# A GAMIFIED LESSON PREPARATION SYSTEM

A Thesis

by

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# A GAMIFIED LESSON PREPARATION SYSTEM

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*To my mother and father*

# ABSTRACT

Good games are embedded with many elements that make them attractive to play. If lessons could also be gamified, they would cease to be boring and become attractive as well. This could result in students spending more time studying and learning in an efficient way. In this thesis, we present a method and tools for preparing gamified lessons. In addition to gamifying the delivery of lectures, assignments, exams, and grading, we incorporate many different game elements into lessons in order to improve the gamification of lessons. We present a visual authoring environment to guide instructors in preparing gamified lessons and also define an index to measure the "gameness" of a gamified lesson. An instructor could use this index to determine whether he/she has gamified his/her lesson enough. Furthermore, we present an interactive web application for students so that they can "play" the gamified lessons.

**Keywords:** gamification, game-based learning, gamified lesson preparation

# ÖZETÇE

İyi bir bilgisayar oyununda, bir kişiyi kendine bağlayan bir çok özellik bulunur. Eğer dersler de oyunlaştırılarak sunulabilirse öğrencilere sıkıcı gelmez ve oyunlar kadar ilgi çekebilirler. Böylece öğrenciler derslere daha çok zaman ayırabilir ve derslerden beklenen faydayı daha hızlı ve etkili bir şekilde elde edebilirler. Bu projenin amacı, oyunlaştırılmış dersler hazırlamanın yöntem ve araçlarını geliştirmektir. Bu projede, derslerde hali hazırda kullanılan konu anlatımı, ödevler, sınavlar, ve puanlamalar gibi aşamaları oyunlaştırmanın yanısıra, derslerde şimdiye kadar hiç kullanılmamış olan ama oyunlarda sıkça faydalanılan bazı ilgi çekici öğeleri de ders tasarımlarına eklemenin yöntemlerini araştırdık. Oyunlaştırılmış dersleri hazırlamak için eğitmenleri adım adım yönlendirecek kolay kullanışlı bir arayüz geliştirdik. Hazırlanan derslerin oyun değerini ölçmek için özgün bir endeks tanımladık. Eğitmenler bu endeksi, dersleri ne kadar oyunlaştırabildiklerini ölçmek için kullanabilecekler. Bu projede ayrıca, öğrencilerin oyunlaştırılmış dersleri takip edecekleri web uygulamaları geliştirdik.

**Anahtar kelimeler:** oyunlaştırma, oyunlaştırılmış eğitim, oyunlaştırılmış ders hazırlama

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I must express my very profound gratitude to my parents for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

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# INTRODUCTION

This chapter provides an introduction to gamification and gamified learning systems. Gamification has been described as the use of game design elements in non-game contexts and draws on the motivational characteristics of games to lead users to adopt specific behaviors and explored recently and increasingly as a way to promote content delivery in education, yielding promising results [1], by increasing student activity [2] and performance [3].

## 1.1 Motivation

When we observe students we frequently see that they get bored with the usual means of delivery of courses, they are not enthusiastic about learning, they can't focus on the material instructors are presenting, they feel inadequate and they perceive themselves as lacking ability and at one point they break away from the course [4]. Due to all these obstacles, students can't reach their full potential and become unhappy. If lessons can be gamified, students could become more enthusiastic about learning and they can achieve the expected benefits of the course. In this thesis, we present an efficient way to gamify lessons.

Games are not only fun and time-consuming activities. In a good game, there are many qualities that make a person feel happy and connect to the game; Such as being a part of a task, choosing how to proceed, overcoming obstacles, wondering about results, expressing oneself, being confronted with surprises, winning a prize, level jumping, struggling in a team, entering a leaderboard, etc. All these features can also be used to make a course engaging. Students use their problem-solving skills in courses too, but courses are usually boring and don't feel like a game. The reason

for this is that courses don't have the elements that make games attractive. Most of the elements that make games attractive can in fact be used in courses in a natural way. For example, topics that need to be learned can be represented as targets that are to be reached, assignments can be given as missions and exams as challenges. Achievements of the students can be rewarded publicly using badges, trophies and leveling. In addition, many game mechanics can be used in courses, such as self-expression (students have the ability to use a picture of themselves or character as an avatar), helping a friend, surprises, raising curiosity through a story, etc. [5].

## 1.2    The Objective of the Thesis

Students are actually aware of the benefits of studying and the time they need to spend. However, there are many activities around them that scatter their attention. By gamifying lessons we can make courses as interesting as these activities and we can motivate students to allocate required time to the classes. With the method we developed, students will be aware of the fact that they are studying, but they will feel like they are in a game while they are studying lessons.

The goal of this thesis work is to design and develop an efficient method to gamify courses. If courses are designed with some specific game elements, students could become more enthusiastic about learning and they can achieve the expected benefits of the course.

