Bilkent University
Department of Computer Engineering

Senior Design Project

Team ID: T2510

Project Name: Mentora

Project Specifications Report

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1. Introduction

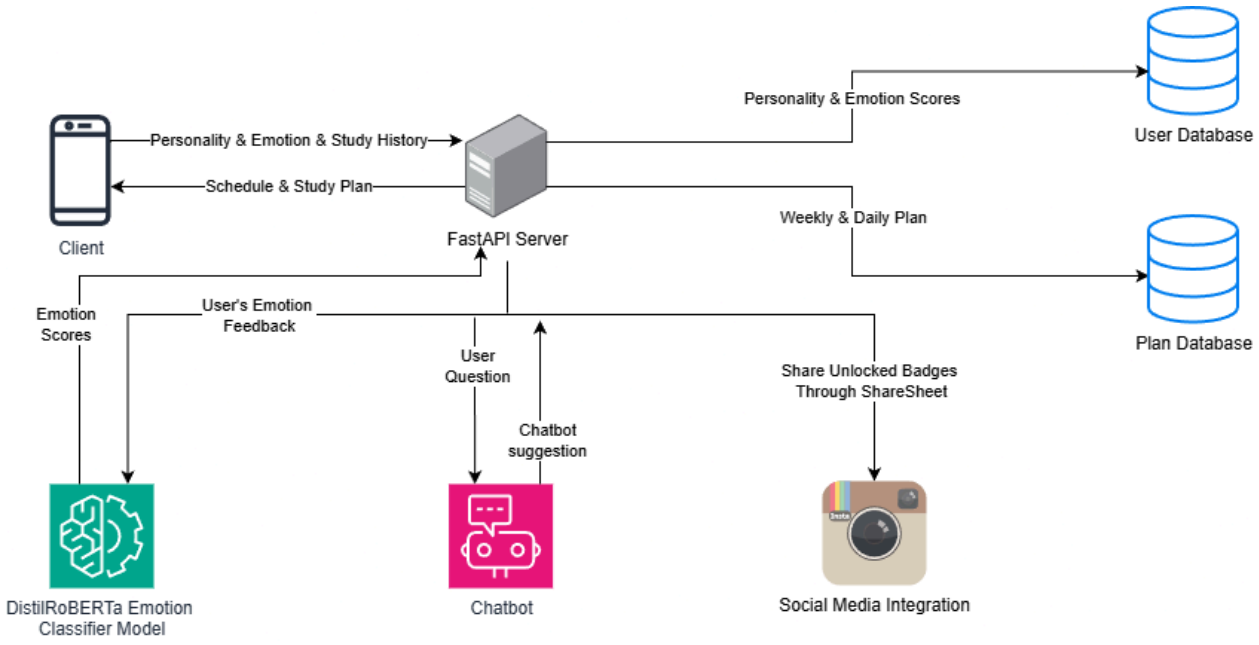
1.1 Description

Mentora is a mobile personalized study assistant. It provides a personalized study plan to its users so that the users will be able to study more efficiently and get motivated easily. Mentora asks the users to fill out a personality test once after the installation of the application. The personality test result will give scores for 5 different personality traits. Each of these personality traits will affect the users' experience differently.

Mentora will consider users' daily emotional situation as well. It will ask users how they feel and based on the users' text-based response, it categorizes the users' emotions. Based on the current emotion, the daily study plan will slightly change for that day. Mentora also changes the plan based on the academic history of the users and coming up assignments.

Mentora has additional features to keep the users in the application. Mentora keeps track of the daily usage streak so that users can see how many days they used the application in a row. Mentora will display a leaderboard based on the study habits of the students so that users can compare themselves with others. Mentora also gives feedback and motivational messages to its users so that users can be motivated more. Mentora provides sharing the accomplishments through social media so that users can be motivated more through external validation.

1.2 High Level System Architecture & Components of Proposed Solution



Mentora is a mobile application which aims to service personalized study experience in a lightweight design. It uses the FastAPI framework to ensure native support for AI/ML integration, built-in validation module, allowing modular development, and native JSON usage between frontend and backend. Mentora uses Flutter for a single codebase for Android and iOS, widget-based user interface which provides Mentora to change schedules on a daily basis, and easy integration with FastAPI through RestAPI. Mentora uses PostgreSQL for databases since PostgreSQL allows to store JSON data as a data type so that Mentora doesn't have to parse all of the JSON data and store them to the database one by one. JSON data can only be parsed when it is going to be used to analyze the user's personality and emotional traits.

