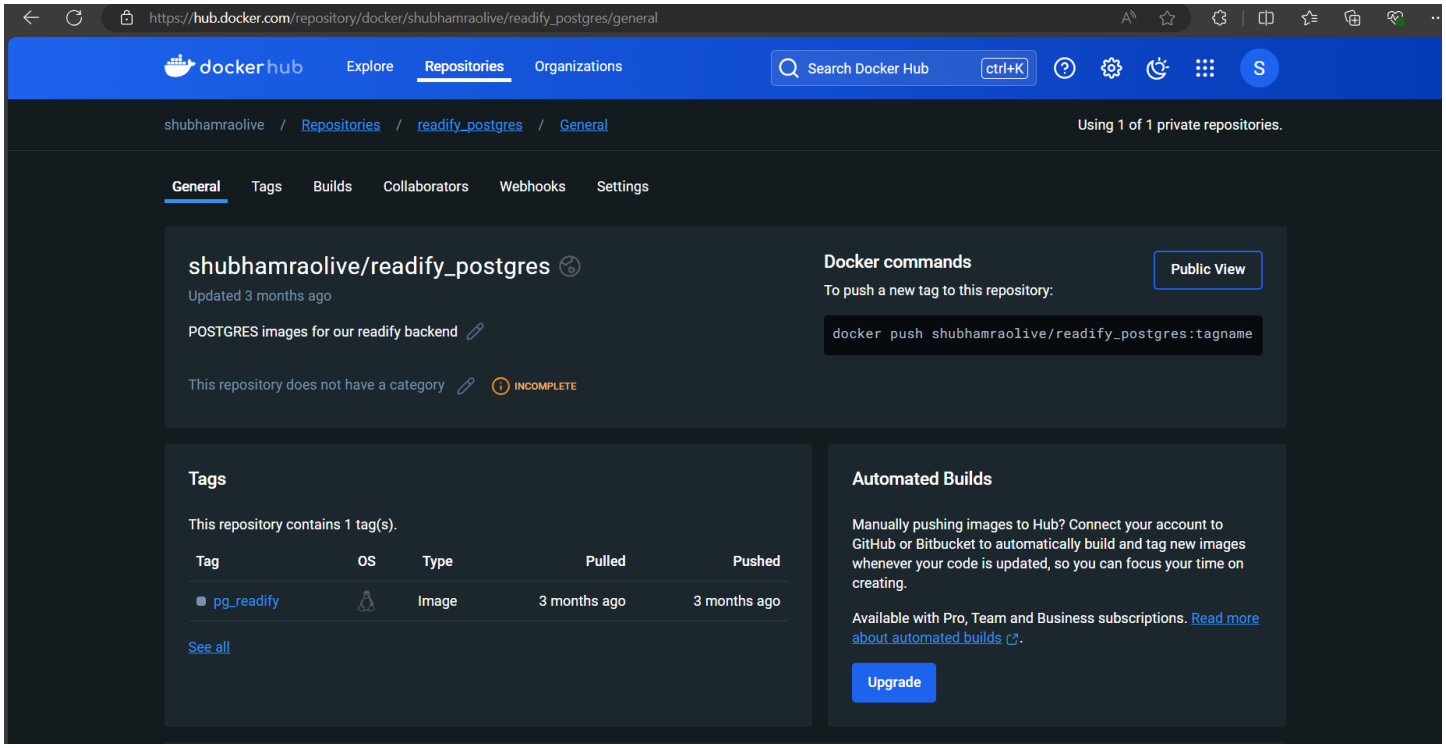

Fig 13: Postgres DB repository in Docker hub

4.7 More tools and technologies

Apart from the core technologies used to do the project, there are a lot of other tools that were really important for the success of this project and these are given in the table below.

Tool/Technology	Description
Amazon Cloud Front 	Amazon CloudFront is a fast content delivery network (CDN) service that securely delivers data, videos, applications, and APIs to customers globally with low latency and high transfer speeds. In the application, CloudFront is utilized to distribute static and dynamic content, such as educational videos and interactive content, from AWS edge locations to users. This reduces load times and improves the responsiveness of the application, enhancing the user experience significantly.
Amazon Route 53 	Amazon Route 53 is a scalable and highly available Domain Name System (DNS) web service. It is used to route end users to Internet applications by translating names like www.example.com into the numeric IP addresses like 192.0.2.1 that computers use to connect to each other. Route 53 effectively connects user requests to infrastructure running in AWS, such as EC2 instances, and can also be used to route users to infrastructure outside of AWS.
Github 	GitHub is a development platform inspired by the way you work. From open source to business, you can host and review code, manage projects, and build software alongside millions of other developers. For, GitHub is used for source code management, allowing multiple developers to collaborate, track all changes, and revert to previous states of the project whenever necessary. It also integrates with tools like AWS for seamless

	deployment and version control.
Bootstrap 	Bootstrap is a free and open-source CSS framework directed at responsive, mobile-first front-end web development. It contains CSS- and JavaScript-based design templates for typography, forms, buttons, navigation, and other interface components. In the project, Bootstrap is employed to develop responsive and mobile-first pages that render effectively on devices of all sizes, ensuring that the application is accessible and aesthetically pleasing across all platforms.

Table 2: More tools and technologies used

Chapter 5 - Project Outcome and Applications

5.1 Readifyai.io - A learning app that generates images using LLMs and audio using AI services

The "ReadifyAI" application, successfully developed and deployed on dual platforms, provides an enriching interactive and dynamic learning environment for children. This solution is accessible on both web and mobile platforms, incorporating a variety of educational tools designed to foster an engaging learning experience. The following text will explore the various features that the applications have which achieves this capstone's purposes.