## 1.3    Literature review

Educational computer games are games that provide educational value to people. This kind of games include hidden or apparent elements that assist people in learning a particular skill as they play. One of the earliest examples of educational games is called Oregon Trail released in 1974 [6]. The original game was designed to teach school children about the historical realities of 19th century pioneer life on the Oregon

Trail. A screenshot of this game can be seen in Figure 1. Other examples of educational games are Immune Attack, Radix Endeavor, Timez Attack, and Mission US. In Immune Attack [7], the player assumes the role of a pilot controlling a nano-robot and learns human biology. With the help of advisors, the player must learn about the different cells and environments in the human body in order to determine how to train the immune system. A screenshot of this game can be seen in Figure 2.
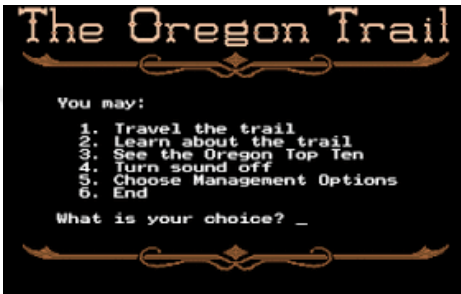


**Figure 1:** The Oregon Trail
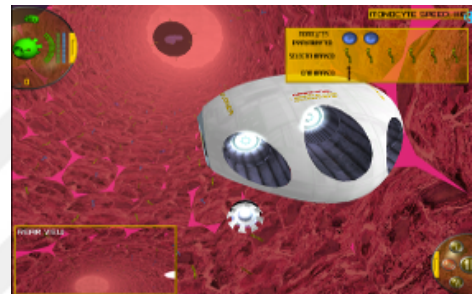


**Figure 2:** Immune Attack

Radix Endeavor [8] is an online multi-player educational game designed by MIT to teach biology and math to high school students. Students use their knowledge of math and science to solve quests in a virtual world. A screenshot of this game can be seen in Figure 3. Timez Attack [9] is designed to teach basic arithmetic operations. Students solve addition, subtraction, multiplication and division problems that appear on monsters instead of shooting them. A screenshot of this game can be seen in Figure 4.



**Figure 3:** Radix Endeavor



**Figure 4:** Timez Attack

Mission US [10] is designed to teach American history. It puts the player in the

shoes of different characters and makes them witness important milestones in the US history. The aforementioned educational computer games can only be prepared by large game development teams. It is almost impossible for an instructor to develop such educational games with his/her limited resources. It is more likely for instructors to prepare their lectures and then gamify them.

The most significant examples of gamified learning applications are Mathletics, Duolingo, Code Hunt, KnowRe, Khan Academy, ClassDojo, GoalBook, and Coursera.

Mathletics [11] aims to help users master mathematics. Mathletics is targeted at the K-12 school market. A student who solves enough problems wins a virtual badge. Students are able to design their own avatars with the points they earn by solving questions. A screenshot of this application can be seen in Figure 5.

Duolingo [12] aims to teach everyone a second language. Lectures are divided into specific fields (basic expressions, idioms, foods, etc.). To complete a course, a certain number of questions need to be answered. The application keeps track of wrong answered questions and uses this information to make the system better. A screenshot of this application can be seen in Figure 6.



**Figure 5:** Mathletics
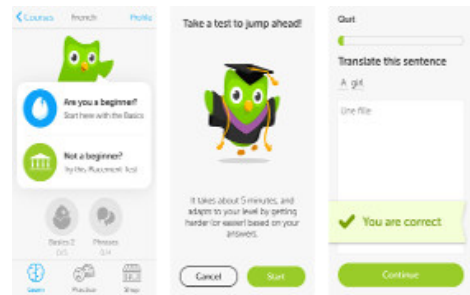


**Figure 6:** Duolingo

Code Hunt [13] is developed by Microsoft to teach computer programming. Users code an unknown computer program using input/output matches. Learning is divided into topics sorted from easy to difficult. The application keeps track of the students' performance and announces best scores on the web site. A screenshot of this application can be seen in Figure 7.

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KnowRe, [14] aims to teach basic math topics. It displays the topics on a map and students earn points as they learn the topics and expand the area they had on the map. Instructors can monitor the students and observe which topics students struggle most and give assignments using the application. A screenshot of this application can be seen in Figure 8.



**Figure 7:** Code Hunt



**Figure 8:** KnowRe

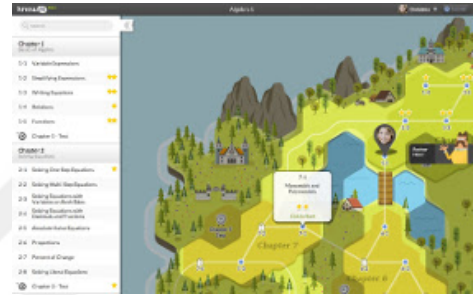Khan Academy [15] is a gamified learning application that includes lecture videos and questions from many different disciplines such as math, art, computer programming, economics, physics, chemistry, biology, etc. Every video corresponds to a knowledge unit and the relationship between knowledge units are displayed on a Knowledge Map. Students are not restricted by the sequence on the Knowledge Map, they can study any topic available on the map without satisfying a prerequisite. Students collect points and badges for watching videos, solving problems, and completing topics. The application allows parents and coaches to tutor the students. A parent/coach can monitor his/her students to identify their weaknesses and guide his/her students accordingly. A screenshot of this application can be seen in Figure 9.

