



TED UNIVERSITY

CMPE 491 Senior Project I

A Gamified Training Platform Supported By AI Project Specifications Report

The URL of the project web page:

<https://isthisecho.github.io/TermProject/>

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1. Introduction

What Are Serious Games?

Games are an important part of human culture and society because they encourage participation and motivation [1]. We can describe a 'game' as something that is interactive, has rules, has one or more goals, has a quantifiable measure of progress, and has an identifiable finale [2]. This is why gaming mechanics are increasingly being applied to non-gaming environments, such as primary and secondary education, adult and further education, healthcare and fitness, the workplace, or consumer behavior, in order to promote desirable motivational, behavioral, and learning results [1]. Gamers are confronted with scenarios in which they have to make short and long-term decisions, as well as develop problem-solving solutions for complex tasks or nested sub-tasks [21]. Computer games have the potential to be a powerful learning tool since they may motivate people and increase interaction while also allowing them to “learn by doing” [21]. Also, it is claimed that playing computer games can help to enhance cognitive skills by allowing for the development of decision-making, design, strategy, cooperation, and problem-solving abilities [21].

Serious games are a subgroup of games that are specifically created for goals other than or in addition to pure enjoyment [2]. So, serious games are non-entertainment games that use game design techniques and technologies to achieve non-entertainment aims like education and training [3]. With the growing use of technology-assisted education, it's more important than ever the effects of serious game-assisted learning [4]. For this reason, the number of studies that reveal the features of successful serious games, including offer points, reward systems, badges and other incentive-based techniques, is also growing [2][4].

Gamification is the application of game design features to non-game contexts, and it is not always about learning, which is why it may be used in any context [2]. Serious games are referred to as educational entertaining tools where players improve their knowledge and practice their skills through overcoming numerous obstacles during gaming while providing a context for measuring and assessing a wider range of skills and constructs compared to traditional assessment approaches [3][4]. These skills and constructs include Competencies that have been identified as important for success in the "real world" in diverse domains [3]. Players' performances are scored during the game process, and players earn some rewards

such as points, progress, and power when they overcome an obstacle [4]. Serious games can be designed to simulate real world settings or take advantage of fictional and fantasy contexts to elicit behaviors that demonstrate creativity, decision-making, teamwork, leadership, and how resources are managed [3].

Furthermore, Botte et al. [20] proposed a taxonomy that divides serious games into three categories [19]. First, role-playing games without the requirement of mimicking real-life scenarios [19]. Second, business games in which the simulation is similar to a reality model that incorporates elements from such games [19]. Third, games that simulate reality in all of its forms [19].

In Which Areas Are Serious Games Used?

Nowadays, serious games are widely used in a variety of fields, including health, education, and industry, since they help people learn and train more effectively by engaging them and enhancing their motivation [19]. They are especially effective in education because, when compared to traditional teaching methods, they encourage pupils to participate in the learning process [19].

Serious games are games with goal-oriented objectives aimed at improving the player's performance and cognitive capacities in both real-world and non-real-world circumstances [5]. Serious games can be effective tools for assessment in a variety of fields, including education, healthcare, industry, corporate training, military training, and public management [3][5]. These games provide feedback in a variety of formats, including tables, graphs, texts, multimedia, synchronous and asynchronous peer feedback, and assessments which can be used to enhance learning in a variety of scenarios [5].

Because of their positive consequences in learning and learner participation, serious games have been frequently used in the field of medical education [4]. The researchers looked at usability, motivation, affective engagement, and learning, and found that serious games were often used and had a high degree of involvement [4].

In the recent literature, plenty of research has been published that show the benefits of serious games in terms of improving the detection and evaluation of neurodegenerative illnesses and their precursor conditions [28].

In addition, the use of serious games in the field of neuroscience learning was also investigated, which reported with positive results [4]. Learners who were aided by serious games gained much more neuroscience information than those without the aid of serious games [4].

Science education was also discovered to be the most used topic for serious games [8]. We can say that science education has progressed so far as a result of its collaboration with serious games that it is now encouraging scholars in other domains to study and better [8].

On the other hand, serious games still provide amusement, joy, and enjoyment to its users while also serving a hidden purpose [6]. For instance, the United States Army's America's Army game provided an enjoyable experience to their use as a "soldier," but there are also hidden purposes such as providing training and testing conditions for mission rehearsal, intelligence capabilities training, survival, and first aid training [6].