The server side of the application communicates with the client side of the application by using JSON data in the HTTP request/response body since Mentora uses a lot of parameters and it is easy to parse different kinds of parameters in JSON templates. These parameters are used to personalize the features of the application based on the users' personality traits and emotional situations. These personality trait and emotional situation data are gathered by asking the users. Mentora personalizes the study duration for each Pomodoro session, break duration between Pomodoro sessions, what and when to study, how and when to give motivation and feedback to the users.

```
{ "weekly_plan":
      { "week_start": "2025-11-17",
      "week_end": "2025-11-23",
      "goals": [ "Finish maths assignment before Thursday",
"Review physics chapter 4", "Prepare flashcards for biology
quiz" ], },

"daily_plan": [ {
      "emotion_state": {
            "detected": "Fear",
            "confidence": 0.82},
            "date": "2025-11-17",
            "emotion_adjustment": {
```

```
                "mode": "add more frequent breaks, smaller
          goals",
                "reason": "anxiety, exam stress" },
     "tasks": [ {
          "title": "Watch calculus lecture 5",
          "duration_minutes": 40,
          "priority": "medium",
          "recommended_break": 20},

          { "title": "Physics practice: Chapter 4 problems",
          "duration_minutes": 60,
          "priority": "high",
          "recommended_break_after": 30,
          "assignment_ref": { "assignment_type": homework,
     "course": "Physics 101", "due_date":
     "2025-11-19T18:00:00Z" } },
```


Users' emotional situations are classified by an AI model based on DistilRoBERTa. This model is going to be integrated externally since such a model is already developed. It classifies the user feedback to 7 emotions with their accuracy scores. Based on these 7 emotions, parameters which decide the study routine of the users are updated. For example, if the user is bored, Mentora tries to come up with a different topic to study, if available. An example output of emotion classification AI model is given below [1]:


```
Input: "I love this!"
Output:
[[{'label': 'anger', 'score': 0.004419783595949411},
  {'label': 'disgust', 'score': 0.0016119900392368436},
  {'label': 'fear', 'score': 0.0004138521908316761},
  {'label': 'joy', 'score': 0.9771687984466553},
  {'label': 'neutral', 'score': 0.005764586851000786},
  {'label': 'sadness', 'score': 0.002092392183840275},
  {'label': 'surprise', 'score': 0.0085286842659115791}]]
```

Mentora is going to include a chatbot which is built by the Mentora developers. This chatbot is going to help students with the usage of Mentora. For example, if a user couldn't find a feature of Mentora, this chatbot can provide the corresponding link to that user. This chatbot will be rule-based AI since it has static responses (application links). However, it is going to understand which link to give to users by understanding the given text.

Mentora is going to be integrated into the social media applications so that users can share their accomplishments on their social media profiles. This feature is going to provide users with an opportunity to engage with the outer world so that they can be motivated to study more. Furthermore, users sharing Mentora's accomplishments are going to make our advertisement unintentionally as well. The sharing is going to be done using ShareSheet which is supported by a Flutter library named share_plus. A ShareSheet example can be seen below:

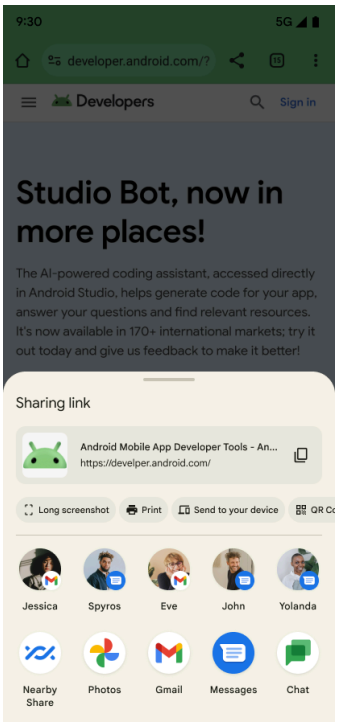


Figure 1: ShareSheet Example [2]