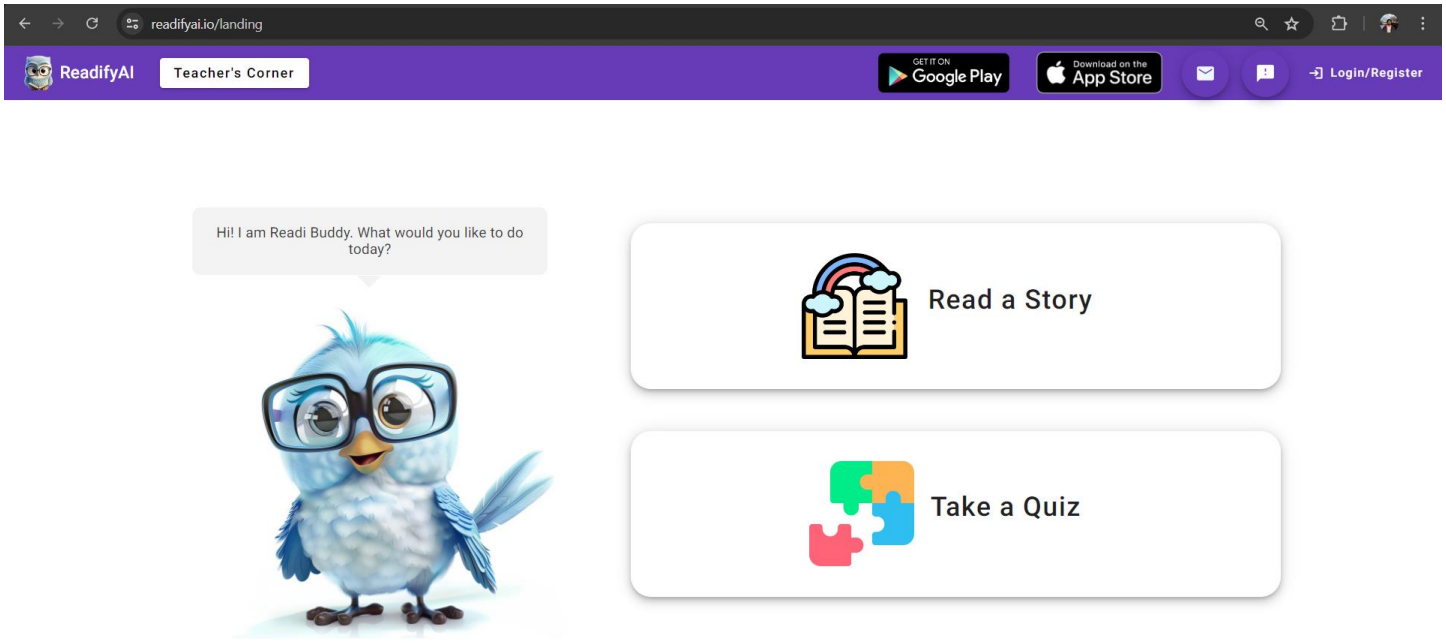

Fig 14: ReadifyAI Landing Page

5.1.1 Interactive Storybooks and Quizzes

"ReadifyAI" offers a diverse range of interactive storybooks, each enriched with vivid illustrations and interactive elements to captivate young readers. Accompanying these storybooks are quizzes that test comprehension and reinforce the material covered, enhancing critical thinking and retention skills.

