iTeachU: AI-Driven Tutor Matching with Geolocation and Personalised Analysis

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ABSTRACT

iTeachU mobile application is one of the applications developed to address the increasing number of requests for individual tutor matching in Malaysia, specifically in the Melaka region. The system will incorporate users' preferences and serve as a simplification tool to identify appropriate tutors based on preferences, as well as gender, subject, tutoring mode, and location. The application implements a hybrid recommendation strategy that combines content-based filtering and the K-Nearest Neighbours (KNN) algorithm, and is boosted by Haversine-based geofencing to find nearby tutors. In concurrence with conventional systems, iTeachU will also rank tutors according to a calculated Best Match and Distance Score, favouring classification based on their attributes rather than just the distance between tutors. The application has been created with Flutter on the front end and a Python (Flask) backend. Registration and preferences are to be saved in Firebase, and tutor details are to be stored in CSV files. Functional and usability tests showed that the app was very stable and user-friendly, and that it makes accurate recommendations by displaying the top matches. The iTeachU application shows what smart, location-based solutions can do to better integrate mobile support into the promotion of personalised educational assistance.

Keywords: iTeachU, Mobile Application, Tutor Identification, Content-based Filtering, K-Nearest Neighbours (KNN)

INTRODUCTION

Malaysia's educational environment nowadays has changed since people have become more aware of the limits of the traditional school system. Many students believe that traditional education alone is insufficient to meet their academic demands. (K, Koon, and Annamalai, 2019). As a result, students tend to rely on private tutoring to improve their academic performance and achieve academic success. This trend is common nowadays, especially among student parents who strive to improve their children's academic performance by paying a lot for private tutoring services.

The phenomenon of “shadow tutoring” is the practice of students receiving private tutoring outside of school. This occurs because peer pressure and parental expectations encourage students to seek additional academic help (Guill, et al., 2020 and Hultberg, et al., 2021). Peer pressure and family expectations are key drivers of children seeking private tutoring. According to (Šťastný, 2021), private tutoring not only serves as an additional educational resource but also helps fill the knowledge and skill gaps students face in regular classroom settings.

The high demand for private tutoring has risen, leading to perceived shortcomings in the formal education system. This has been shown as substantiation of the claim that large class sizes and a lack of personalised attention impede successful learning. Therefore, student parents frequently seek out private tutors who can provide specialised assistance to their children with specific academic requirements, and finding skilled tutors who meet these qualifications can be difficult, which takes longer and can cause irritation for both students and parents. Personalised education solutions have highlighted issues associated with tutor expertise mismatches, the difficulty of finding local tutors for physical or face-to-face sessions, and the need for personalisation choices regarding tutor gender (Tan & Sheng-Hung, 2020).

One of the main factors contributing to this difficulty is the lack of trained tutors or educators in each geographical location. Studies have found that students tend to struggle to find a qualified or skilled tutor who meets their individual needs and preferences, which may hinder their academic progress (Abu-Shawish, 2023). These variables lead to a subpar tutoring experience, which can negatively impact academic success and student pleasure. Therefore, each of these challenges will enable the project to design an application that assists students in addressing their problems.

This project aims to help students efficiently and flexibly match with tutors to meet their academic needs. Regardless of students' locations across the Melaka area, these mobile apps allow them to identify and connect with qualified tutors with a few simple taps. Consequently, for those with limited educational resources nearby, this app will be valuable, as this aspect is important for students seeking quick, easy access to academic support, especially in rural areas. This feature is crucial in eliminating geographical barriers, allowing students to access excellent tutoring services wherever they live.

With this app, students have easy access to quality tutors. They can choose their preferred tutoring format: face-to-face, which is interactive, or online, which is more convenient for remote learning. The app's impact is particularly beneficial for students from diverse backgrounds, including those in disadvantaged areas, as it enables them to interact with experienced tutors and improve their learning outcomes.

LITERATURE REVIEW

Introduction to Tutoring

Tutoring has grown significantly in recent years, especially as the world faces the COVID-19 pandemic, which has been used as a response or as an easy alternative to this challenge. COVID-19, caused by the SARS-CoV-2 virus infections, emerged in late 2019 and was recognised as a pandemic by the World Health Organisation on March 11, 2020. It mainly appears as an acute respiratory disease with fever, cough, and dyspnoea. However, the condition creates various gastrointestinal symptoms, neurological difficulties, and long-term sequelae known as "long COVID" in a large proportion of people. This echoes findings across regions, highlighting that social distancing measures, while necessary for managing the pandemic, are sometimes difficult to adhere to due to socio-cultural obstacles. (Zakar, Yousaf, Zakar, & Fischer, 2020).

Therefore, to meet students' diverse needs, adapting tutoring practices to hybrid and online learning environments is required. According to a study by Corzo-Zavalet et al., (2023), it is important to address students' academic orientation needs through individual tutoring, especially during the pandemic, when hybrid learning models are implemented to facilitate educational continuity. This transition emphasises the importance of tutors being equipped with practical strategies to support students both online and physically.

The most effective way to improve academic achievement is through peer mentoring. Peer mentoring can improve tutors' academic skills. It is structured not only to benefit students but also to create a mutually beneficial learning environment (Verdun et al., 2022). The positive impact of peer mentoring on student learning outcomes is especially evident in complex subjects such as science and mathematics. The reciprocal nature of peer mentoring fosters a collaborative learning atmosphere that can significantly increase student engagement and understanding.

Moreover, individualising instructional practices is essential to meet students' unique learning needs. According to Sylenko (2023), professional training of prospective teachers in Ukraine identified the need to integrate instructional technology into the educational framework to enhance the effectiveness of instructional interventions. This individualised approach is further supported by the work of Abdulkarim et al., who showed that reciprocal peer tutoring strategies can lead to significant improvements in student performance in mathematics (Abdulkarim et al, 2022). Such findings highlight the need for educators to adopt flexible instructional strategies that can be tailored to students' specific contexts and challenges.

Current Online Tutoring Platforms in Malaysia

Nowadays, online tutoring services, which mainly use web-based interfaces and mobile applications, have entirely changed how students seek academic assistance. These platforms, however, frequently have distinct features and limitations that impact their effectiveness, especially for Malaysian students.

Popular online tutoring platforms in Malaysia, such as MyPrivateTutor, TutorKami, Tutoriku, and Superprof, provide features including flexible learning options (online and in-person), access to a wide range of certified tutors, and the ability to select by subject, location, and tutor gender. These systems have certain limitations, such as limited coverage in rural areas, non-optimised tutor-student matching, user-unfriendly interfaces, and the inability to support mobile apps for some users. With everything considered, there is still a need for more sophisticated, individualised, and location-aware tutoring programs that cater to the various requirements of Malaysian students.

Furthermore, many online tutoring platforms do not consider geolocation a critical factor in designing and providing their services. The lack of locally relevant information and context might impede learning in a multicultural nation like Malaysia, where regional educational discrepancies are common. While specific studies on Malaysian students are limited, it is widely recognised that students often struggle with content that does not reflect their cultural or educational context, which can affect their engagement and comprehension. The cultural relevance of educational materials plays a significant role in how students relate to the content being taught. Therefore, rather than promoting fair access to high-quality education, platforms that fail to address these issues may unintentionally widen the educational divide.