Moreover, serious games are used in team research and allow for the investigation of team constructs not easily researched through traditional means [18]. Serious game developers would benefit from team research because the use of serious games allows researchers to maintain rigorous criteria for internal validity, external validity, and generalization of findings while comprehensively probing the criterion space of effective team performance [18].

What Are the Advantages of Serious Games?

Serious games have a number of advantages, including making players feel accountable for their own success based on their actions, bringing together high-quality content, displaying high levels of involvement, and turning mistakes into learning elements [5]. Also, according to self-reports of players, serious games may improve their overall

pleasant mood and happiness level [4]. In serious games, the performance of users can be tracked, summarized, and then validated to other verified measurements or real-world behaviors [3]. For this reason, serious games are seen to be particularly advantageous as a technique of measuring behavior-based skills and competences beyond typical self-report assessments since they capture data on behaviors in interactive environments [3]. Another advantage of employing serious games as evaluation tools is their natural capability to utilize current technologies [3]. Through advanced methods and innovative technologies that go beyond typical "one-shot" assessment measures, serious games in digital software environments can be configured to record, store, and share vast amounts of user data over time [3].

Educational technologies, such as serious games and mobile applications, increase learners' academic success and encourage their participation in learning activities [4]. Serious game-based learning was found to be significantly more effective than traditional learning [4]. Learners and teachers were significantly more motivated, desirable, helpful, and less hindered in the serious game-based learning approach compared to the nongame-based [4]. Although there were no significant differences in knowledge exams, it was empirically proven that learners who learned through playing serious games scored significantly higher than those who did not learn through gameplay [4]. Furthermore, research has shown that digital game-based learning has great potential for increasing students' learning motivation and engagement, as well as cultivating their minds and spirits, hence improving their learning efficiency [7].

Serious games offer a great deal of potential to support vocational training in learning factories as extra teaching tools, increasing both learning fun and efficiency [9]. In the serious game, the participants integrate Industry 4.0 technology into a traditional factory hall, and, thereby allowing them to think about people, procedures, technologies, planning, and application fields [9]. The game moves on to the debriefing phase after the game master has finished the scenario or the fictitious production system has been successfully modernized, in which the learners reflect on their experiences by answering prepared questions that serve to evaluate the training program and are in line with the group's previously defined learning objectives [9]. Since the concept of the game scenario promoted a high level of social interaction among the players, the choice fell on a standard serious game form with an orientation to the concepts of simulation and business games [9]. Because of its modularity

and extensibility, the serious game concept may be changed and developed to meet the needs of an advanced training session [9]. In addition to factors such as motivation and enjoyment, participants acquire a favorable learning outcome as long as challenge and ability are balanced [9].

There are eight typical traits or elements of serious games: The necessity of effective facilitation and communication; space for reflexive learning, collaboration, and dialogue; negotiation and resolution; autonomous learning; and leveraging local knowledge [17]. Furthermore, serious games synthesize a variety of data sets to allow players to obtain a sense of the correlations between variables without having to perform precise quantitative analysis or manually integrate data sets [17].

Artificial Intelligence and Serious Games

Learning is most effective, according to modern theories of effective learning, when it is active, experiential, contextual, problem-based, and delivers instant feedback [24]. Serious games' effectiveness is highly dependent on their ability to strike the correct balance between gameplay and educational experiences [22]. This necessity poses difficulties in terms of realizing their intelligence and personalization [22]. Although AI and personalisation are important features of serious games, designing and implementing them effectively and efficiently still have major challenges [22]. It is critical to ease the process of authoring and adjusting serious games by individuals without programming skills in order to achieve diverse pedagogical goals in various educational contexts [22].

Commercial game technologies and AI frameworks from intelligent tutoring systems and intelligent narrative technologies are skillfully combined in intelligent game-based learning environments to offer engaged learning experiences that are both effective and interesting [23]. Intelligent game-based learning environments provide enormous potential for learning both in and out of the classroom because of their capacity to dynamically alter narrative-centered problem-solving scenarios, customize advice to students, and give real-time assessment [23].

Situating learning refers to the concept that a suitable deploying environment and appropriate interactions must be established in order for the learning to best fit the context of

use and this can be used in a variety of ways in practice [24]. For example, an immersive 3D environment could be powerful and successful only if it meets the learning objectives [24]. So, if the game simulates a highly realistic circumstance, the learning experience could be classified as an actual learning-by-doing attempt. Also, web-based games can benefit from receiving the appropriate data and content, as well as support the player in the learning task in real time [24].