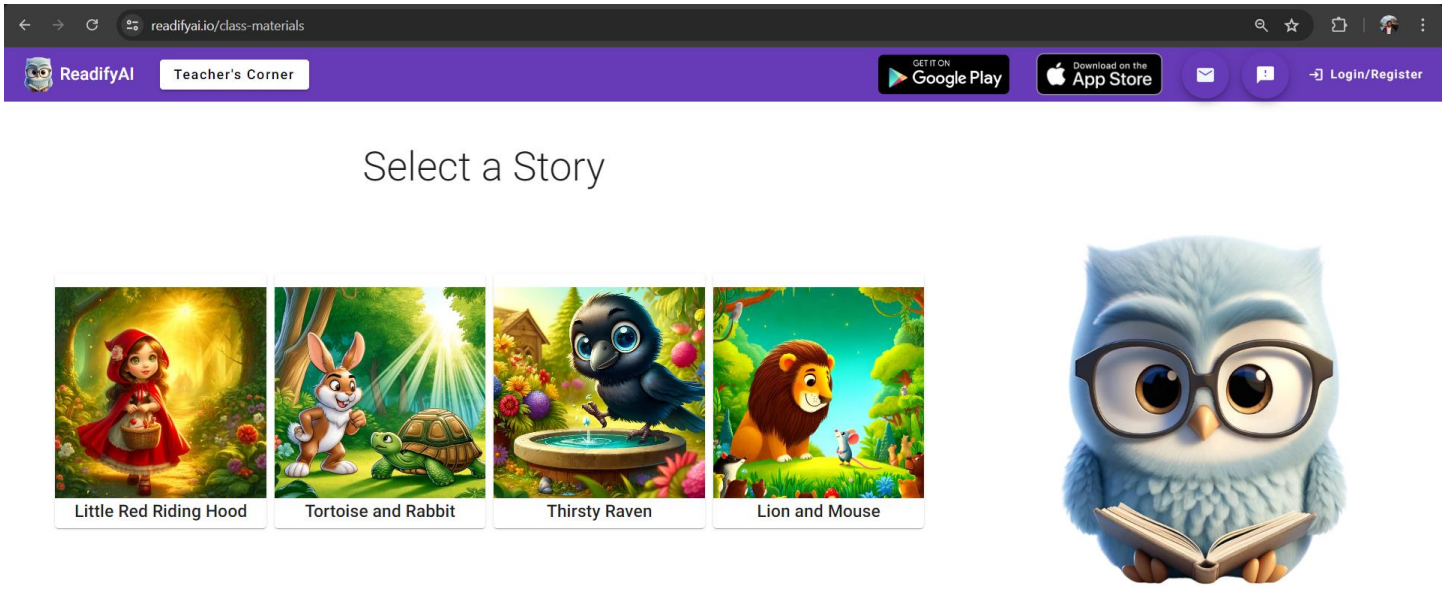

Fig 15: ReadifyAI Story Selection Page

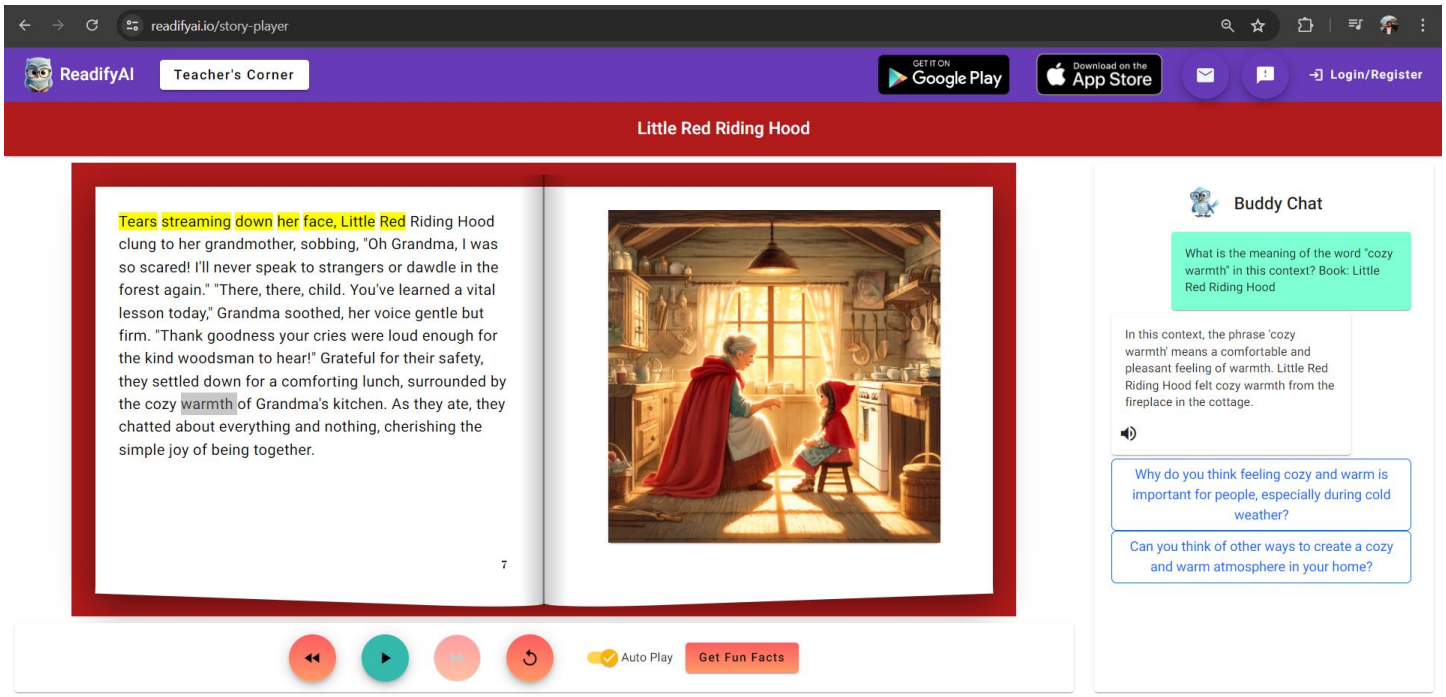

Fig 16: ReadifyAI Story Player

5.1.2 Customizable Learning Experience

The application allows educators and parents to tailor the quizzes and learning materials to fit the child's educational pace and preferences. This customizable approach is facilitated by an intuitive user interface, ensuring that the learning experience is always optimally aligned with each child's unique educational needs.