ClassDojo [16] is a classroom management tool to help teachers improve behavior in their classrooms. It improves specific student behaviors and helps engagement by issuing awards and recording real-time feedback. Each student gets an avatar which can be visibly displayed in ClassDojo. For positive behavior it is easy for the teacher to initiate quick feedback to the student, awarding feedback points with a simple click on her mobile device or computer. This instantly reinforces good behavior

and engages other students. Because the feedback time is shorten, the resulting positive reinforcement helps students develop a sense of purpose in the classroom, which enhances intrinsic motivation over time. By giving students visibility and data on their own behavior, the class becomes less disruptive, creating a more positive learning environment. A screenshot of this application can be seen in Figure 10.



**Figure 9:** Khan Academy
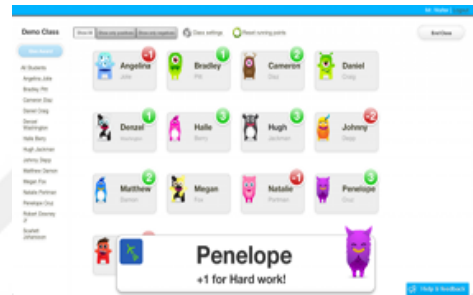


**Figure 10:** ClassDojo

GoalBook [17] is an online platform that helps teachers, parents and students collaboratively track progress. With GoalBook, a teacher can easily access the profiles of all her students and review their goals. The teacher can then monitor the progress of each student as they complete the objectives for each goal. When a goal is met, the teacher can quickly update the student's profile and then share it with student's team. From teacher's webpage, a teacher can easily update and celebrate the accomplishments for any of his/her students, as well as see what they are sharing. A screenshot of this application can be seen in Figure 11.

Coursera [18] is an educational technology and social entrepreneurship company that partners with leading universities to make some of their online courses available for free. Subjects include courses ranging from the Sciences and Engineering to Humanities and Business. The courses are designed to be delivered as a series of short video lectures on different topics and assignments, which are typically submitted on a weekly basis. Progress can be measured by completing assignments and tests online where machine grading and evaluation can be used. The results are immediately

reported to the student, as well as the instructional staff, providing feedback and re-
inforcement to the student. In some cases, leveling up, badges and other rewards sys-
tems are implemented. Interactivity among the students is emphasized to encourage
engagement and assist in long-term retention of concepts. This also provides frequent
feedback which enables the student to monitor their progress and self-evaluate their
understanding of the material. A screenshot of this application can be seen in Figure
12.
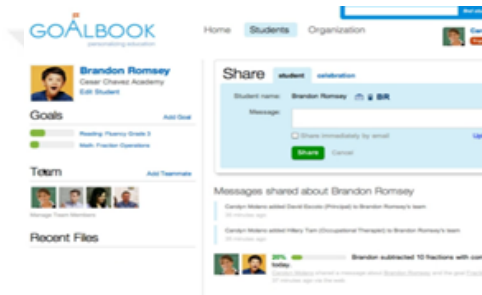


**Figure 11:** GoalBook
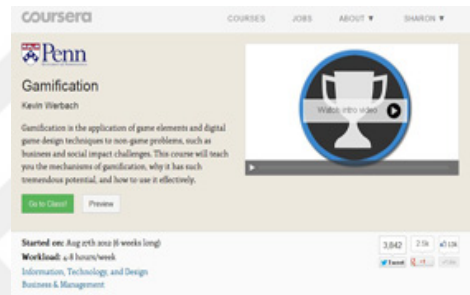
**Figure 12:** Coursera

The aforementioned applications do not offer tools for instructors to prepare their
own gamified lectures. Only Doulingo has tools for people who may want to add
new languages to the application however the application itself is limited to language
education. Furthermore, these applications employ only few game mechanics such
as points, badges and leaderboards. Using more game mechanics would make the
application more attractive and increase the time spent for learning. We use a larger
set of game mechanics in our system than examples mentioned above.

## 1.4   Contribution of the thesis

Instructors play a key role in introducing innovations in the classroom, especially
technology-related innovations such as gamification [19]. Gamification is both a
promising and a challenging tool for teachers willing to implement technological game-
based innovations in their courses. Instructors might face difficulties when choosing
and designing materials to gamify their courses because of their lack of experience.

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The main contribution of this thesis work is to provide user friendly software tools including solid and instructive guidance for instructors to create their gamified lectures and for students to learn those gamified lectures. Lesson preparation and learning tools are developed to serve these purposes. Additionally, a large set of game mechanics used is in our system. Gamification toolbox is developed in relation with lesson preparation and learning tools to ensure using gamification mechanics for gamifying the lectures and presenting those gamified lectures. In addition, an index has been developed to measure the "gameness" of a gamified lesson. An instructor could use this index to determine whether he/she has gamified his/her lesson enough. Gameness index depends on how many game mechanics used by instructor in a course.

## 1.5   Outline of the thesis

This thesis is structured as follows:

**Chapter 1** gives general introduction by taking a brief look at gamification and gamified-learning systems and also sets the objective of the thesis.

**Chapter 2** contains detailed information about the gamified learning system components and the design details developed in this thesis.

**Chapter 3** gives an overview of the software development platform used in this thesis work and presents all the details of the implementation, explaining function of each component, giving details about every task processed by the software part of the system.

**Chapter 4** is to serve as a review of the outputs of the work, including educational software and gamified lecture examples.