1.3 Constraints

1.3.1 Implementation Constraints

- Mentora will be implemented as a cross-platform mobile application.
- The frontend will be developed using Flutter; the same codebase will target at least Android and iOS mobile platforms.
- The backend will be implemented in Python using the FastAPI framework.
- Communication between the client and the backend will be done via a RESTful API over HTTP/HTTPS.
- A PostgreSQL relational database will be used as the main data store.
- SQLAlchemy will be used as the Object Relational Mapping layer to integrate FastAPI with PostgreSQL.
- The database must allow storing JSON fields for flexible data types such as personality test responses and weekly feedback forms.
- All main features of Mentora (creating study plans, Pomodoro timers, personality scoring, workload analysis and weekly updates) will run on the backend server, so the mobile application stays simple and lightweight.
- The emotion detection module will be implemented using open-source text-based AI models that can run within the Python/FastAPI environment.
- Text-based analysis of students' feedback will rely on open source NLP libraries compatible with Python.

- Source code will be developed using VS Code with formatting and linting extensions to maintain a consistent code style.

- Git and GitHub will be used for version control, branching, pull requests and issue tracking throughout the project.

- Only free or university provided tools and services will be used. No commercial SDKs or paid cloud services are assumed in the baseline design.

1.3.2 Economic Constraints

- Since the project doesn't have enough budget, all technologies that will be used must be open source and free.

- PostgreSQL, FastAPI, and Flutter are free options for this project because they offer complete functionality without requiring a payment.

- For version control, teamwork, and issue tracking, GitHub's free plan will be used.

- To avoid the high cost of commercial APIs, open-source libraries will be used to implement NLP and emotion detection modules.

- Because of the financial constraints, development and testing will be done using personal laptops or computers provided by the university; large-scale cloud services cannot be used.

- Since paid datasets are not practical for the project, all datasets required for development will be sourced from free internet sources.

1.3.3 Ethical Constraints

- Mentora processes sensitive personal data like academic history, personality test scores, daily emotional situation, and weekly reflections. These data types must be carefully handled due to their sensitive nature.

- By using the data minimization principle, only the minimum amount of data needed for personalization will be gathered from the user.

- Users must be informed about all data processing activities with a privacy notice and an explicit consent form, specifying data categories, usage purposes, storage durations, and user rights on these data.

- Emotional data and personality profiles gathered from the user will be handled with caution and stored only when required, based on discussions with psychology and law faculty members [3-4].

- To prevent unauthorized access, the system will use technical safeguards like hashed and salted password storage, and encrypted communication between client and server.

- Users must be able to access, update, or request the deletion of their personal data within reasonable limits.

- The system must avoid any design decisions that could result in psychological pressure on the users. Feedback and recommendations to the users should remain supportive and within mental health principles.

- No user data will be shared with third-party services unless explicitly stated and approved through a written agreement with the user.

- The project will follow the ethical guidance provided during our faculty consultations, while also complying with broader privacy and legal standards such as KVKK.

1.4 Professional and Ethical Issues

As the Mentora developers, it is important that we obey ethical standards and professional obligations while developing Mentora. We ensure that the features we design are clearly explained to the user and do not create unrealistic expectations since the system interacts with personal information such as emotions, personality traits, and academic habits of users. It should always be clear that Mentora's study plan suggestions are aiming to assist users with their study habits instead of offering psychological diagnoses. We should only collect the data required for the system to operate effectively, and user data must be carefully protected through secure coding techniques and limited access. Furthermore, the application's message tone should continue to be polite and supportive so that the user doesn't feel overwhelmed by notifications or feedback messages. Lastly, we must obey software engineering standards, record what the system can and cannot do, and be aware of potential threats like privacy issues or unintentional emotional impact while developing the project.

1.5 Standards

- The structure and behavior of the system will be modeled using UML 2.5.1 standard. This standard includes diagrams that will help to clearly and consistently represent the design, such as use case, class, and activity diagrams [5].

- The project's requirements will be documented by following the IEEE 830 standard, guaranteeing that all functional and non-functional requirements are written in an intelligible, structured, and clear manner [6].