There are games that modify the content to the learner's level, learning speed, reaction time, and even mistakes [27]. The introduction of Machine Learning and artificial intelligence algorithms will provide a lot of new uses to serious games, all of which will improve the results of transmission of the existing learning's knowledge object [27]. The results of the analysis of the data processed by the AI algorithms buried in the serious game will allow the teacher to make quick judgments depending on the learner's interactions with the serious game [27]. Understanding the learner's level in real time allows the supervisor to improve the learning process as it progresses, and in a personalized manner if necessary [27].

Furthermore, serious games may be a great way to not only learn and practice new abilities, but also to closely explore an environment without the constraints of time and space [25]. They also provide feedback and assessment, as well as the ability to customize learning [25]. A key component of a successful serious game is for the game designer's ability to strike a balance between the fun element and the main objective of the game which is clearly not entertainment [26]. This indicates that the game's enjoyment element should not be sacrificed in the pursuit of the game's main purpose [26].

What Are The Gamification Elements ?

The following is a complete list of the elements examined in our research:

- Badges: Throughout the course, badges were awarded for completing a mile-stone. Finishing an optional activity, completing a mission, or completing the course are all examples of this[12].
- Feedback: When performing activities, immediate feedback is offered.

The learner received an automatic response for each completed job[12].

- Missions: The tasks were divided into groups based on their missions.

Each mission had a set of activities to do, and once all of the tasks were completed, the mission was completed and a badge was received.[12]

- Points: When executing a specific activity or completing a specific assignment, certain points were rewarded. The challenges became more difficult as the course progressed, as did the number of points earned once each one was completed.[12]

- Levels: A set number of points were necessary for each level.Users level up as they earn more points. The number of points required for the next level rose as the level progressed.[12]

- Leaderboard: A table that displays a list of all participants. You can view the names of the participants, as well as their scores and levels.[12]

- Time limit: The amount of time allotted to perform a task. There were time constraints set for the completion of activities and the resolution of questions.[12]

- Blocked content: Completion of a previous task was necessary to complete some of the course tasks.There were additional locks on certain course aspects up to a certain date, in addition to task locking.[12]

Game mechanics contain budgets, points, and leaderboards.It is possible to extract game elements from various types of games, such as serious games [10].

The use of points, badges and leaderboards improves motivation and is considered an appropriate combination of mechanisms in the implementation of any gamification process in higher education [11] . Gamification in learning makes use of game components, i.e. the features that make games fun while also making them great learning environments.

Gamification, in other words, transforms a learning environment into one that is entertaining and fun. Also, according to an earlier study [10], gamification is a strategy that employs game aspects to solve a problem in a fun learning environment[12].

To give an example of one of the game elements, Points are one of the most commonly discussed gamification features (Morschheuser, Hamari, and Koivisto 2016)[11]. The platform in question, in particular, is furnished with conspicuous point mechanisms. Individual points accrue as solvers enroll in and win crowdsourcing contests (Liu, Alexandrova, as well as Nakajima 2011)[11]. A solver's points for a crowdsourced task are calculated depending on the task prize's transaction amount[11]. The solver will receive more points as the transaction amount increases[11]. As a result, user levels and solver points are intended to provide obvious measures of ability and performance (Vasilescu et al. 2014)[11].

Use Of Artificial Intelligence In Games

Artificial Intelligence (AI) is gaining popularity as a key component in video games. It allows players to avoid playing alone. As a result, the goal of AI in computer games today's generation is to provide a realistic experience for players to play with human-like logic skills [14]. Adopting game aspects and integrating them in a way that serves educational needs allows for the creation of educational games that can engage learners in learning new abilities such as problem-solving [15]. In order to boost player interest and learning outcomes, AI approaches have been utilized in game-based learning [15]. We can give examples about AI achieving superhuman skills in some circumstances, such as AlphaGo is well-known for defeating one of the best human Go players [15]. Also one of the first important achievements in AI playing video games was IBM's Deep Blue in 1997, when it defeated Chess world champion Garry Kasparov utilizing a Minimax algorithm, evaluation functions, and the power of a supercomputer, according(Yannakakis & Togelius, 2018) [16]. The level of AI sophistication is important matches like Left 4 Dead (Valve, 2008) and The Elder Scrolls V: Skyrim (Bethesda Softworks, 2011) supports this argument and suggests that advances in NPC AI have reached satisfactory levels for many of the NPC control challenges encountered during game development[13]. Recent years have seen a shift in academic and industrial interests in game AI due to the rise of robust and effective industrial game AI solutions, the convergence to satisfying NPC performances, support for the multidisciplinary