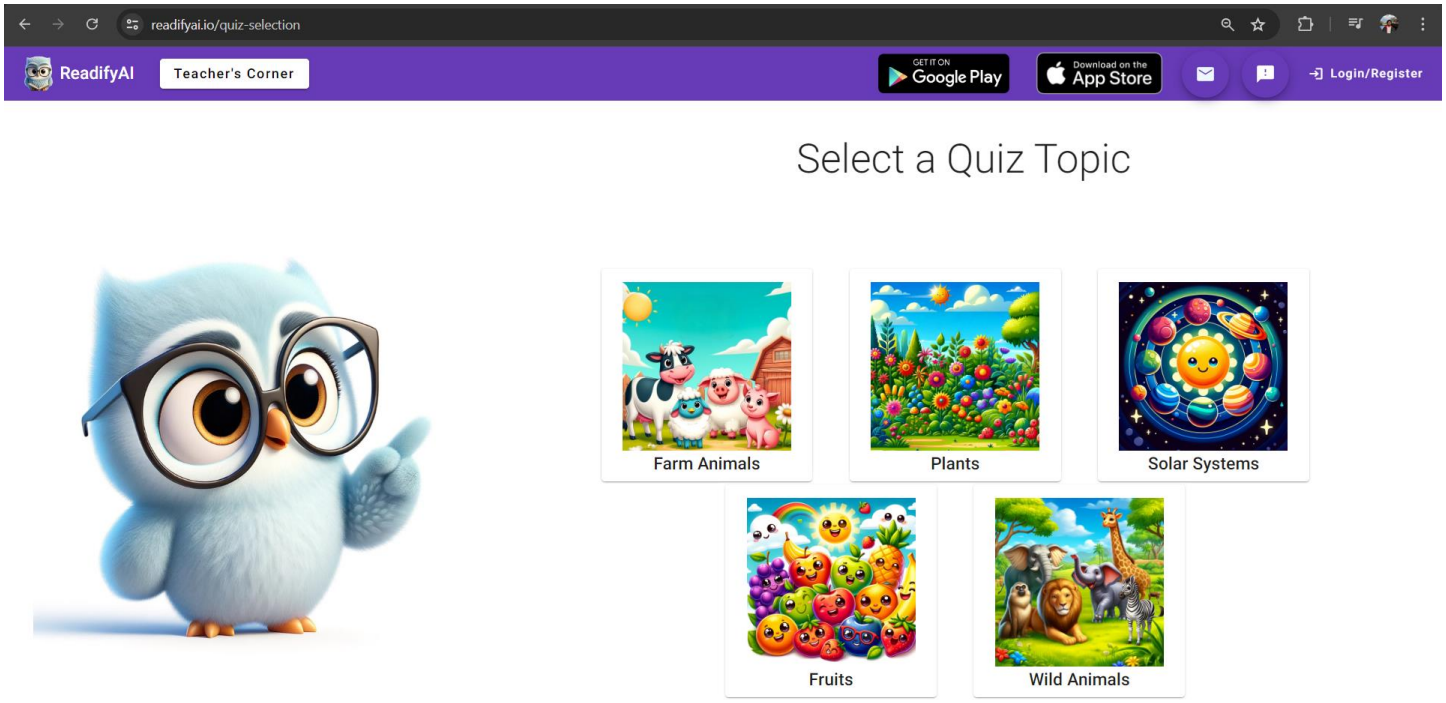

Fig 17: ReadifyAI Quiz Selection Page

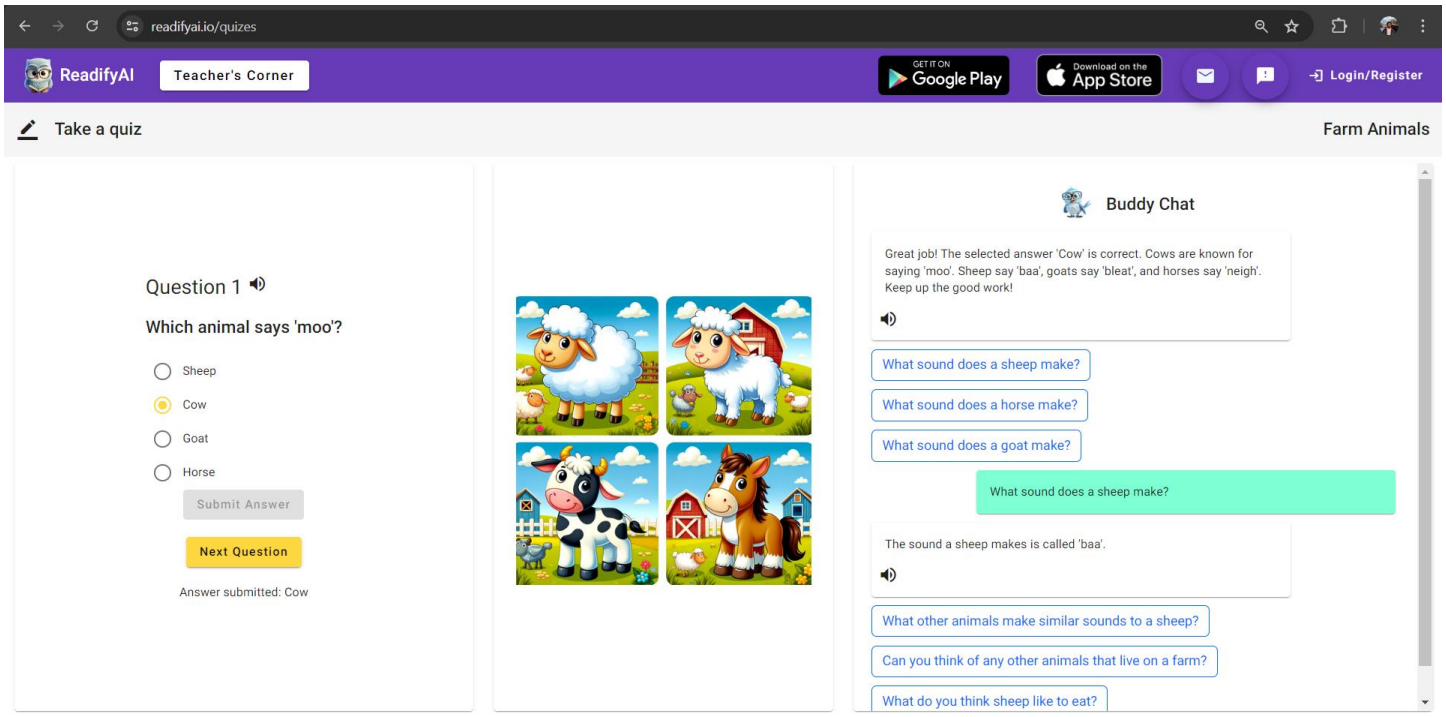

Fig 18: ReadifyAI Quiz Page

5.1.3 Engaging User Interface

Designed to be child-friendly and appealing, the application's user interface features colourful graphics and interactive elements. Features such as "Buddy Chat" engage children in a conversational manner, turning learning into a fun and interactive activity.

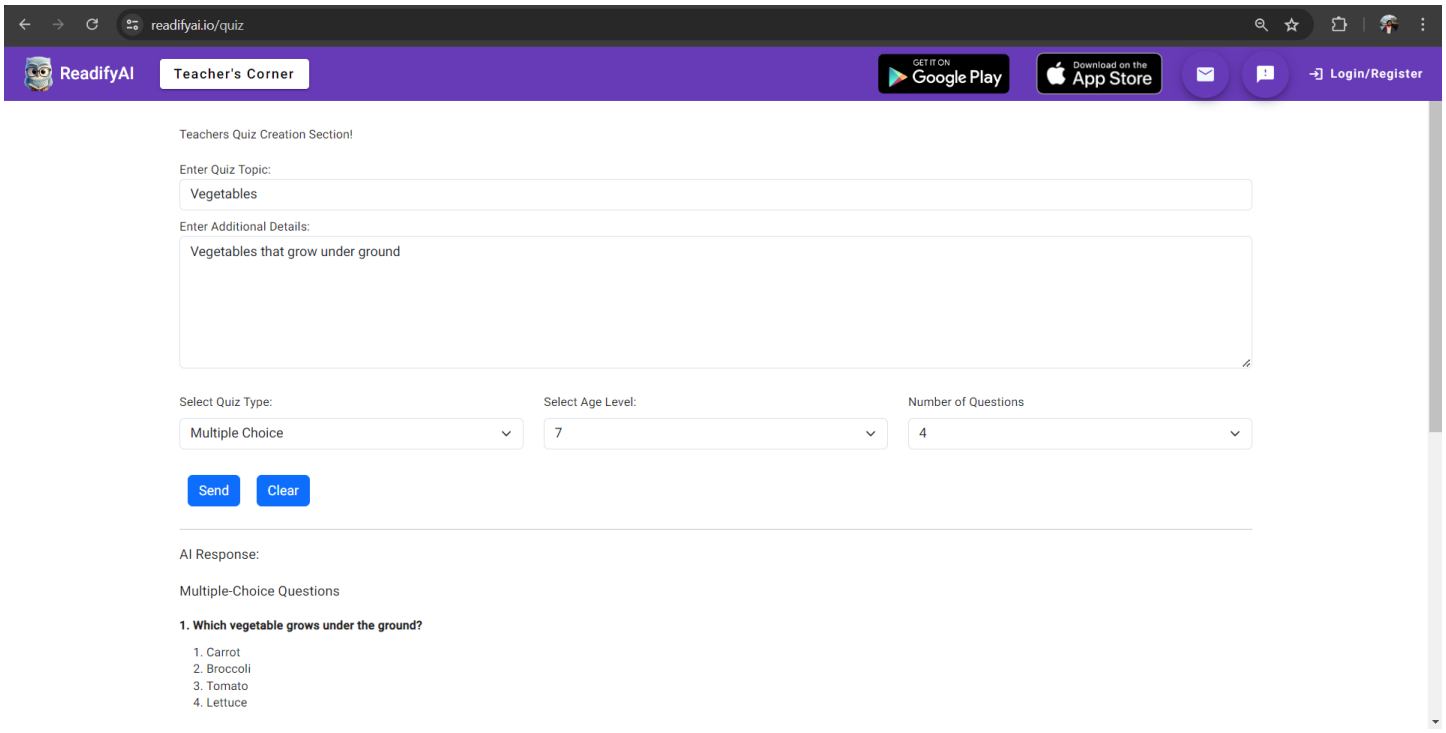

Fig 19: ReadifyAI Quiz Creator

5.1.4 Analytics Dashboard

Our application offers comprehensive trend analyses, as illustrated in the line and bar charts. This data is instrumental in identifying subjects and topics where students may excel or need additional focus, enabling targeted educational interventions.