**Chapter 5** contains a summary of the study, contribution to the literature and suggestions for future work.

# CHAPTER II

# GAMIFIED LEARNING SYSTEM

## 2.1  System overview

Considering the features that make games attractive, we determined what tools should be employed when creating gamified content and how this content should be presented. We developed a gamified course generation platform for this purpose.

In our approach, the basic hierarchy of a gamified course follows the following path; Learning Outcomes > Subjects > Topics > Knowledge Units. As seen in Figure 13, every course has a certain number of goals, which are nothing but the learning outcomes of the course. In order to reach a goal, students must learn specific subjects. Subjects are the divided into topics related to the subject. Topics could be at basic, intermediate or advanced level. Topics consist of knowledge units related to the topic. Learning of knowledge units could be tested with easy, medium, or hard questions. In order to learn a topic at a minimum level, a student must solve easy questions of the knowledge units that belong to that topic. Students collect points by answering questions. If enough points are collected from questions, they will be considered as successful in that knowledge unit. In order to learn a subject at a minimum level, students must learn every topic under the subject at least at a minimum level. Finishing all the topics at a minium level successfully is necessary for leveling up and having an access to intermediate and advanced topics of the subjects. If a student learns a subject, he or she is deserved to receive a badge. In order to reach a learning outcome (goal) and have a trophy, students must finish all the subjects related to that learning outcome.

Students are able to see the points they collected and hence they are able to follow

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their progress towards the goals of the course. Students also see the points collected by their classmates so they have a chance to compare their progress. Students are motivated by earning badges and trophies depending on their success level in subjects and learning outcomes (goals), respectively.
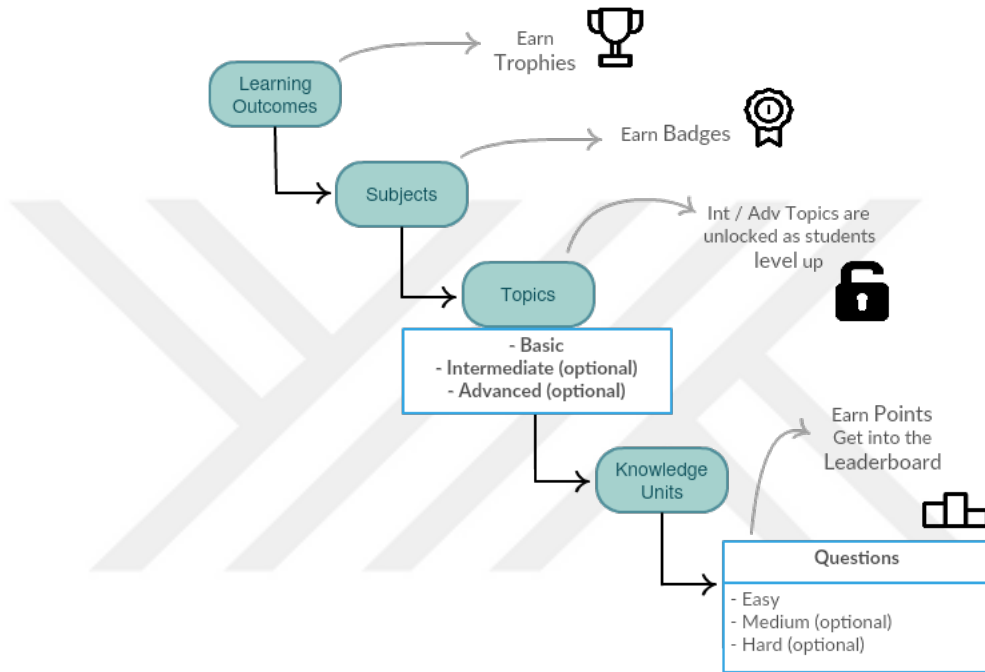


**Figure 13:** System overview

## 2.2   *Gamified lesson preparation tool*

A careful planning of the course is required so that the game-based learning elements are well integrated and are not just seen by students as breaks or fun moments in class. Gamified lesson preparation tool is a web application for instructors for preparing content of courses that are going to be gamified.

### 2.2.1   Learning outcomes

Learning outcomes are connected with subjects and there's a many-to-one relationship between subjects and learning outcomes. Each subject is linked to a single learning

outcome. Several subjects may be linked to the same learning outcome. Instructors should map the course subjects against the learning outcomes of the course. In order to reach a learning outcome (goal), students must fi nish all the subjects related to that learning outcome. In case the rewarding module is enabled, students who reached a learning outcome are rewarded with a trophy.

### 2.2.2 Course subjects

Course subjects are like chapters in a book. The relationship between subjects and learning outcomes defines which subjects need to be learned in order to reach a specific learning outcome. In order to learn a subject at a minimum level, students must learn every topic under the subject at least at a minimum level. In case of rewarding module is enabled, students who learn a subject are rewarded with a badge.

### 2.2.3 Topics

Topics contain course contents. Topics are main learning materials provided by instructor of the course. Materials can be included in topics in different forms like text, images, and videos. In order to learn a topic at a minimum level, a student must solve easy questions of the knowledge units that belong to that topic. Topics can be connected to each other using the achievement module in the gamification toolbox. In that case, in order to unlock a topic that is preceded with a connection, students would have to complete the pre-requisite topics at a minimum level.

### 2.2.4 Knowledge Units

The smallest unit of learning materials are called as knowledge units. For instance, under every topic, students will learn different methods and each method might be a knowledge unit. Topics consist of knowledge units related to the topic. Learning of knowledge units could be tested with easy, medium, or hard assignments.