nature of game AI, and a more pragmatic and holistic view of the game AI situation[13]. Also we can give an example about QuizMAster game known as an intelligent educational game. To give detail, A quiz game-based learning system is being developed with the goal of providing students with adaptive assessments. In this game, intelligent agents are used to do activities such as creating a player's profile, assessing a player's degree of expertise, and so on, in order to provide an adaptive assessment for each player [15].

Because of its important significance in computer applications, AI should receive a lot of attention. In games, various AI approaches are used. Many research have demonstrated the effectiveness of AI in both games and instructional applications [15].

2. Proposed system

2.1. Overview

In the project, we want to make an education platform supported by artificial intelligence. Our project will consist of two parts, a web program running on the web side and a mobile application. We also want to add gamified materials to increase the impact of the content on users.

Mentally, there will be two divided programs which are .NET based server with MsSql database at the backend side and React Native application at the frontend side. Also, artificial intelligence powered by ML .NET will be used for suggestions.

Since Asp .NET Core will be used to build RESTful API, mediator pattern which enables developers to separate GET method with other REST methods in order to optimize web performance has been chosen. To obtain a more flexible and responsive UI experience, React which is a JavaScript library will be used for development of our web application. Unlike the traditional usage of React hooks, MobX state management framework will be preferred. To be able to avoid chaos of the compatibility between backend side and mobile side, Formik library will be implemented. For the push notifications, onesignal platform will be preferred due to ease of use and flexibility.

Instructors will be able to upload education materials such as videos, documents or slides according to related courses and subjects to the web app. Also, students will be able to reach these materials by using a mobile app.

In addition, There will be online and offline quizzes to determine understanding levels of students. According to these outcomes, ML .Net based artificial intelligence facility will suggest specified education materials which contain missing parts about lectures. At the end of the day, Instructors will get the ability profile of their students.

2.2. Functional Requirements

REQ1 The system shall require email address and password. When a user does not enter required information, the system shall display an error message. **(Mobile, Web)**

REQ2 System shall not let users enter more than 3 times the wrong username or password. After the third inaccurate try, the user will be asked to enter the verification code which has been sent to the user's email address by system. **(Mobile, Web)**

REQ3 System shall not allow users which are not signed in to manage their information. **(Mobile, Web)**

REQ4 If the user is not able to login within 30 seconds, the system displays an error message and the process ends. **(Mobile, Web)**

REQ5 The user who wants to reset his/her password must enter the registered email address. **(Mobile, Web)**

REQ6 The user must enter the confirmation code sent to his/her email address in the box. **(Mobile, Web)**

REQ7 The system shall require name, surname, email address, ID number and password. When a user does not enter required information, the system shall display an error message. **(Mobile, Web)**

REQ8 The system shall not accept passwords shorter than 8 characters. When a user attempts to choose a password which is less than 8 characters, the system shall display an error message. **(Mobile, Web)**

REQ9 The system shall not accept emails and ID numbers which are used in previous registrations. When a user attempts to choose a used email or ID number, the system shall display an error message. **(Mobile, Web)**

REQ10 The system requires confirmation of the agreement form to successfully complete the account registration. When a user does not confirm agreement form, the system shall display an error message. **(Mobile, Web)**

REQ11 The system shall require a password from the user to make changes in Account Information. **(Mobile, Web)**

REQ12 The system shall require the user to enter their old password to change the password. **(Mobile, Web)**

REQ13 The system shall not accept passwords shorter than 8 characters. When a user attempts to choose a password which is less than 8 characters, the system shall display an error message. **(Mobile, Web)**

REQ14 If the password change process is successfully completed, the system shall send an informative message to the user's email address. **(Mobile, Web)**

REQ15 The system shall show students their total scores and rankings. **(Mobile)**

REQ16 When the user clicks on the name of any user, the system shall show earned badges of this user. **(Mobile)**

REQ17 When the user clicks on the course, the system shall open the course page and display the chapters. **(Mobile)**