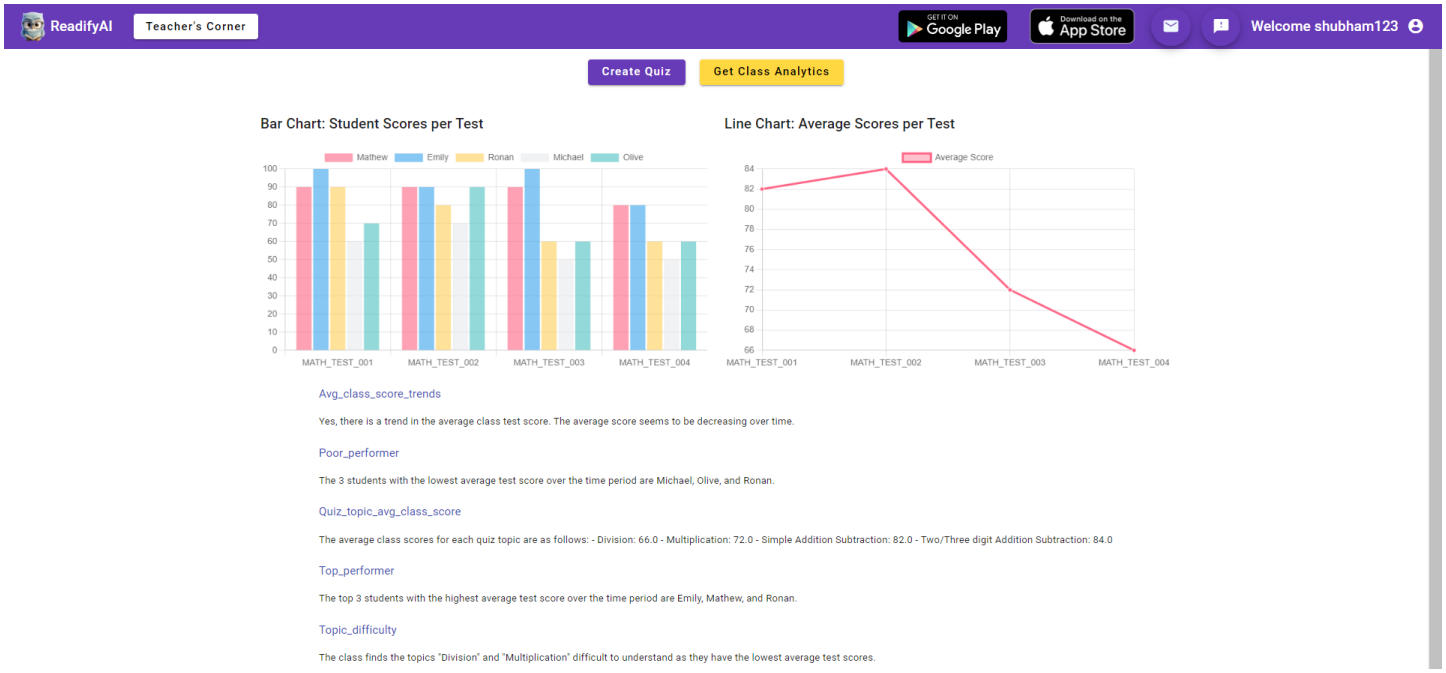

Fig 20: ReadifyAI Analytics Dashboard

5.1.5 Deployment Success and Reach:

Since its launch, "ReadifyAI" has been actively downloaded and used across various regions, including India, Ireland, the United Kingdom, and the United States. The decision to deploy the application on popular app stores significantly contributed to its accessibility and increased its reach, allowing users from different parts of the world to easily download and interact with the app. Analytics data reflect a strong engagement rate and user retention, demonstrating the application's effectiveness and broad appeal. This success in the app stores underscores "ReadifyAI's" ability to meet the educational needs of a diverse user base, enhancing the learning experience for children globally.