As can be seen in Figure 14, every knowledge unit must have easy questions (easy

assignment). Medium and hard questions are optional. The type of questions are multiple-choice and they might have one or more correct answers. Easy questions of a knowledge unit contain basic questions about the knowledge unit. If a student answers fifty percent of the questions in easy questions of a knowledge unit successfully, the system considers that student have basic information about the knowledge unit. Fifty percent is a default value and it can be changed by the instructor. Questions are connected to each other directly and solving easy questions may have unlocked the medium questions and solving medium questions may have unlocked the hard questions if an instructor gamify the course using achievement module in gamification toolbox.

The questions authoring tool component is an application that can be used to construct questions interactively by adding/editing questions. Since exam questions often make use of visuals, questions that are in image formats are also supported. Solving questions can provide immediate feedback to the student about how much he/she has learned.

## 2.3 Gamification toolbox

Using the gamification elements is significant to keep the students' interest and further motivate them to investigate the subject on their own. A careful planning from the part of the instructor is required so that the game is effectively incorporated in the overall course learning process in order to support the achievement of the course learning outcomes, with the active engagement of the students.

Gamification toolbox is for gamifying the course prepared by instructors. It includes different game mechanics as modules. Instructors can decide which module (game mechanic) they want to use in their course when they gamify their course. As seen in Figure 18, Rewarding, Achievement, Level, Quest, and Leaderboard modules are implemented.
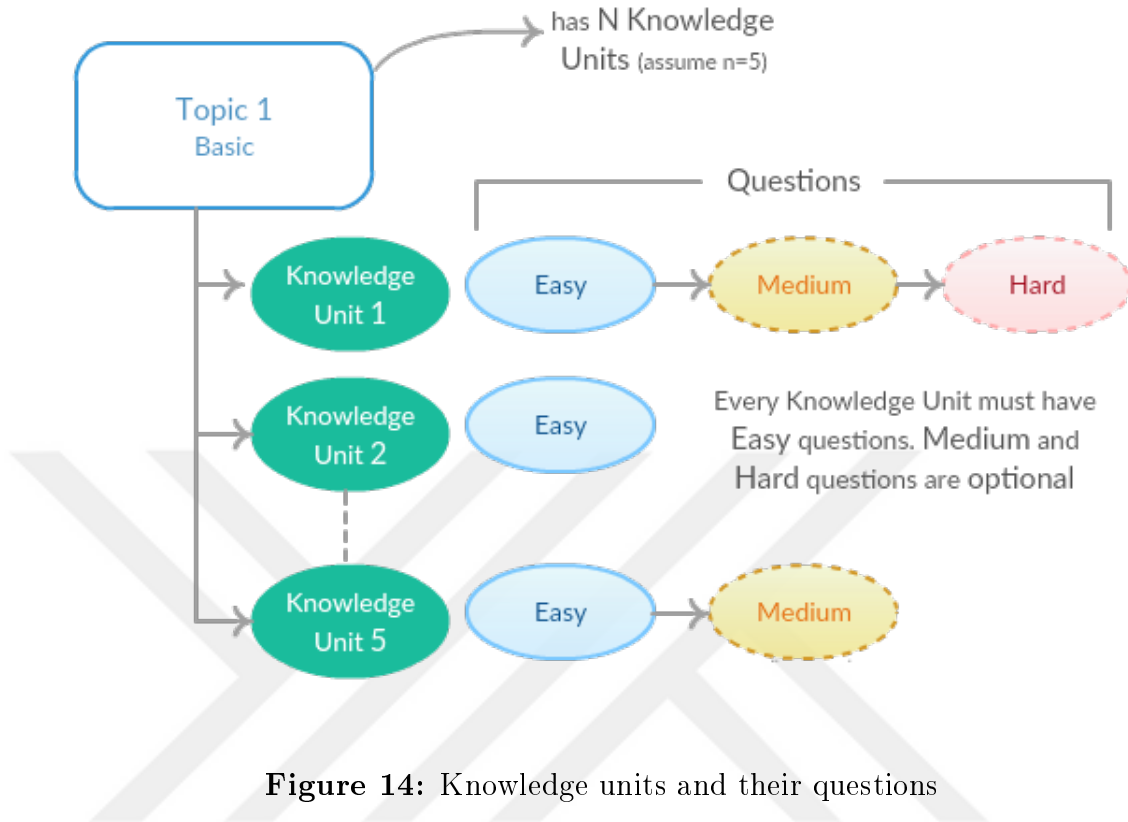
**Figure 14:** Knowledge units and their questions

As can be seen in Figure 15, solving questions gives students points. Points are used as the basis for getting badges and trophies and also position within a Leaderboard.

These points determine where the students sit on a leaderboard, giving them some level of status. Progress bars that show progression, images of badges and leaderboards are also visual aids to monitor feedback.

### 2.3.1 Rewarding module: Points, Badges and Trophies

Points are numerical values that are given to players after each action or multiple actions are succeeded. Badges mark the completion of the goals and steady progress of play inside the system. In case of enabling this module, students collect points by solving the questions, earn badges after finishing a subject and trophies after reaching a learning outcome.