REQ18 The system shall display the courses in which the student is enrolled in a different color from other courses. **(Mobile)**

REQ19 The system shall allow the student to filter the courses as all courses and my courses. **(Mobile)**

REQ20 The system shall display the completion percentage of the courses. **(Mobile)**

REQ21 The system shall display the course description and the instructor name when the user clicks on the 'i' icon. **(Mobile)**

REQ22 When the user clicks on the course name, the system shall display the videos, pdf's and documents of the course separately on a new page. **(Mobile)**

REQ23 When the user clicks on the videos, the system shall display the videos according to the chapters they belong to. **(Mobile)**

REQ24 The system shall display online quizzes in green and offline quizzes in red to the user. **(Mobile)**

REQ25 The system shall display the start and end date of online quizzes. **(Mobile)**

REQ26 The system shall allow users to filter quizzes online or offline. **(Mobile)**

REQ27 When the user clicks on the open quiz, they will be able to start the quiz. **(Mobile)**

REQ28 The system shall display the question text and answer options to the user. **(Mobile)**

REQ29 The system shall let the user be able to skip to the previous and next questions. **(Mobile)**

REQ30 If the quiz is online, the system shall show the remaining time to the user. **(Mobile)**

REQ31 If the user completes and submits the quiz, the system shall close the quiz for the user. **(Mobile)**

REQ32 The system shall display the success percentage of total courses of the student. **(Mobile)**

REQ33 The system shall display the student's percentage of success in the quiz. **(Mobile)**

REQ34 The system shall display the number of correct and wrong answers of the student. **(Mobile)**

REQ35 The system shall show the missing chapters to the student according to the subjects of the questions answered incorrectly by the student. **(Mobile)**

REQ36 The system shall display the correct answer option in green. **(Mobile)**

REQ37 The system shall display the student's wrong answer in red. **(Mobile)**

REQ38 The system shall allow the user to delete the notification by clicking the delete sign next to the notification. **(Mobile)**

REQ39 The system shall display the new incoming notification in a different color from the old notifications. **(Mobile)**

REQ40 The system shall require an instructor certificate of the user to create an account. When a user does not upload the required document, the system shall display an error message. **(Web)**

REQ41 When the user clicks on the calendar, the system shall open the calendar in a popup window. **(Web)**

REQ42 When the user clicks on the notification icon, the system will open the notifications in a popup window. When the user clicks on the notification icon, the system will open the notifications in a popup window. **(Web)**

REQ43 When the user clicks on the profile icon, the system will open the account information in a popup window. **(Web)**

REQ44 The system shall let the user sort and search. **(Web)**

REQ45 The system shall allow users to create courses by clicking the 'Add Course' button. **(Web)**

REQ46 The system shall allow users to create a quiz by clicking the 'Add Quiz' button. **(Web)**

REQ47 The system shall require course name and description. When a user does not enter required information, the system shall display an error message. **(Web)**

REQ48 If the course creation process is completed successfully, the system shall display an informative message. **(Web)**

REQ49 The system shall require chapter name, chapter code and chapter description. When a user does not enter required information, the system shall display an error message. **(Web)**

REQ50 If the chapter creation process is completed successfully, the system shall display an informative message. **(Web)**

REQ51 The system shall require subtopic name and subtopic description. When a user does not enter required information, the system shall display an error message. **(Web)**

REQ52 If the subtopic creation process is completed successfully, the system shall display an informative message. **(Web)**

REQ53 When the user clicks on the student's name, the system shall open the student's profile. **(Web)**

REQ54 The system shall display students whose total earned score is lower than the average in red. **(Web)**

REQ55 The system shall require the user to select the material type to be loaded. When a user does not choose the type of the material, the system shall display an error message. **(Web)**

REQ56 The system shall require the user to drag and drop the file they want to upload into the box. **(Web)**

REQ57 If the material upload process is completed successfully, the system shall display an informative message. **(Web)**

REQ58 The system shall require the course name, chapter name, date, time and type of the quiz to be created. When a user does not enter required information, the system shall display an error message. **(Web)**

REQ59 If the event creation process is completed successfully, the system will display an informative message and send notification to students. **(Web)**

REQ60 The system shall require the text of the question. When the user does not enter required information, the system shall display an error message. **(Web)**

REQ61 The system shall require answer options of the question to be created. **(Web)**

REQ62 The system shall require selecting the answer of the question to be created. **(Web)**