Overall Discussion on Related Algorithms

In personalised recommendation systems, the K-Nearest Neighbours (KNN) algorithm is one of the methods that have been repeatedly tested and shown to work well for selecting student-tutor pairs. This algorithm performs well in scenarios where user preferences, such as subject interest, tutor gender, mode of study (online or physical), and geographical proximity, are essential for providing appropriate, accurate recommendations. KNN, as compared to other algorithms, has the merit of being stronger in predictive accuracy, which makes it a particularly appealing option in this task

Content-based filtering can be combined with KNN to improve the recommendation process further. This approach considers patterns mined from user-item interactions and suggests recommendations based on the preferences of others whose profiles resemble the user's. Combined with KNN, the algorithm can consider not only each student's explicit likes, but also the likes of other students with comparable features who are proximate to them. This dual method enables a more complete understanding of user requirements, leading to improved matchmaking between students and tutors.

In the context of location-based systems, selecting an appropriate distance measure is critical for accurately calculating tutor proximity. While traditional distance measurements such as the Euclidean and Manhattan distances are commonly used, they may not be appropriate for geolocation tasks. The Haversine distance, which determines the shortest distance between two locations on the surface of a sphere, is more suitable for this purpose. This measure accounts for Earth's curvature, providing a more accurate representation of distances between students and tutors at different locations.

METHODOLOGY

Overview of Project Methodology

In developing the mobile application, the project will use the agile model due to its superior features. According to (Popoola et al., 2024), the Agile model is a flexible, evolving method for software development that emphasises iterative progress, close collaboration with customers, and adaptable planning. Agile software development derives its origin from the principles set forth by the Agile Manifesto that values highly the individuals and interactions over processes or tools, the functionality of the software over extensive documentation, the frequent involvement with the customer over formal contracts, and the ability to respond to changes over the ability to follow an unchangeable plan correctly.

This Agile methodology model encompasses an iterative development cycle with six primary stages: requirements, design, development, testing, deployment, and review. This approach promotes continuous adaptation and collaboration, facilitating ongoing enhancements throughout the software development process. Agile is especially beneficial for projects that demand flexibility and frequent feedback, making it well-suited

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to fast-paced domains like mobile or web application development. The following sections provide in-depth descriptions of each phase of the cycle. The agile methodology phases are shown in Figure 1 below. Even though there are six phases, only the requirements phase—design, development, and testing—has been applied in this project, as the final objectives were achieved in testing.

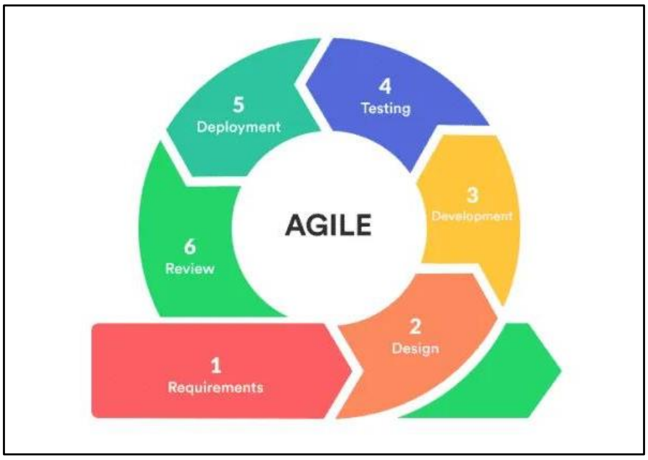

Fig1. Agile Methodology

SYSTEM DEVELOPMENT

Software Architecture

The term "software architecture" refers to the high-level structure of a software system, defining its components, interactions, and overall design. Its goal is to provide a framework for both system development and maintenance, providing scalability, performance, and maintainability while satisfying the project's functional and non-functional criteria. Effective software architecture helps manage complexity, facilitate collaboration, and ensure the system can adapt to future changes.

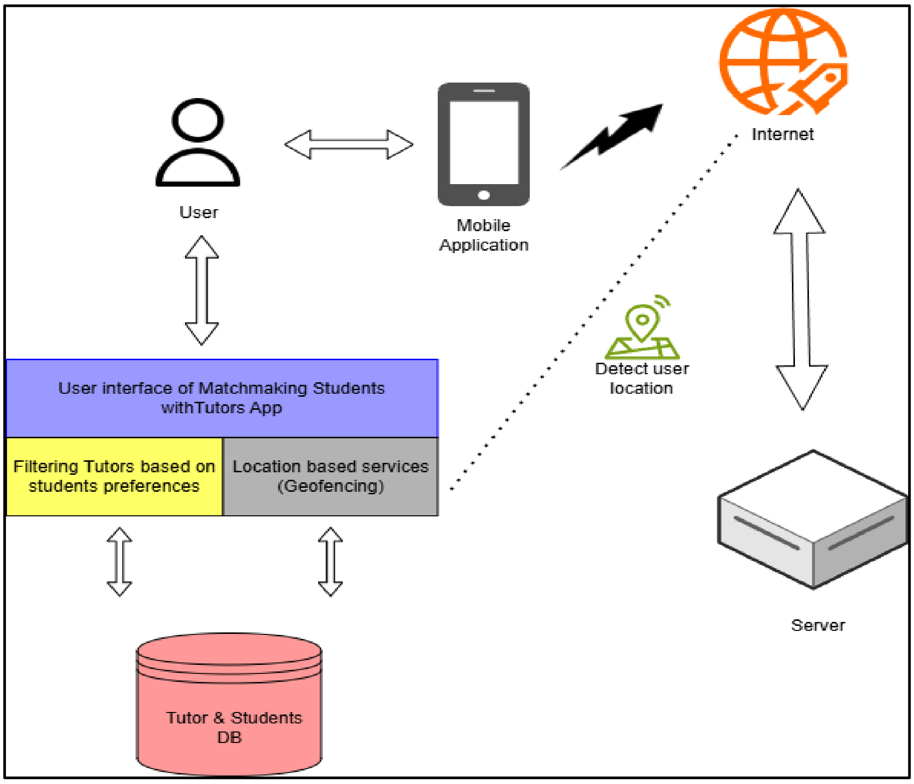

Fig 2. Match-making Students with Tutor System Architecture

Figure 2 shows an overall system architecture for matching students with tutors' mobile application:

1. User - A user who is a student can access the matchmaking student tutor mobile application named iTeachU to either find a tutor or provide tutoring services.
2. Mobile Application - The user interface (UI) of the mobile application allows the user to interact with features such as profile management, search, and booking.
3. Internet - Facilitates communication between the mobile application and the server to ensure real-time updates and data exchange
4. Server - Handles all services and processes required by the application, such as matchmaking and geofencing algorithms
5. Database – Stores and manages information, including user profiles, location data, and personalised recommendations