- We will do our work during the development process with the general framework offered by IEEE 12207 standard, which specifies the phases of the software life cycle, including planning, analysis, design, implementation, testing, and maintenance [7].

- To have an organized and traceable design process, design-based decisions like layout, module descriptions, and interface definitions will be done using the IEEE 1016 standard [8].

- We will use IEEE 1058 standard, which provides helpful methods for planning and overseeing software projects, as a guide for project planning and management tasks [9].

2. Design Requirements

2.1 Functional Requirements

2.1.1 User Account and Profile Management

Users shall create a personal account and securely log into the application. Users shall enter basic profile details such as their department, year, courses, and academic goals. Users shall complete the OCEAN personality test and save the results in their profiles. Every week, users shall be able to give feedback about their feelings and study plans. Users shall also change their study hours, free times, performance comparison settings, and study group requests.

2.1.2 Personalized Study Plan

According to the user’s personality, course and exam schedule, the system shall generate a personalized weekly study plan. The weekly study plan shall be broken down into daily tasks and users shall follow regularly. According to the user’s mood and weekly performance, the system shall change and update the study plan. The workload of related courses shall be increased 1 week before the exam or 1 day before the deadline . The system shall track weekly goals and users’ progress.

2.1.3 Emotion-Based System

According to the user's written feedback, the system shall analyze users’ emotions and mood. The user’s emotions shall be categorized as joy, sadness, fear, anger, boredom, surprise, or neutral. When emotion changes, the system shall update study slots, break time, and also study techniques. The system shall also give supportive messages taking into account the user's mood.

2.1.4 Pomodoro-Based Study and Break Activity Recommendation

Users can start and stop Pomodoro-based study times. The system shall give a break after the study session. According to the user's stress level and requests, the system shall give a recommendation to break activities such as breathing exercises, yoga, or relaxing music. The system shall follow the user’s daily and weekly total study time.

2.1.5 Gamification and Achievements

Streak mechanism shall be used to follow users’ activities . The system shall give badges when users succeed many different achievements, and these badges shall be shown on their profiles. The system shall unlock new features according to the achievements of the user. Visual progress animations such as watering a flower or growing a tree after study sessions end are supported. This system shall increase user motivation and consistency.

2.1.6 Feedback and Notifications

Users shall answer weekly feedback questions about their study experience and their satisfaction about the system. After each feedback, the system shall update the next week’s study plan. It shall assess whether the user achieved their goals and give new recommendations. Upcoming exams and assignments shall be informed by sending automatic notifications. If the user does not use the system for a long time, motivational reminders shall be sent for user engagement. The user shall also examine their weekly progress and study reports.

2.1.7 Leaderboard

Users shall be able to create their own groups and join other study groups. The leaderboard shall be organized according to weekly or monthly study time. The system shall allow users to hide their ranking.

2.1.8 Chatbot System

The system shall provide a chatbot to guide users. Users shall be able to ask the chatbot to learn features' location. The chatbot shall also help to learn how to use them. The chatbot shall give automatic response and basic navigation support.

2.2 Non-Functional Requirements

2.2.1 Usability

The interface of the Mentora system shall be simple and easy to use. The application shall work on mobile devices and it shall be compatible with different screen sizes. Users shall easily find features' location and understand their purposes thanks to the understandable interface. Visual animations shall relax the user and shall not cause distraction. The chatbot shall guide users in a simple and clear way.

2.2.2 Reliability

The Mentora system shall save study time, weekly schedules, and personal information in an ordered and correct way. The Pomodoro timer and planning system shall work steadily. When the application is closed and opened again, user information shall not be lost. The system shall guarantee that personal information is not shared with other users and is protected. The system shall be designed to prevent crashes and data errors.

2.2.3 Performance

The Mentora system shall analyze emotions, generate weekly plans and deliver notifications without significant delay. Long waiting times shall not occur for the user. Animations shall not slow down the application performance. Notifications shall be delivered on time. The plan shall be updated rapidly.

2.2.4 Maintainability and Supportability

The architecture of the Mentora system shall be flexible. Upcoming updates and new feature additions shall be supported. The emotion analysis model and personality tests shall be extended and changed if it is needed. Backend and frontend components shall be organized independently. The system shall be updated without large service interruption.