REQ63 The system shall allow users to upload images for the questions. **(Web)**

REQ64 The system shall allow the user to save the question by pressing the 'Save Question' button. **(Web)**

REQ65 The system shall allow the user to delete the question by pressing the 'Delete Question' button. **(Web)**

REQ66 The system shall allow the user to complete the quiz by pressing the 'Complete' button. **(Web)**

REQ67 If the quiz creation process is completed successfully, the system shall display an informative message. **(Web)**

REQ68 The system shall display the newly created instructor accounts to the admin. **(Web)**

REQ69 The system shall display the creation dates of the accounts. **(Web)**

REQ70 The system shall allow the admin to view the certificates by clicking the 'Examine Certificate' button. **(Web)**

REQ71 The system shall allow the admin to approve or reject the reviewed certificate. **(Web)**

2.3. Nonfunctional requirements

REQ1 The System needs very few system resources in order to work and the response time of the program shall not be more than one second. The system's load time shall not be more than ten seconds.

REQ2 The information of the users is securely transferred to the database without any change or loss in the information

REQ3 The system shall be available to users 24 hours a day, 7 days a week. The system will provide all the features and the tools that support features of the project, but in case of failure it will give an error message.

REQ4 The system never allows users to view or change another user's account or payment information.

REQ5 Moving from one OS to another OS shall not create any problem.

REQ6 System shall be capable enough to handle one hundred thousand users without affecting its performance.

2.4. System Models

2.4.1. Scenarios

As mentioned above, there will be two integrated programs which are a web application for Instructors or Admins and a mobile application for students.

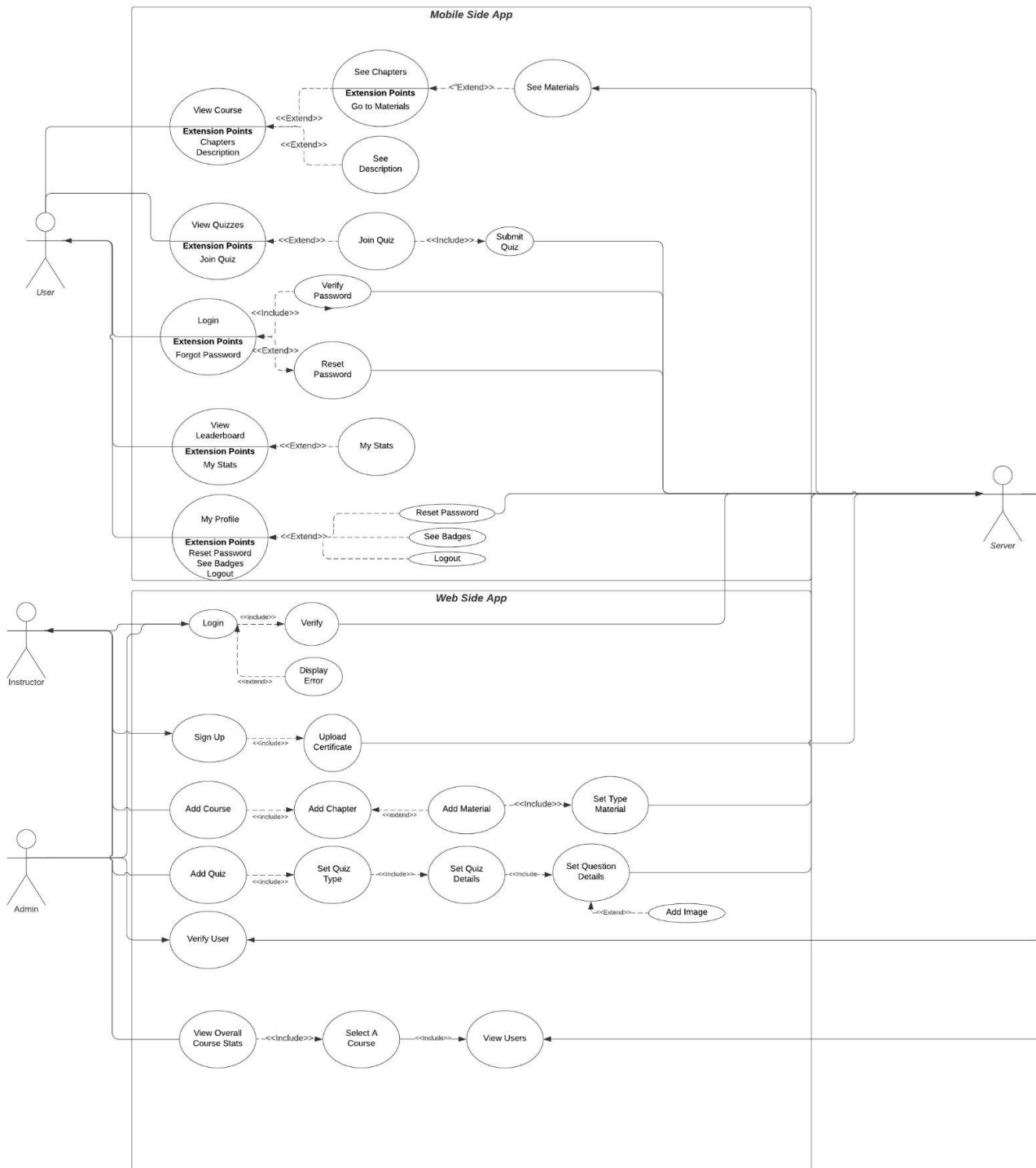
Instructors will be able to sign in or sign up through the web panel, create, update or delete courses and its subtopics. Also, Instructors have authority on adding students to their classes as well. Then, they can upload course material such as videos, word documents or pdf's. In addition, Instructors can add online or offline quizzes under a group of courses or a single course that has chosen by themselves, a specific course or its subtopics. Moreover, there will be a chance to see the performance of an entire class or individual student.