Use Case Diagram

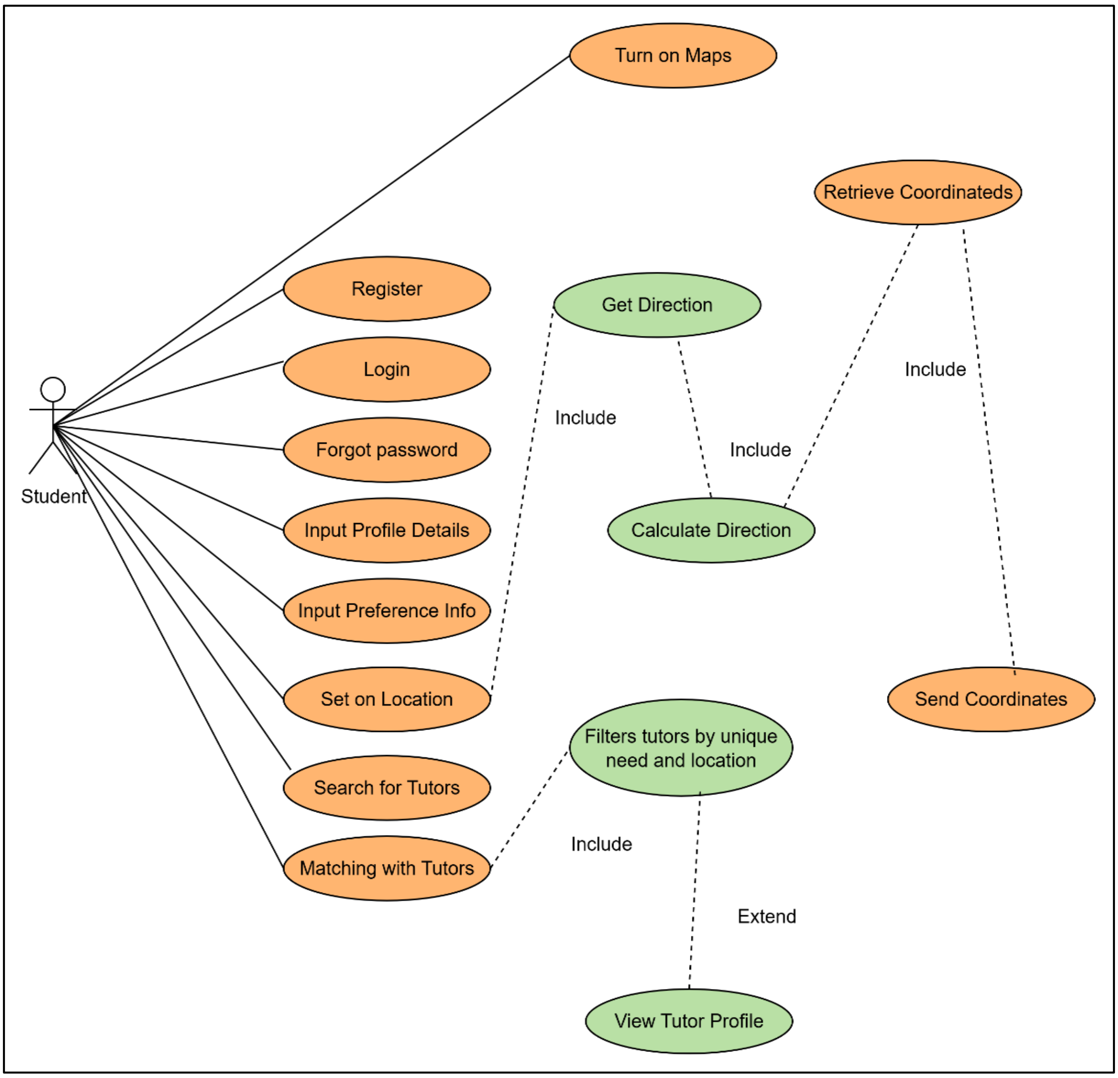

Fig 3. Use Case Diagram

The use case diagram for the iTeachU mobile application shows the flow of interactions between the student and the system's functions, as shown in Figure 3. The leading actor is a student who can perform the following actions: register, log in, change the password, and manage their profile. After the authentication process, the student can enter their preferences, including the choice of a setting, level of subject knowledge, subject, gender, and tutoring mode (online or physical).

Upon preference filings, the student searches for tutors. This input is sent to the back-end API, which processes the request using internal algorithms. In particular, the system uses the Haversine formula to calculate the distance between the student's location and available tutors. Then it invokes the K-Nearest Neighbours (KNN) algorithm to match them with the most relevant one. The system narrows down tutors within a 10-kilometre

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radius, and the student will only get tutors who are in the neighbourhood or provide services relevant to the student.

The last step allows students to view the detailed profile of the matched tutor, which will help them make informed choices. This use case diagram captures the most fundamental student-based flow, prioritising personalised and location-based matching, as well as easy backend processing via API communication. However, these are not physically depicted in the diagram.

Algorithm Design

The K-Nearest Neighbour (KNN) algorithm is adopted to advise students on which tutors to select based on individual input. The model is also written in Python, trained, and tested within the scope of the system's backend integration in Jupyter Notebook.

KNN is selected because it is used to calculate recommendations, and it does so by measuring how similar a student's preferences are to current tutor profiles. The measure of similarity used in this project is a combination of categorical features encoded with the one-hot technique (gender, teaching mode, area, and subject) and the Haversine distance, which is an appropriate measure of geographical proximity based on latitude and longitude. This will ensure that students are recommended based on their preferences and within a 10-kilometre radius.

The tutor dataset is pre-filtered based on core inputs, and feature vectors are then matched using a KNN model, yielding a series of truly matching suggestions. In an endeavour to make relevance take pre-eminence, subject compatibility has been given greater weight in the overall similarity score. The number of neighbours is calculated dynamically relative to the size of the filtered dataset, so all areas in the system remain responsive, even when the area is small.

The algorithm design supports location-aware, real-time, and preferred recommendations in the iTeachU mobile application to provide quick, personalised application of the tutoring service to students in Melaka.

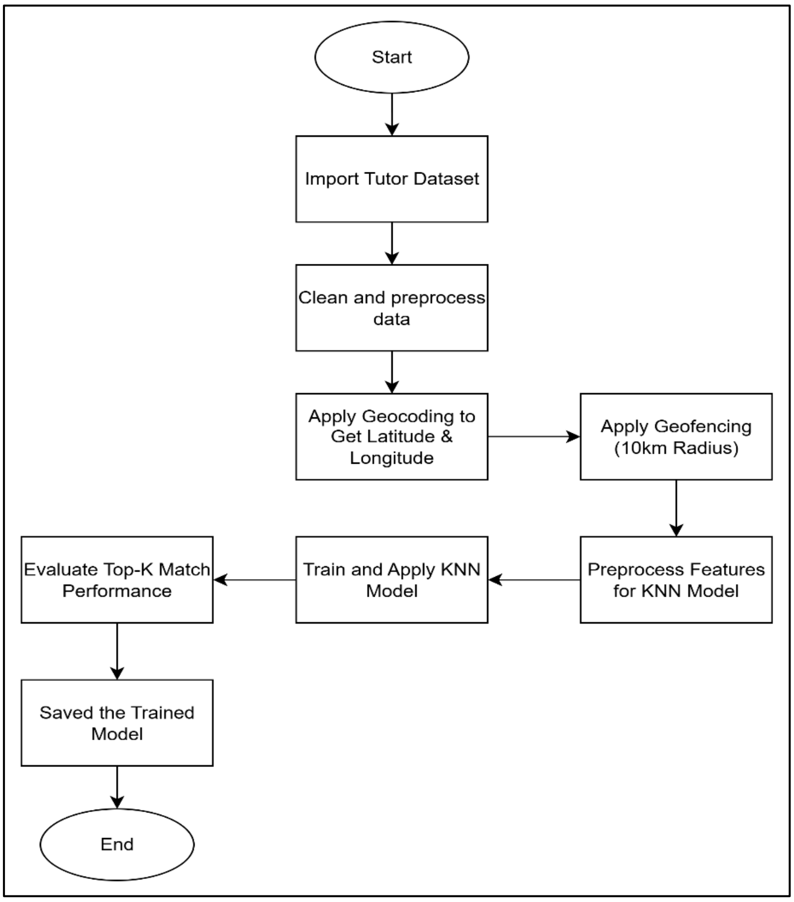

Fig 4. Flowchart of Algorithm Design

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As shown in Figure 4, the flowchart illustrates the KNN-based tutor recommendation process in the iTeachU mobile application. First, the dataset of tutors is imported, cleaned, and gathered on TutorKami. Then, the data is preprocessed to account for missing values and normalise fields. Geocoding uses tutor location points to create the latitude and longitude of a tutor location, after which geofencing uses the latitude and longitude of a 10-kilometre radius of the tutor location to filter tutors.