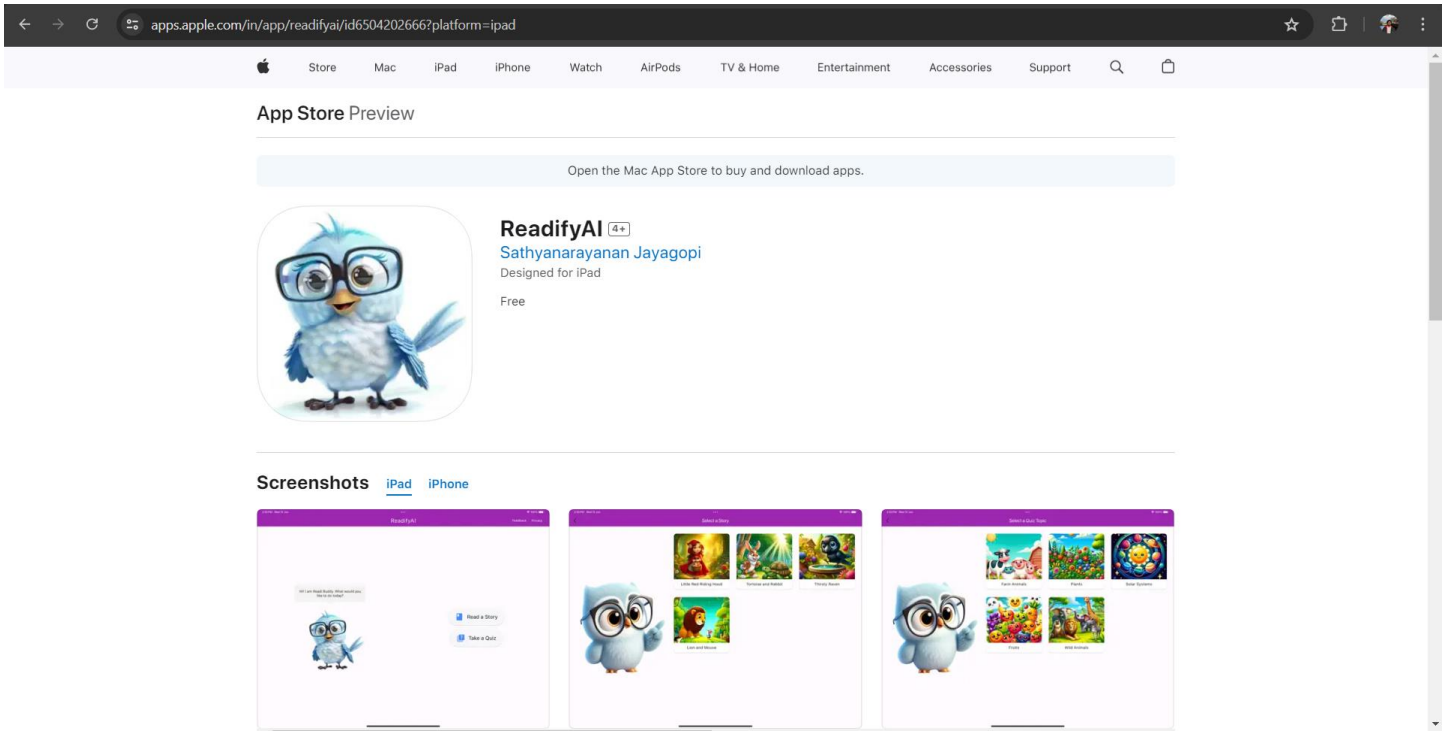

Fig 21: App store page for ReadifyAI

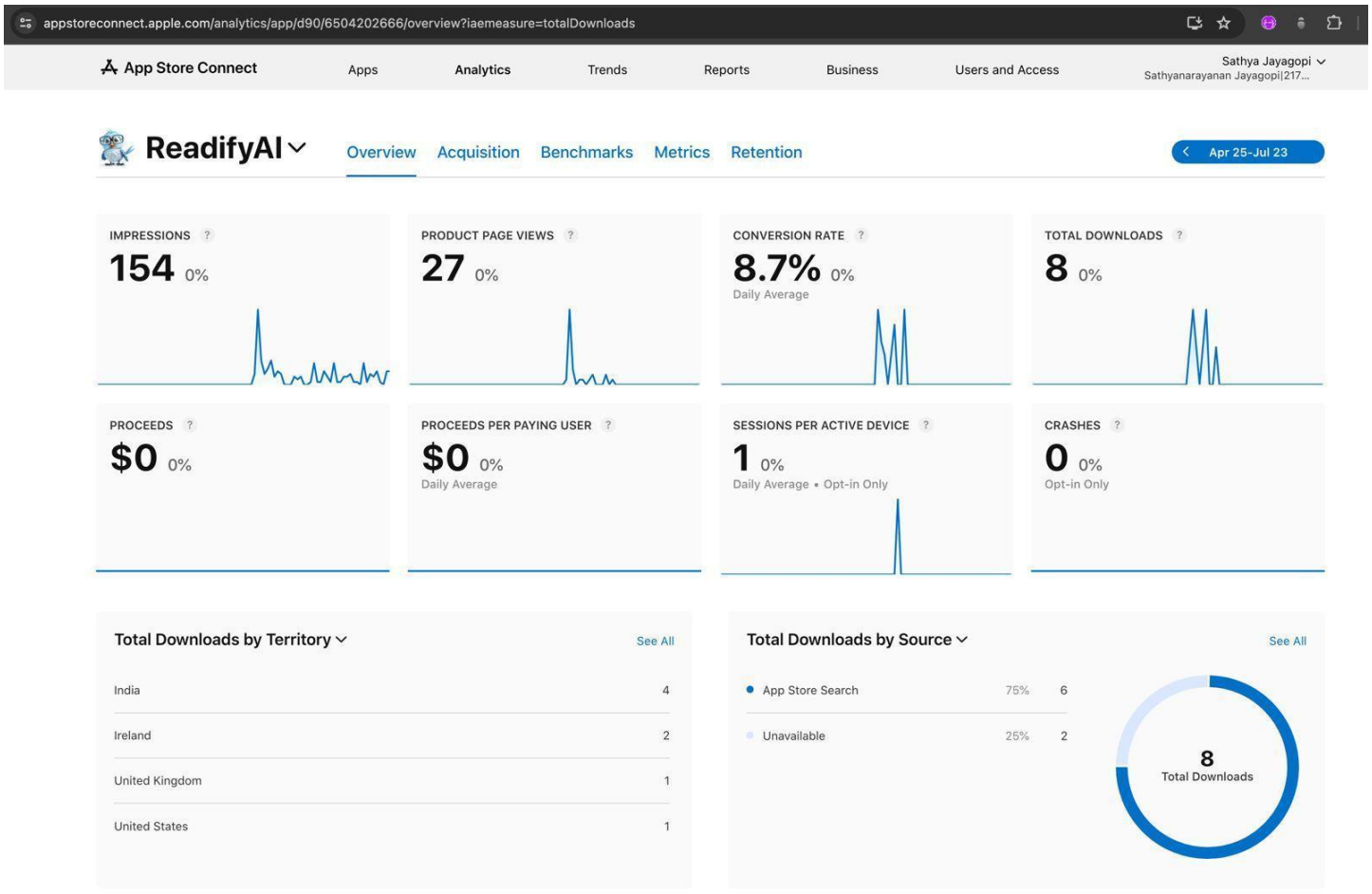

Fig 22: App store analytics for ReadifyAI

5.2 Content Filter Process:

The content filtering mechanism within "ReadifyAI" is a critical component designed to ensure the safety and appropriateness of the content delivered to users. The system is illustrated through the following technical architecture:

- **Client Interaction**: The client interfaces, built with Angular for a rich interactive experience, communicate user requests to the server.
- **Server Processing**: Backend operations are handled by Python FastAPI, ensuring efficient and scalable request handling.
- **Content Safety Check**:
    - The content generated by ChatGPT is first processed through a safety check that uses Text Blob for profanity filtering, ensuring all content is age-appropriate.
    - If the content is flagged as not safe, it undergoes prompt engineering to modify the input until the output is deemed safe for children.
- **AWS Hosting**: The entire backend, along with the content filtering logic, is hosted on AWS, providing reliable and scalable cloud services to manage user data and application logic effectively.