Admins will be responsible for approving or rejecting the sign up process.

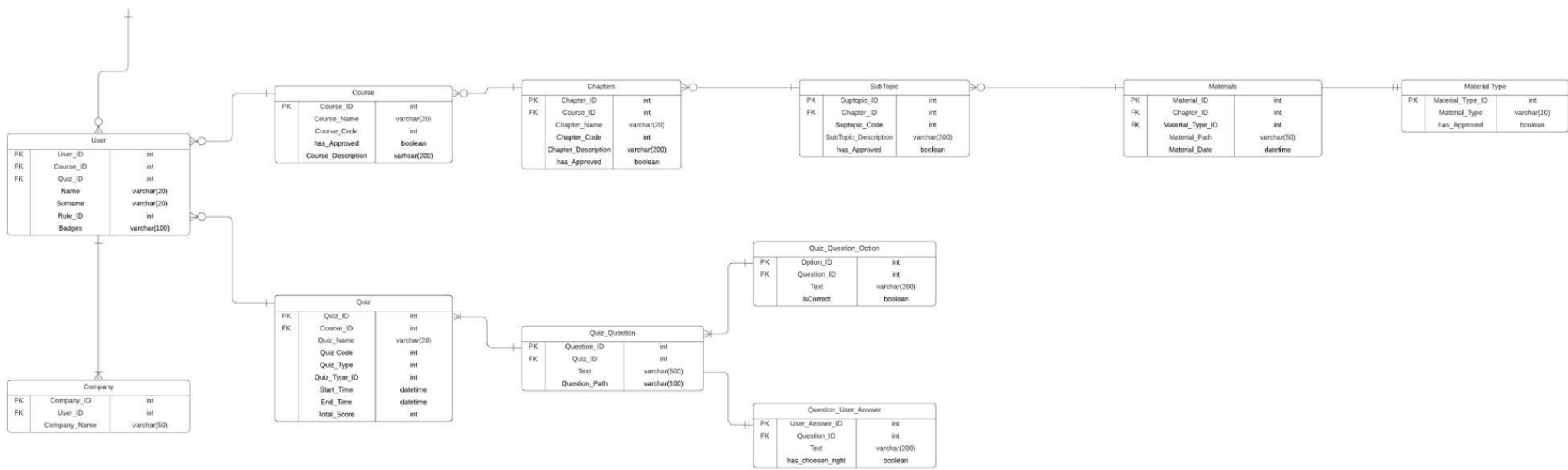
Students will be able to sign in or sign up through the mobile panel, reach course materials which have already been uploaded by their instructors, join online or offline quizzes and finally see their standings among other students.

Both Instructors and students will be able to see their profile preferences and change them via a related user panel.

2.4.2. Use case Model



2.4.3. Object and Class Model



2.4.4. User interface - navigational paths and screen mock-ups

<https://balsamiq.cloud/se2d5pn/p5ovqee>

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