Then the categorical features, including subject, mode, and gender, are encoded in preparation for use by the KNN model. After preprocessing, the KNN model is trained and used to calculate similarities between tutors and student preferences. The top-K match performance is then tested on the system to ensure the recommended tutors are highly relevant and precise. Lastly, the trained model is stored for future use, thus completing the cycle of recommendations.

Flowchart of the Mobile Application

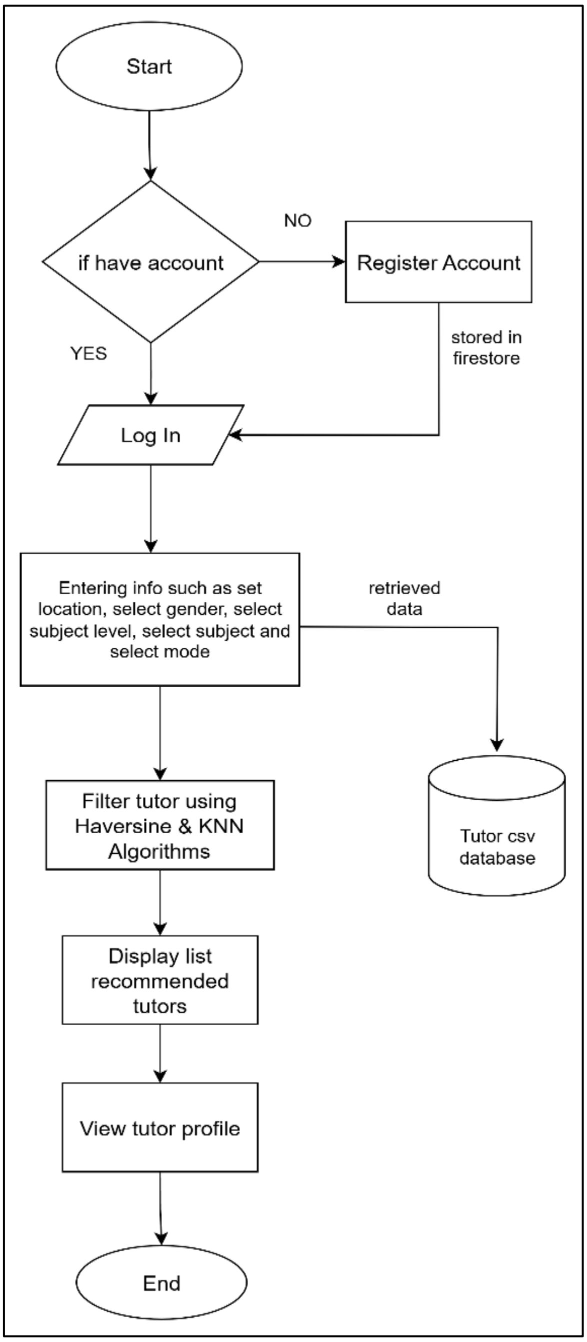

Fig. 5 Flowchart of Mobile Application

Figure 5 shows the flowchart of the iTeachU application, outlining how a student will use the mobile system to find an appropriate tutor. The user will start experiencing the flow when they launch the app and open it for the

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first time, at which point they will either create an account or sign in with their email. After a successful login, the student then enters his or her preferences for what he or she would like to search for, such as a location, the preferred sex of the tutor, the level of the subjects, a specific subject, and the preferred mode of tutoring (online or physical). After such preferences are posted, they are sent to the backend system, where the two most important algorithms are used: Haversine and KNN.

The Haversine formula is used to calculate the distance between the student's location and each tutor's location, and the KNN algorithm is used to compute the other preferences to rank the tutors by relevance and similarity. These processes will be based on the queries to a structured CSV database with all tutor profiles. The system will then provide a filtered list of recommended tutors that match the student's preferences and location. These findings are displayed to the student, who can then check the profile of each suggested tutor to assess their qualifications, the subjects they teach, and their teaching mode. This flow guarantees a customised, efficient experience for matching with a tutor, including preferences, smart geolocation, and machine learning.

Mobile App Interface and Functionality

This section describes the user interface and the functionality of the iTeachU mobile app. The app was developed with Flutter and presents a smooth, functional UI through which students can register, log in, set preferences, view tutors' recommendations, and save their favourites. All screens aim to provide a smooth user experience, with real-time interaction with the backend services and the Firebase database.

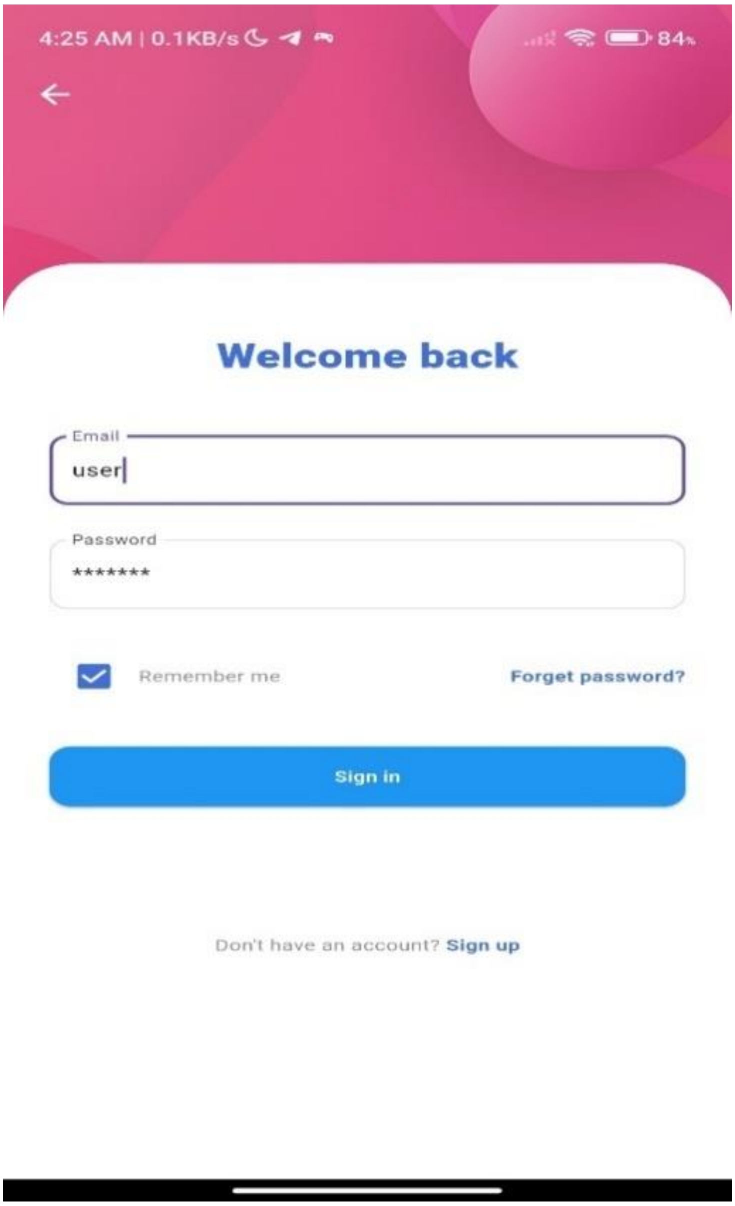

Fig 6. Registration Page

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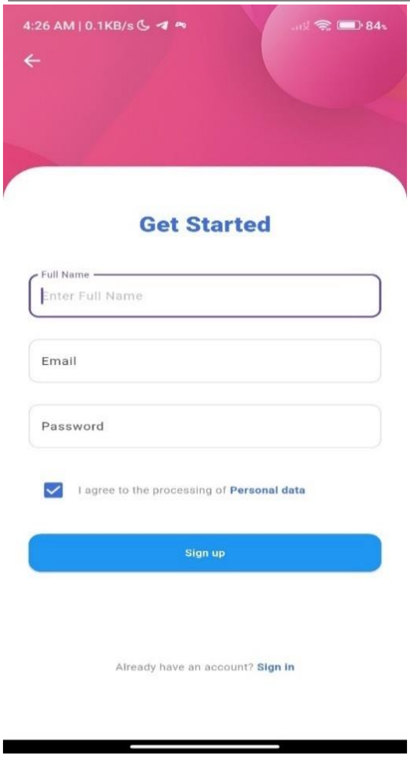