2.2.5 Scalability

The system shall continue to work regularly even if a large number of users start to use the system. Increased user traffic shall not lead to significant performance loss. The database shall support an increasing amount of data. Heavy processing components, such as emotion analysis, shall be deployed as separated services if it is needed.

2.2.6 Privacy and Security

The system must prevent unauthorized access. Hash and salt methods must be used when passwords are stored. Encryption must be applied for data communication between the client and the server. Explicit user consent must be required for processing personal data. User data shall not be shared with third parties. Users shall have the right to view, update, and delete their data. Data about personality and emotion must be treated as sensitive personal data.

2.2.7 Legal and Ethical Conditions

Mentora shall not be used for therapeutic purposes or psychological diagnosis. Users shall not be applied psychological pressure Competitive and performance comparison setting features shall not be mandatory. The system shall follow a supportive and motivating approach. The application must obey personal data protection laws.

3. Feasibility Discussions

3.1 Market & Competitive Analysis

3.1.1 General Overview of Market

The global education technology (EdTech) sector has grown quickly over the past decade. This growth is driven by more people using digital tools, a higher demand for personalized learning, and the rise of mobile-first study habits. Students and professionals now look for tools that help them improve productivity, organize their learning, and stay motivated during long study sessions. As competition heats up, platforms that combine data-driven insights with strong user engagement are capturing more market share. The EdTech market was valued at USD 334.29 billion in 2023 and is expected to reach USD 738.60 billion by 2029,

with a compound annual growth rate (CAGR) of 14.13%. The global EdTech market is very competitive, featuring many companies and solutions that aim to improve education using the latest technologies. Several established companies and start-ups are competing to get a larger share of the EdTech market and meet the changing needs of learners and educators. Key trends shaping the market include:

- **Shift toward personalized learning:** Users increasingly expect platforms that adapt to their study habits, preferences, and behavior patterns.
- **Growth of AI-driven productivity tools:** The rise of AI planners, intelligent study assistants, and automated scheduling systems is reshaping user expectations.
- **Popularity of gamification and community-driven study models:** Engagement features such as groups, progress tracking, and competitive or cooperative learning environments significantly improve retention.

3.1.2 Target Users

1. **High School Students**

Getting ready for big national or international tests and looking for organized study help, time management tools, and ways to stay motivated..

2. **University Students**

Managing a lot of classes and seeking for better ways to prepare, keep track of, and improve their grades.

3. **Competitive Exam Candidates**

People who are getting ready for important tests like the SAT, GRE, IELTS/TOEFL, YKS, KPSS, or certification tests need to plan ahead and stick to a program.

4. **Young Adults & Professionals**

Trying to find a balance between employment and school, and looking for tools to help me be more productive, stay focused, and create good habits.

5. **Self-Improvement & Psychology-Oriented Users**

People who actively look for ways to improve themselves, study about behavior, and learn in community-based settings to stay motivated over time.

3.1.3 Competitive Analysis

1. **Smart Study AI [11]**

Smart Study is a study tool integrated with AI that generates multiple-choice questions, flashcards, and short-answer questions. It generates these contents based on the uploaded notes, textbooks, or lectures.

2. **Evergreen [12]**

Evergreen is a student support platform developed by a university. It is focused on emotion-based planning, behavioral insights, and social well-being, adapting to users' routine behaviors and digital habits.

3. **Vaia [13]**

Vaia is a study platform which offers personalized study schedules, a chatbot, streak tracking, a calendar, and flashcards which are based on a large library of AI-generated and user-shared contents.

4. **MyStudyLife [14]**

MyStudyLife is a classic academic planner application that provides Pomodoro timers, streak tracking feature, task and calendar management, and simple progress tracking with a progress bar.

5. **Smart Timetable [15]**

Smart Timetable is a flexible scheduling app with multi-schedule support, iCloud sync, lesson notifications, Apple Watch integration, and detailed timetable widgets. It provides tracking the coming up assignments and exams.