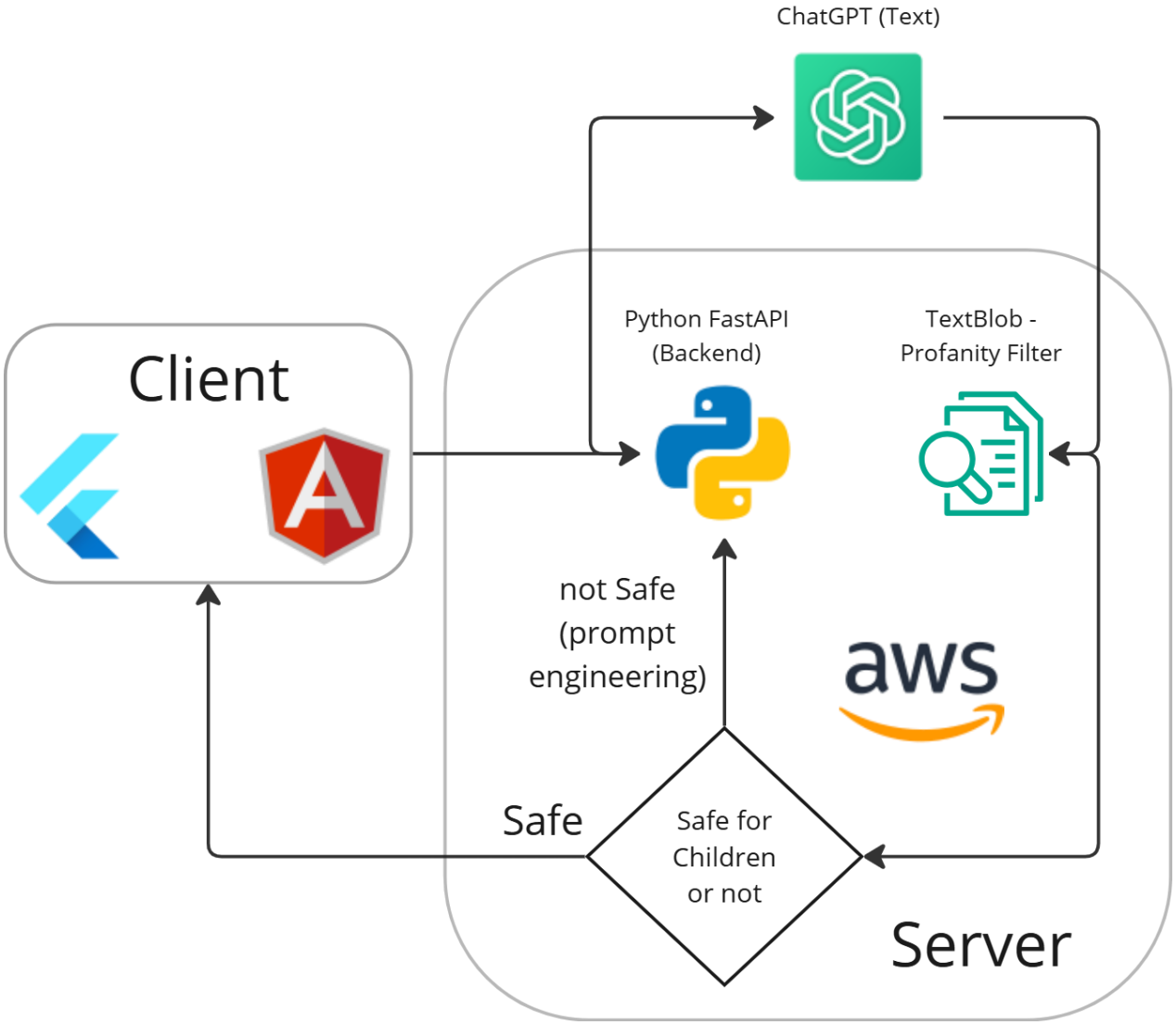

Fig 23: Process diagram for content filter

This architecture not only supports real-time content generation and filtering but also ensures that the educational material provided through "ReadifyAI" meets the highest standards of safety and educational value.

5.3 Feedback from Parents and Teachers:

Following the launch of our app, we conducted an anonymous survey to gather feedback from parents and teachers regarding the app's usefulness and the features they found most valuable. This survey was essential in understanding the app's impact on its target audience and identifying areas for improvement. The feedback process involved both qualitative and quantitative responses, ensuring a comprehensive evaluation of the app's effectiveness.

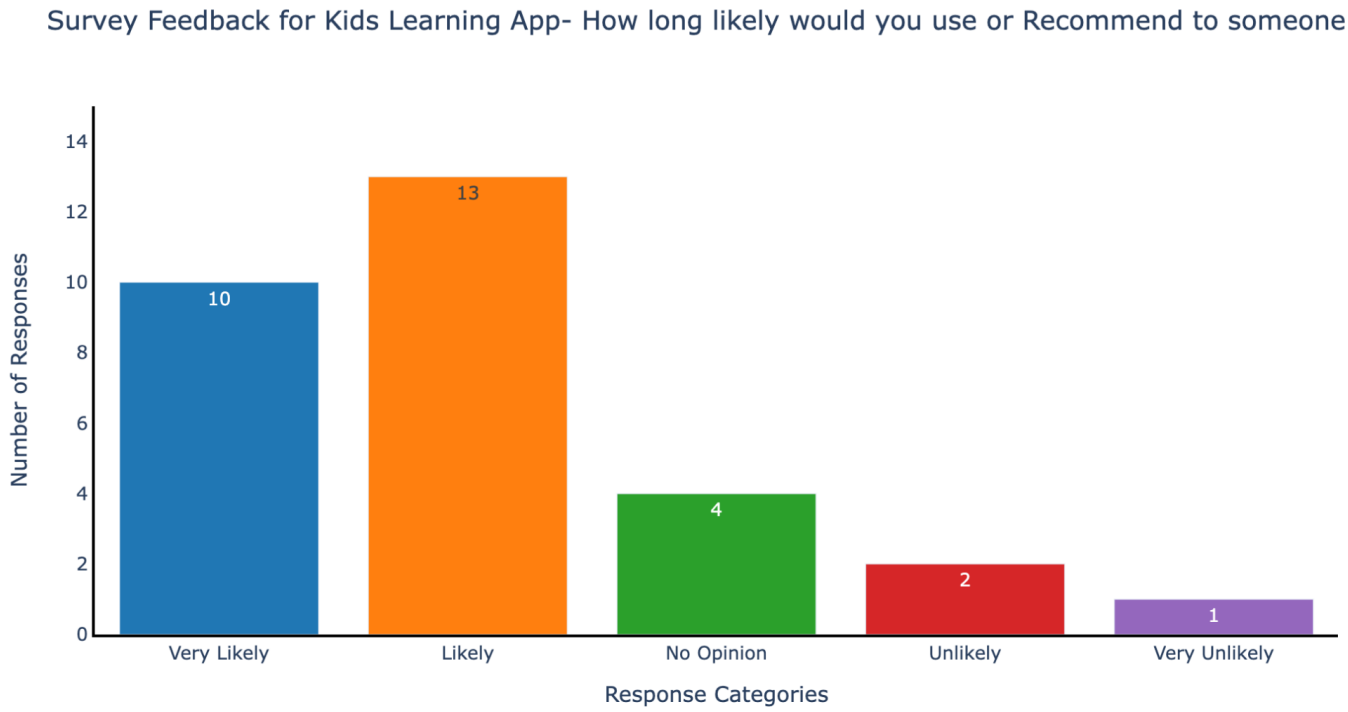

Fig 24: Survey Response for How long likely would you use the app or recommend to someone