Fig 7. Login Page

Figure 6 shows the registration page, which enables new users to create an account by entering their full name, email address, and password. Firebase Authentication handles the backend logic for securely storing user credentials. The form validation and user agreement checkbox are implemented to ensure compliance with data usage policies. This interface supports seamless account creation and directly links to the Firebase Realtime Database upon success. Figure 7 shows the login page of the iTeachU mobile application. To access the app's services, a user must enter their registered email address and password. It has a simple interface built with Flutter widgets and integrates with Firebase Authentication to sign in securely. There is a checkbox to remember me that lets the user maintain session state. Below are links to reset the password and create a new account in case the user forgot the password.

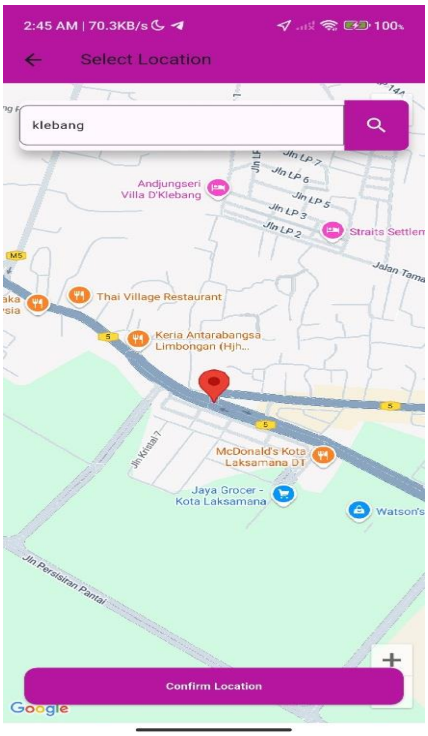

Fig 8. Tutor Recommendation Page

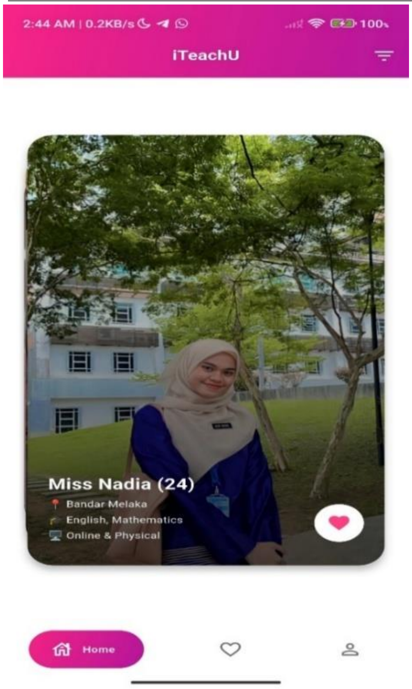

Fig 9. Location Picker Page

Figure 8 shows the Tutor Recommendation Card Page, which lists tutors that satisfy the user's preferences. Every card shows a photo of a tutor, their name, location, subjects, and tutoring mode. The heart catcher icon also enables students to keep the tutor as a future reference. This card-like presentation offers users an easy way to browse. Figure 9 shows that the Location Picker Page gives students an opportunity to search for and select a geographic area using Google Maps. After finding a confirmed location, the geofencing logic will be based on it to retrieve tutors within a 10-kilometre radius using the Haversine formula.

Figure 10 shows that the Filter Settings Page provides students with the opportunity to specify their search using filters for location, gender, subject level, subject, and mode of tutoring (online or physical). With the dropdown menus and the location picker, users may modify these fields. To cast a query, the settings can be used to initialise queries on the backend matching engine, ensuring that the results retrieved are contextual and relevant. Figure 11 shows that the "No Matching Tutors Found" page is displayed when no tutors can be found that fit the user's preferences and the selected general location radius. It shows a centred message alongside an icon of a magnifying glass, clearly indicating to the user that there are no results based on their filters. This page serves as a feedback system and encourages users to adjust the filter level to expand the search range or use other criteria.