Feature	Smart Study AI	Evergreen	Vaia	MyStudyLife	Smart Timetable	Mentora
1. Personalized Study Scheduling	✗ (focus on question generation)	✓ (emotion-based planning & routines)	✓ (exam-based scheduling)	✓ (basic scheduling)	✓ (multi-schedule system)	✓
2. Progress Tracking / Streaks	✗	✓ (learns from behavior)	✓ (streak counting)	✓ (progress bar & streak)	✗ (not mentioned)	✓
3. Gamification (badges, XP, leaderboard)	✗	✗ (no XP/leaderboard)	✗ (only streaks)	✗	✗	✓
4. Flashcards / Active Recall Tools	✓ (AI-generated questions, flashcards)	✗	✓ (flashcards + shared cards)	✗	✗	✗
5. Study Timer (Pomodoro)	✗	✗	✗	✓ (Pomodoro-like timer)	✓ (countdown timers for lessons)	✓
6. Calendar & Task Management	✗	✓ (routine schedule)	✓ (calendar & planning)	✓ (calendar-based tasks)	✓ (complex scheduling)	✓
7. AI Chatbot / Smart Assistant	✓ (feedback + Q&A generation)	✓ (conversational assistant)	✓ (chatbot)	✗	✗	✓
8. Emotion / Behavior-Based Adaptation	✗	✓ (emotion-based planning)	✗	✗	✗	✓
9. Sync & Multi-Device Support	✗	✗	✗	✗ (not specified)	✓ (iCloud, Mac, iPad, Watch sync)	✗
10. Community / Social / Shared Content	✗	✓ (focus on social connection)	✓ (view other students' flashcards)	✗	✓ (share schedules with others)	✓

3.2 Academic Analysis

In this project, it is essential for us to base our implementation of structural study schedules that are determined by the personality traits and the current emotional state of the users with an academic background, as otherwise the project would lack a solid foundation. We sought assistance from Bilkent instructors who are related to the field and consulted some academic papers.

Research shows that both emotional state and personality traits significantly influence students' learning behaviour. [16] Negative emotions such as stress, fatigue, or anxiety reduce sustained attention and working-memory performance, making long, uninterrupted study sessions less productive. [17]

Alongside emotions, stable traits are captured by the OCEAN personality model. These traits have been shown to correlate with academic performance, self-regulated learning strategies, and effective learning styles. [18] They offer suitable predictors of students' preferred learning strategies, including time management, concentration, self-testing, motivation, and effective study planning.[19] This suggests that a student's stable personality profile significantly influences how they approach studying. Beyond static personality trait data, daily emotional state adds a second layer of personalization by detecting a student's daily mood. Then, the system can make small adjustments to help avoid cognitive overload or disengagement on difficult days or commit to more intense sessions on days when motivation and focus are high.

These findings support the value of personalized learning systems that adapt to a learner's personality and emotional state. Adaptive e-learning environments, such as Mentora, which are based on learning styles (in Mentora's case, correlated with personality traits and emotional state), have been shown to improve student engagement and motivation compared to conventional and generalized programs. [20]

Thus, our solution of integrating OCEAN-based profiling and tracking emotional state to generate structured, adaptive study schedules is consistent with the current academic evidence and promises to increase students' adherence, motivation, and learning efficiency.

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[2]: https://developer.android.com/training/sharing/send

[3]: **Assoc. Prof. Dr. Elif Küzeci**

Vice Dean, Faculty of Law, Bilkent University

Expertise: Data Protection Law, GDPR, KVKK (Turkish Personal Data Protection Law), AI Ethics, Legal Philosophy and Sociology, State Theory.

Dr. Küzeci provided guidance on data privacy obligations, explicit consent requirements, processing sensitive data, and legal limitations related to profiling and personal data retention. Her expertise was instrumental in shaping the privacy and ethical approach of the project.

[4]: **Dr. Ezgi Sakman, Ph.D.**

Lecturer, Department of Psychology, Bilkent University

Expertise: Personality assessment, emotional data interpretation, cognitive performance under stress, attachment psychology, individual differences in relationship dynamics, parenting behaviors and child outcomes.

Dr. Sakman advised on the psychological sensitivity of emotional and personality related data, the interpretation limits of such measures, and ethical boundaries when designing supportive study recommendations based on users' psychological profiles.

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