The survey question response indicated a generally positive reception of the app. A significant portion of respondents, 13 in total, stated that they were "Likely" to continue using or recommending the app, while 10 respondents indicated that they were "Very Likely" to do so. These findings reflect a strong endorsement of the app's educational value and usability.

However, there were also a few respondents who expressed hesitancy. Specifically, 2 respondents selected "Unlikely" and 1 chose "Very Unlikely." Upon further inquiry, it was found that their reluctance stemmed from a belief that children should not be exposed to electronic devices at a young age, even in an educational context. This highlights the ongoing debate among parents and educators regarding the appropriate use of digital tools in early childhood education.

Notable Review Comments:

SNo.	Reviewer	Comments
1.	Dr. Patrick Burke (Phd Education)	“Really interesting application has huge potential to be used to improve educational curriculum in Ireland”
2.	Parent of a child with Down Syndrome	“Can be really helpful to help children with down syndrome to help with their pronunciation (audio)”
3.	After School teacher	“Kids have a short span of attention and this application has the potential to keep then engaged in learning activities”

Table 3: Reviews from parents and teachers for ReadifyAI App

Chapter 6 - Conclusion and Recommendations

In conclusion, the development and implementation of our proof-of-concept application demonstrated the significant potential of leveraging Generative AI (Gen AI) and Large Language Models (LLM) for early childhood education. Through the realization of our four primary objectives, we created an engaging, interactive, and educational platform that enhances children's learning experiences.

Objective 1: Proof of Concept

Our first objective was successfully achieved by developing a web and mobile application that reads books to children, provides fun facts related to the content, and supports these features with audio. The application also allows children to click or press on unfamiliar words to receive meanings and audio explanations, creating a comprehensive learning tool that is both engaging and educational.

Objective 2: Ensuring Content Safety for Text

We implemented a robust content filtration system to ensure that the text generated by LLM is appropriate and safe for children. This system's effectiveness was continuously monitored and refined through regular audits and feedback from users and educational experts, ensuring a secure learning environment for all users.

Objective 3: Track Kids' Learning/Quiz Performance

The development of a tool that allows parents and teachers to create customizable quizzes and track children's learning progress was another key achievement. This feature provides personalized learning experiences and detailed performance metrics, supporting the continuous development of children's skills and knowledge.

Objective 4: Gather Feedback from Parents and Teachers

To ensure the app's relevance and effectiveness, we conducted an anonymous survey to gather feedback from parents and teachers after the app's launch. The feedback focused on the app's usefulness, ease of use, and the features that were most appreciated. Overall, the majority of respondents expressed strong approval of the app, with many indicating that they would likely continue using it or recommend it to others. However, a small number of respondents were hesitant about children using electronic devices at a young age, highlighting the need to balance technological innovation with appropriate age-related considerations. This feedback has been invaluable in guiding future enhancements of the app to better meet the needs of its users.

Recommendations:

1) Government and Educational Department Involvement: Encourage government departments of education to adopt and adapt similar applications to include content that fits the curriculum for children's education. Empowering teachers with such tools can enable them to provide personalized learning experiences, allowing them to focus more on the teaching aspect rather than on grading and lesson planning. By integrating these

technologies into the education system, we can significantly enhance the learning experience and effectiveness for young students.

2) Support for Speech Pathology: Explore the potential of the application to assist children with speech pathology issues. Incorporating features where the AI listens to children reading aloud and provides feedback on pronunciation can help improve their speaking skills. This functionality can be especially beneficial for children who require additional support in developing their speech and language abilities.

3) Expand Content Safety Measures: Continue enhancing the content filtration system, particularly for visual content generated by AI, to ensure all forms of generated content are appropriate and safe for children.

4) Gamification and AI Integration: Leverage gamification techniques along with Gen AI/LLM to make the learning process more engaging and effective. Integrating educational games that adapt to the child's learning pace and preferences can enhance motivation and retention. Gamified elements such as rewards, levels, and interactive challenges can create a more immersive and enjoyable learning experience, thereby improving educational outcomes.

5) Enhance Personalization: Incorporate more advanced AI techniques like creating AI agents with memory to further personalize learning experiences, adapting content to individual learning paces and preferences.

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List of Contributors

David Horgan - As a mentor and project sponsor, David played a crucial role in directing the focus and refining the objectives of this project. He provided essential guidance on identifying and addressing the core problems we needed to solve. His expertise was invaluable in mentoring the team on how to effectively pitch the project at the NOVA UCD startup event and during our final presentation.

For more information about David Horgan's professional background and contributions to the field, visit his LinkedIn profile: https://www.linkedin.com/in/dhorgan/

Dr. Patrick Burke - Dr. Burke played a pivotal role in guiding the literature review process for our project, identifying key research areas that align with our problem statement. His expertise in educational methodologies provided invaluable insights into what educators specifically look for in teaching tools and support systems for young learners. Furthermore, Dr. Burke contributed significantly by highlighting current gaps in learning competencies among new students, advising our team on critical areas to focus on. His contributions were essential in shaping the direction and scope of our educational platform, ensuring it meets the real-world needs of teachers and students alike.

For more information about Dr. Patrick Burke's professional background and contributions to the field, visit his LinkedIn profile: https://www.linkedin.com/in/patrick-burke-55081220/

Mark Connor - As our project supervisor, Mark Connor was instrumental in overseeing the progression of our project. He provided continuous reviews and refinements, ensuring that each phase of our development met high standards of quality and relevance. He offered comprehensive overviews and practical insights into the application of these technologies within our project, enhancing our understanding and implementation of these advanced tools. His guidance was vital in navigating the complexities of integrating AI into educational settings, ensuring our project remained innovative and effective.