Fig 10. Filter Settings Page

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue X October 2025

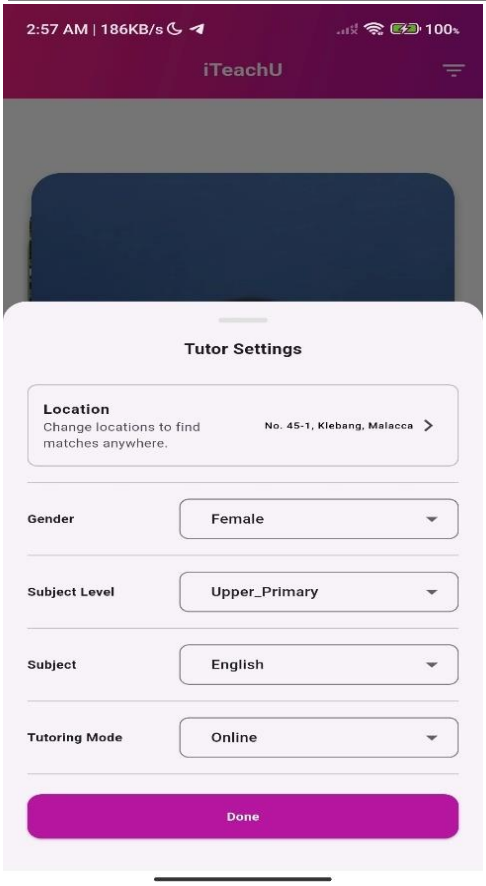

Fig 11. No Matching Tutors Found Page

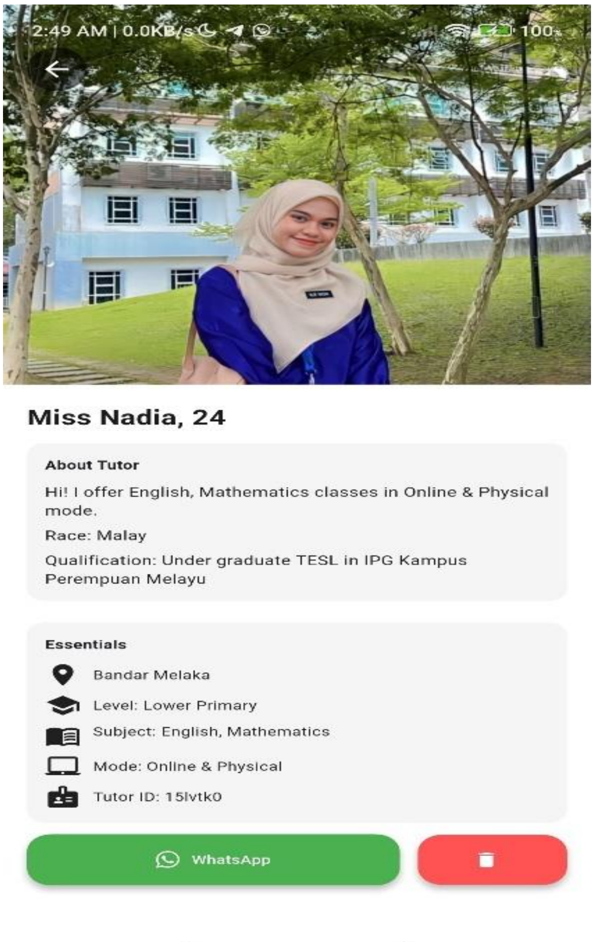

Fig 12. Saved Tutors Page

Fig 13. Tutor Profile Page

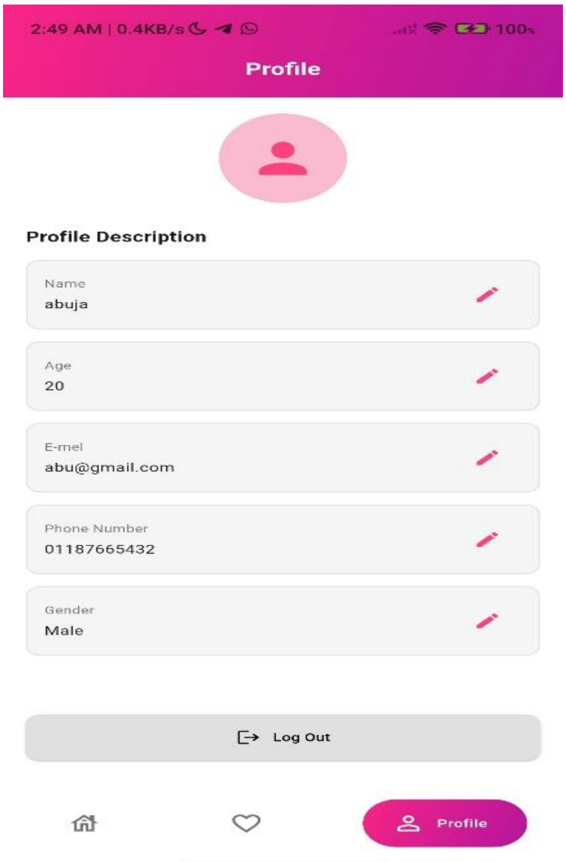

Fig 14. WhatsApp Message Page

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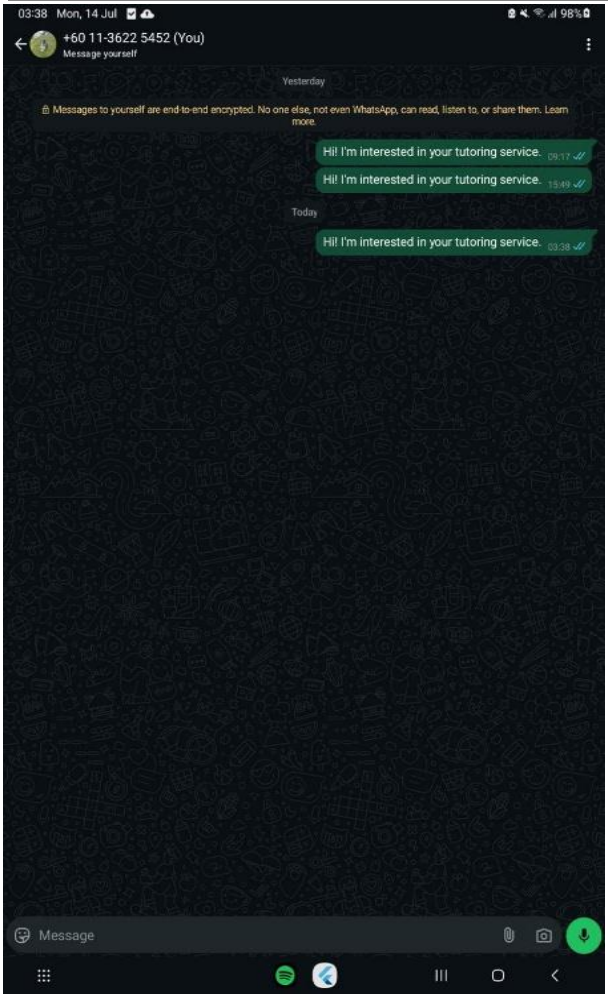

Fig 15. Student Profile Page

Figure 12 shows the Saved Tutors Page, which displays tutors saved by the student by tapping the heart icon on tutor cards. There is a display of tutors in a two-column grid, with each tutor depicted by an image, name, and age, so a student can easily return to their favourite profile and compare potential choices. The Tutor Profile Page in Figure 13 provides comprehensive tutor information, including name, age, qualifications, race, tutoring mode, subjects taught, and area. Interface focuses on a clean, well-organised interface, as well as a WhatsApp button to call the tutor directly, reducing students' effort in communicating with tutors. Figure 14 shows the WhatsApp Message Page, which indicates the outcome of the contact button on a tutor page. It uses a default message to open WhatsApp, like “Hi! I would like to use your tutoring service”, which will enable the student to start a conversation with the tutor fast and straightforward. Figure 15 shows that personal information, such as name, age, email address, phone number, and gender, can be found on the Student Profile Page. This page enables simple editing by displaying inline pencil symbols. This helps all students keep their information up to date, which is essential for proper filtering and the logic of recommendations.

RESULTS

This section provides an analysis of the data utilised in the app with respect to behaviour patterns and tutor demographics. The conclusions aid in describing decisions made at the system level, including the logic behind recommendations and the availability of subjects.

Distribution of Gender

In Figure 16, the gender distribution indicates a significant disparity in the makeup of tutors, with females constituting the overwhelming majority. This implies that the tutoring population in the dataset is more female. Such demographic imbalance can affect subject specialisation, the manner of subscribing to tutoring services, and gender-sensitive user matching.

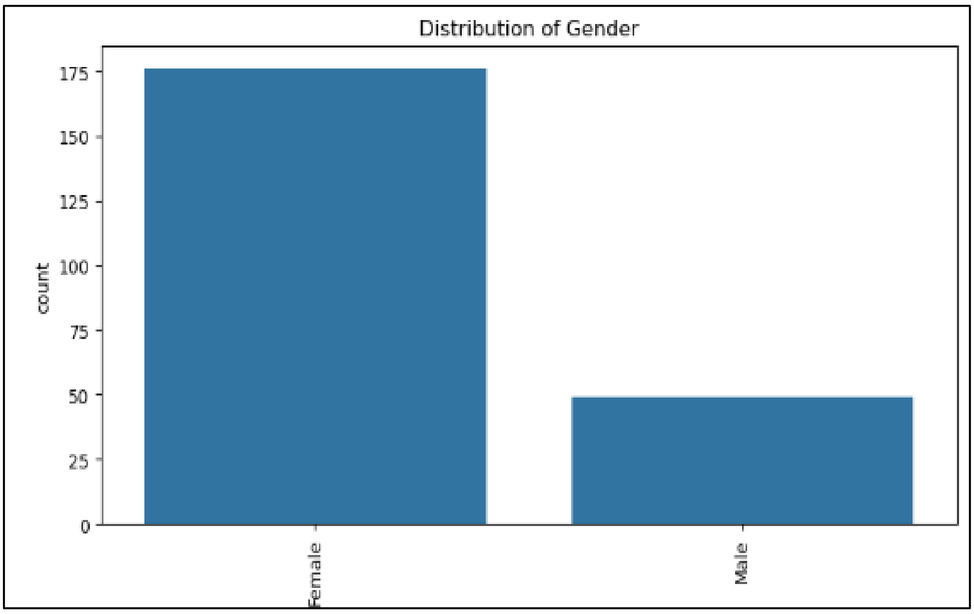

Fig 16. Distribution of Gender

Tutor Availability by Area

The availability of tutors by area chart in Figure 17 gives the number of tutors in various regions within Melaka. The most significant number of tutors is found in Melaka Tengah, Alor Gajah, and Ayer Keroh, which may be attributed to their central or urban locations. On the contrary, in the Batang Melaka, Sungai Rambai, and Serkam rural regions, the number of tutors is extremely low. This makes clear the necessity of creating online or flexible instructional options in less-served locations and helps define where they will concentrate their efforts to recruit tutors.