Default value of a quesiton is one point. Solving a question brings one point to

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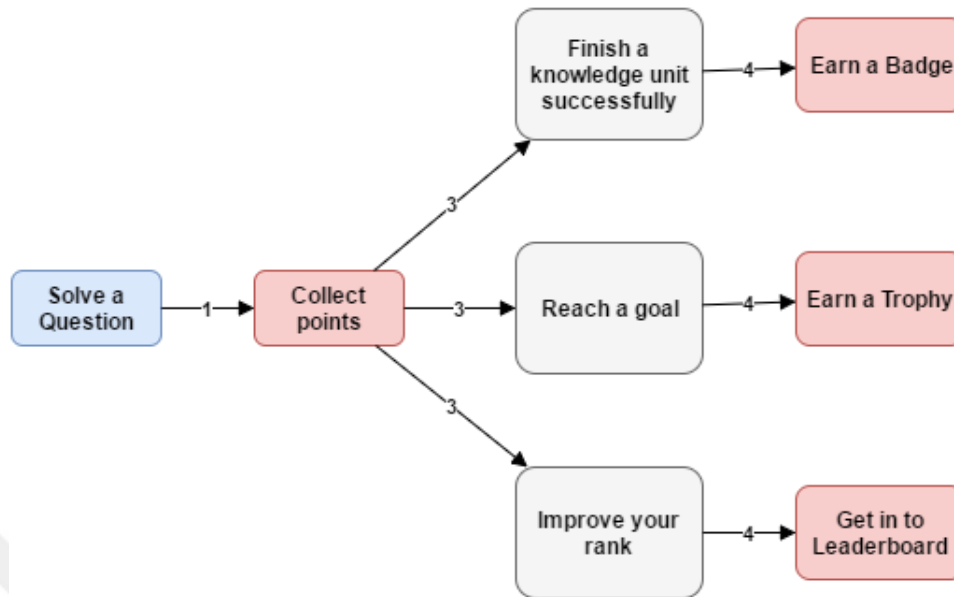
**Figure 15:** Points, Badges, Trophies and Leaderboard as game mechanics

a student by default. An instructor may change the default value of each question if he or she thinks a question worth more points to solve.

Trophies and badges are a form of virtual achievement by students. Students receive three type of badges - bronze, silver and gold - based on their achievements. If a student finishes all easy questions of a subject, he or she is rewarded with a bronze badge. In case of finishing all medium and hard questions of a subject sucessfully, a student is rewarded with a silver and gold badges respectively. Badges provide positive reinforcement for the targeted behavior like learning subjects. Similarly, if a student achieves a goal (learning outcome) of a course, he or she is rewarded with a trophy. Achieving a goal means being successfull with all the subjects that related with a specific learning outcome of the course.

### 2.3.2  Achievement module

Achievements are a virtual or physical representation of having accomplished something. In case of enabling this module, topic contents become locked until students unlock them one by one. A topic content and related questions become available

by finishing easy questions of previous topic successfully. This module also unlocks medium and hard questions of knowledge units until students unlock them solving easy and medium questions respectively.
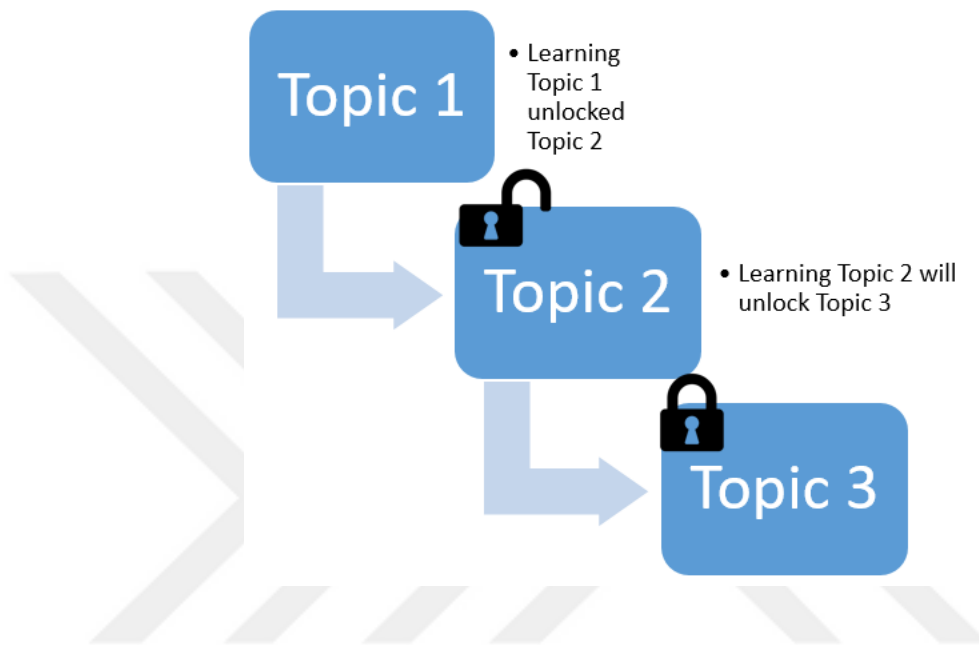


**Figure 16:** Achievement module

### 2.3.3 Level module

Levelling is one of the highest components of motivation for gamers. Levels are a system, or "step", by which players are rewarded. Levels are used a motivational note to keep students progressing forward. In case of enabling this module, all students starts with level one. If a student finishes all the basic topics, he or she becomes level two and unlocks intermediate topics. After finishing all the intermediate topics, he or she becomes level three.