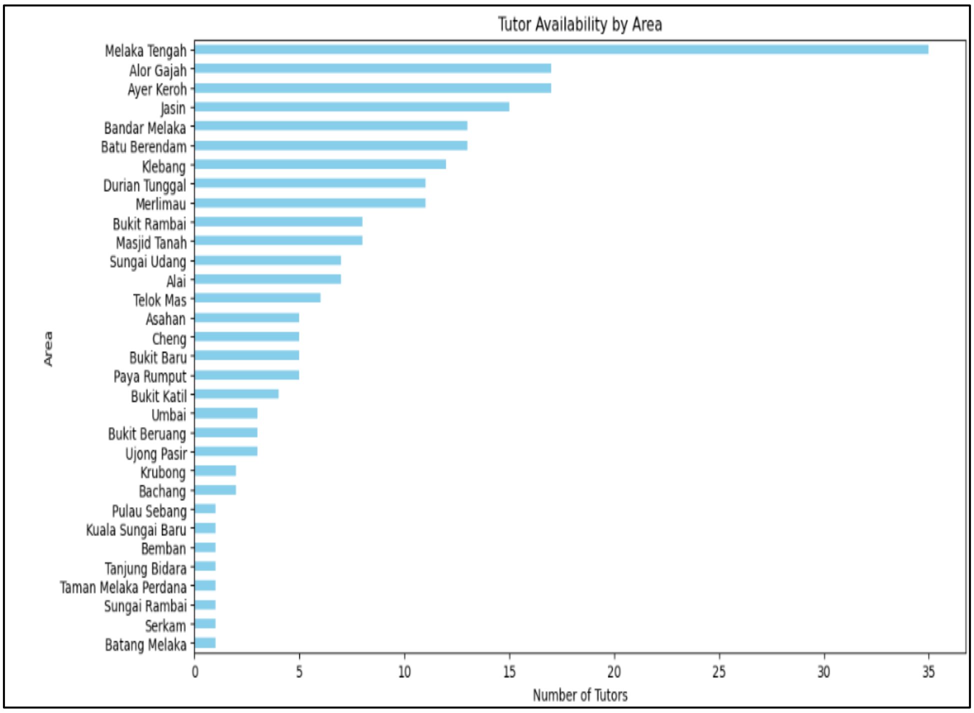

Fig 17. Tutor Availability by Area

Age Distribution of Tutors

The tutor age distribution in Figure 18 is right-skewed, with most tutors aged 25-30. This means that the majority of the tutors will be recent graduates, university students, or new teachers. The number of tutors also decreases

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as age increases. This trend indicates that young people have a greater likelihood of providing tutoring services, perhaps because of their flexibility, availability, and proximity to academic information.

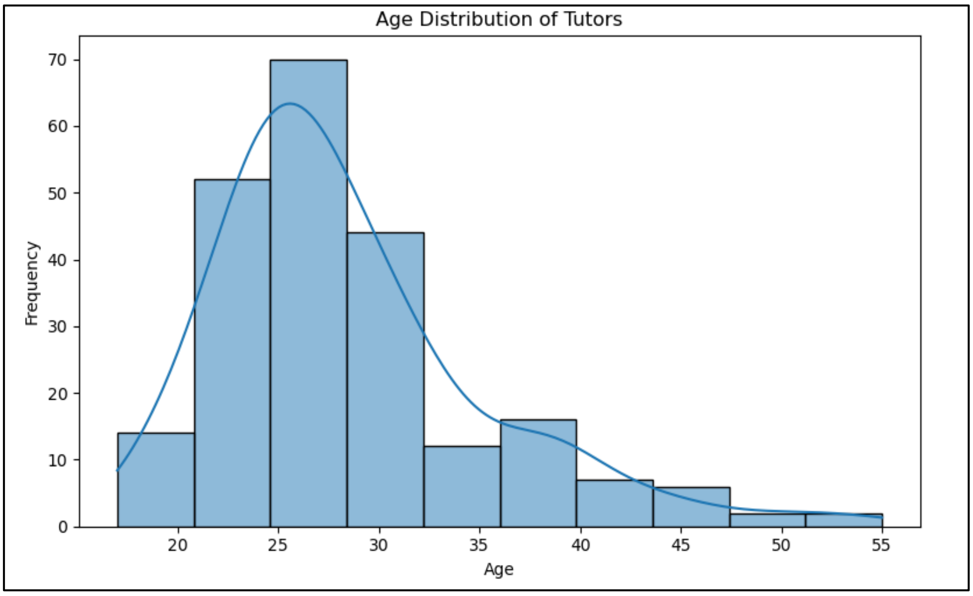

Fig 18. Age Distribution Tutors

Correlation Between Teaching Preferences

The heatmap in Figure 19 shows the relationship between various teaching preferences, including subject level and teaching modes. There is a moderately negative relationship between being a primary and a secondary school teacher, in that tutors specialise in one or the other. Also, the online and physical modes show low correlation, indicating that most tutors choose to teach online or face-to-face, but not both. Through these insights, it is realised that the perfect matching of preferences in the recommendation system is paramount.

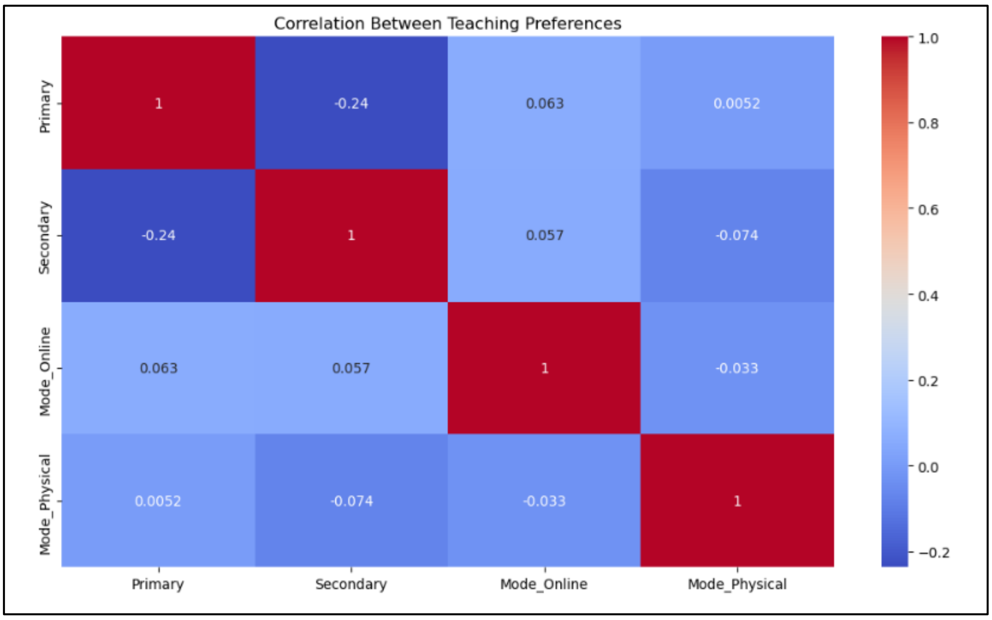

Fig 19. Correlation Between Teaching Preferences

Correlation Heatmap of Tutor Features

The heatmap in Figure 20 examines the correlation between the characteristics of tutors (i.e., age, number of subjects, teaching level, and teaching mode). There is a small negative association between age and teaching at the primary level. In contrast, the number of subjects shows a positive association with teaching at both the primary and secondary levels. This implies that tutors who handle several subjects usually span the various levels. The overall small correlations are positive, indicating that relative independence among most features in the system is advantageous to the flexibility of the recommendation engine when scoring tutor profiles.

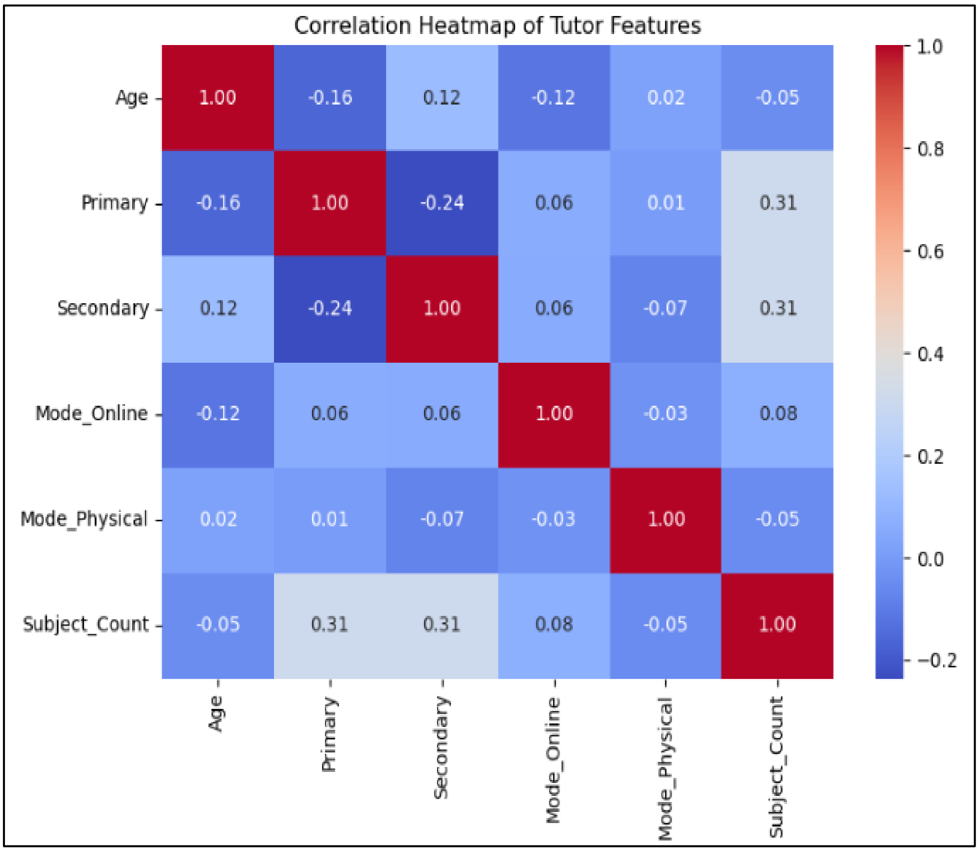

Fig 20. Correlation Heatmap of Tutor Features

Top 10 Subjects by Gender Preference

The bar chart in Figure 21 displays the top 10 subjects by gender, indicating a high proportion of female tutors across all subjects, especially the prominent ones, English, Mathematics, Science, and Bahasa Melayu. Tutors Male tutors are more common in technical subjects like Mathematics and Science, but they are still hugely underrepresented. This non-random gender distribution of the subjects is relevant concerning the diversity and balance of tutor availability in the system, especially when students should be able to filter by gender or subject strength.

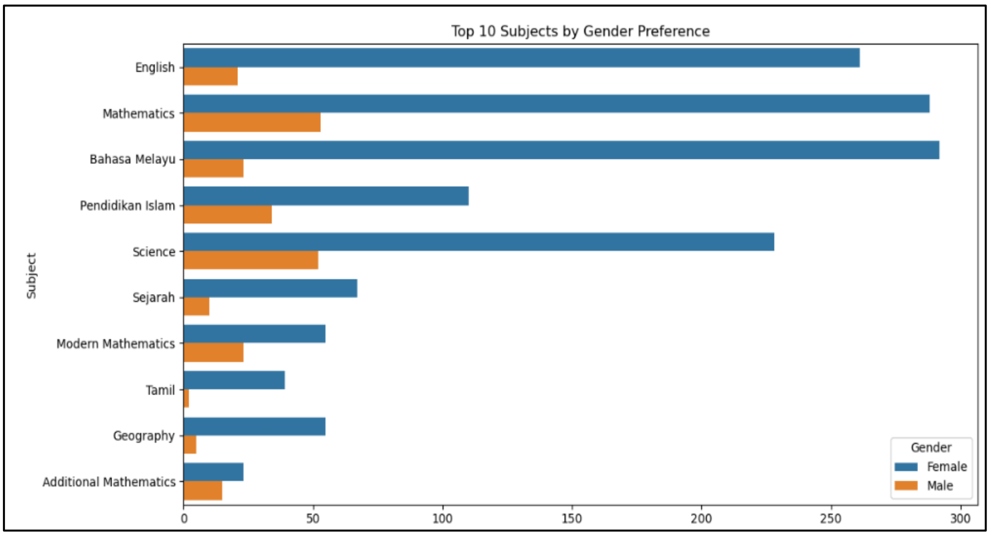

Fig 21. Top 10 Subjects by Gender Preference

CONCLUSION

This project aimed to develop a mobile application, iTeachU, that would practically recommend a tutor to a pupil who aligns with their learning preferences. To achieve this, the primary objective was to develop a clever matching platform with a mobile interface to improve the tutoring selection process. The designed application is intended to enhance students' experience by providing access to tutors through custom recommendations and filtering capabilities.

The first objective was to design an interactive, user-friendly interface that makes finding a tutor easier. It was done with the help of the Flutter framework to create a contemporary interface that allows students to enter their preferences, including location, subject, gender, and tutoring mode. The app has attractive tutor cards, a Facebook name-based location input using Google Maps, and real-time dropdown filtering of results, making the process of searching and selecting a tutor easy.

The second objective was to develop a recommendation engine that recommends the most appropriate tutors based on student input. It has been done using the K-Nearest Neighbours (KNN) algorithm. Contrary to traditional systems that offer only location or manual search, iTeachU provides a Better Match Score, a hybrid measurement that considers both categorical and location options. Based on criteria at the subject level, tutoring mode, and distance, the system creates and prioritises the top three most compatible tutor matches for every student. Results are accurate and reliable, and the test cases also indicate that the top matches align with what the student expects.

The third objective focused on testing the functionality and user-friendliness of the mobile application through real interactions. Android devices and emulators were used to test the app, and all central features were found to be stable and working correctly. User testing has shown that the system returned results quickly and accurately, and that the overall user experience was smooth. This included features such as saving tutors, viewing their detailed profiles, and communicating with them via the WhatsApp application, which are beneficial for achieving the goal of high usability.

Overall, the iTeachU application could meet its goals, as it presented a location- and preference-based tutor-recommendation system with a fascinating and practical interface. It is value-added to the education ecosystem because it offers students significant and customised links to tutors in Melaka.

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