As can be seen in Figure 17, topics can be connected to a students' level. By default, all topics are available for level one, but if achievement module is enabled, instructors might lock some advanced contents and those advanced contents are unlocked as students level up.
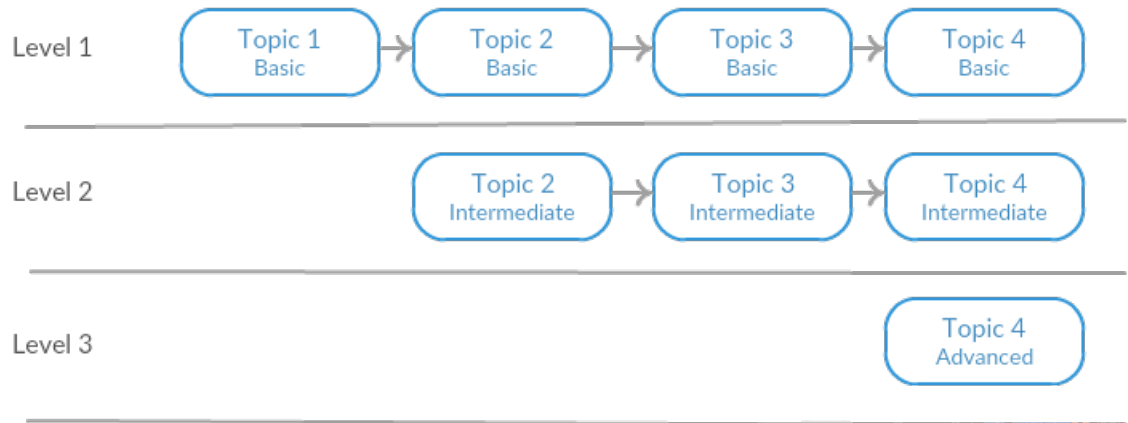
**Figure 17:** Advanced contents are available as students level up

### 2.3.4 Leaderboard module

Leaderboard helps students to see their position compared to other students and pushes them to get higher place on the top if they have increased their points. Placement in leaderboard is adjusted by points that students have.

### 2.3.5 Quest module

Quest is one of the significant game mechanics since it is very effective in terms of keep on playing. Quests usually imply a time limit or competition. In case of enabling this module, students are assigned with timed questions to solve. Instructors need to determine a duration in minutes of the quest and scope - which subjects are covered in the quest - they created. Quests are similar with pop quizzes. For example, if there are questions from subject two and three in a quest, the quest will appear to student after he or she finishes subject three. Quests are nice opportunity for a student for earning extra points to make improvement in their leaderboard placement.

## 2.4 Gameness index

We developed an index to measure the "gameness" of a gamified lesson. An instructor could use this index to determine whether he/she has gamified his/her lesson

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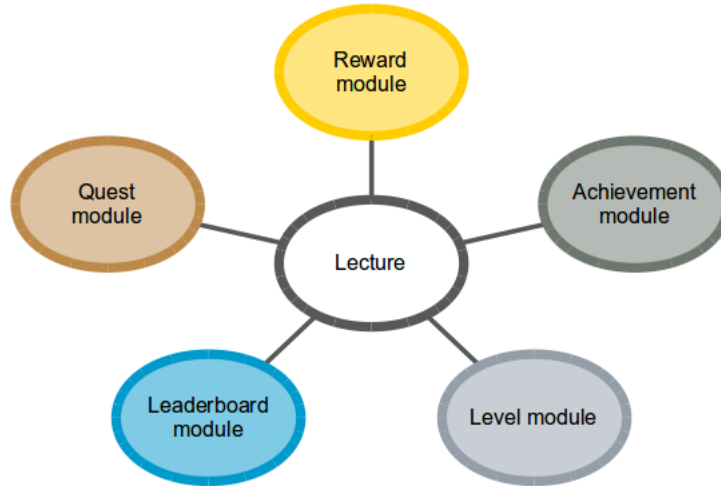
**Figure 18:** Gamifying modules

enough. Gameness index depends on how many game mechanics used by instructor in a course. Currently there are 5 game mechanic modules implemented. So gameness index is defined between 1 to 5. For example, if instructor uses Reward module and Achievement module in a course, gameness index will be defined as 2.

## 2.5    Learning tool

This tool is for students so that they can access gamified lessons, assignments and visuals to follow their progression. Progress of students is measured by completing assignments and tests online where machine grading and evaluation is used. The results are immediately reported to the student. In order to receive personalized services from the system, a prospective student must first enroll to the system. The performances of the students in the courses they are enrolled in are also provided on their own pages on the Web interface.

Gamification should engage learners effectively and be interactive teaching and learning experience. Students should be introduced to game-based learning and its purpose since the beginning of the course so that they connect it with the course content and outcomes and understand its benefits. Therefore, this tool provides an

orientation content about this game-based learning application for students to make them feel confortable with the system.

### 2.5.1 Course content

Students can view the available material and navigate as desired. Course content covers subjects, topics and knowledge units and its questions. A topic includes texts, pictures and videos or PDF, PowerPoint documents.

### 2.5.2 Assignments

An assignment has multiple-choice questions for students to solve. The assignments send their results to a database for future guidance. Statistics of the assignments as well as the correct answers to the questions are made available to the student while the results are sent to the servers. Every knowledge unit must have easy questions that called an easy assignment to make student evaluation possible, but medium and hard assignments are optional according to the instructor's preference.

### 2.5.3 Progression and feedback

Progression and feedback on gamified educational software is used to measure student performance. Students can monitor their progress. It provides score to know how well a student is doing related to others, students can see how many points they earned and they are provided information on their progress toward their goals (learning outcomes). It displays to students their progress in the course and measures how much assignments and course content they completed. It shows how many points collected and which badges and trophies are earned, which level the students are in.

Two types of feedback that can be valuable in gamification and the creation of game-based learning. One type of feedback often in games and gamification that helps with learning is conformational feedback. Conformational feedback is designed to indicate the degree of "rightness" or "wrongness" of a response, action, or activity

[20]. Feedback immediately informs the learner if he or she did the right thing, the wrong thing, or if it was somewhere in the middle but doesn't tell the learner how to correct the action. Another form of feedback provides guidance. This type of feedback guides the learner toward the correct instructional outcome. It is called corrective feedback. If the learner did the wrong thing, he or she will be prompted, guided, or pointed toward a more appropriate action or activity. Corrective feedback informs the learner that their response was incorrect and provides knowledge of the correct or desired response. It indicates the right answer for the learner. In this thesis work, corrective method is used to give feedback to students in the assignments.

# CHAPTER III

# SOFTWARE PLATFORM DEVELOPMENT AND EXAMPLES

## 3.1 Software Platform Development

Interest in the use of educational software to stimulate learning has motivated the development of educational environments, but for this to become a real way in the learning process arise two issues: the need for stable environments for formal and systematic development of educational software for gamifying the lessons and the need for efficient ways to engage students in the learning process.

To overcome these issues, a web application is developed using Laravel PHP framework. Laravel is a free, open-source PHP web framework, created by Taylor Otwell and intended for the development of web applications following the model-view-controller (MVC) architectural pattern. The Model-View-Controller pattern is a way to organize your code and separates it into three parts: models, views, and controllers. As can be seen in Figure 19, the model represents the data, the view displays the model data, and sends user actions to the controller, the controller provides model data to the view, and interprets user actions.

For example, in our application, a model is created to represent a Goal (Learning Outcome) and this model is associated with a database table named goals. Then, to handle all requests related to the model, a controller is created named GoalController. This controller is able to handle requests such as listing goals, creating a new goal, displaying, editing or removing a specific goal. Also the controller uses the Goal model to retrieve the designated Goal object from the database and loads a view for the Goal page, and pass it the Goal object retrieved from the database. Last, a view

20

is created to display the model data and receive user actions related with Goal model. Since we passed the Goal object to the view in the controller, we can access it in the view.
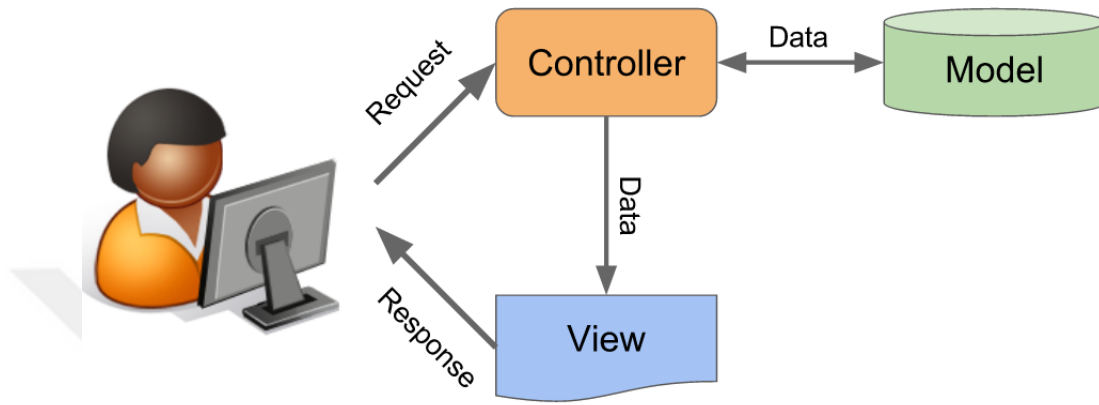


**Figure 19:** Model-View-Controller pattern

Web-based applications offer a range of advantages over traditional desktop applications. Unlike traditional applications, web systems are accessible anytime, anywhere, via a PC with an Internet connection, putting the user in charge of where and when they access the application. The user interface of web-based applications is easier to customise than it is in desktop applications. This makes it easier to update the look and feel of the application, or to customise the presentation of information to different user groups. In addition to customising content for user groups, content can also be customised for presentation on any device connected to the internet, including tablets, mobile phones, etc., further extending the user's ability to receive and interact with information.

To store all the data (course contents, questions, gamification contents) and table relationships, MySQL is used. MySQL is an open-source relational database management system. The data in a MySQL database are stored in tables. A table is a collection of related data, and it consists of columns and rows. A part of the database design can be seen in Figure 20.
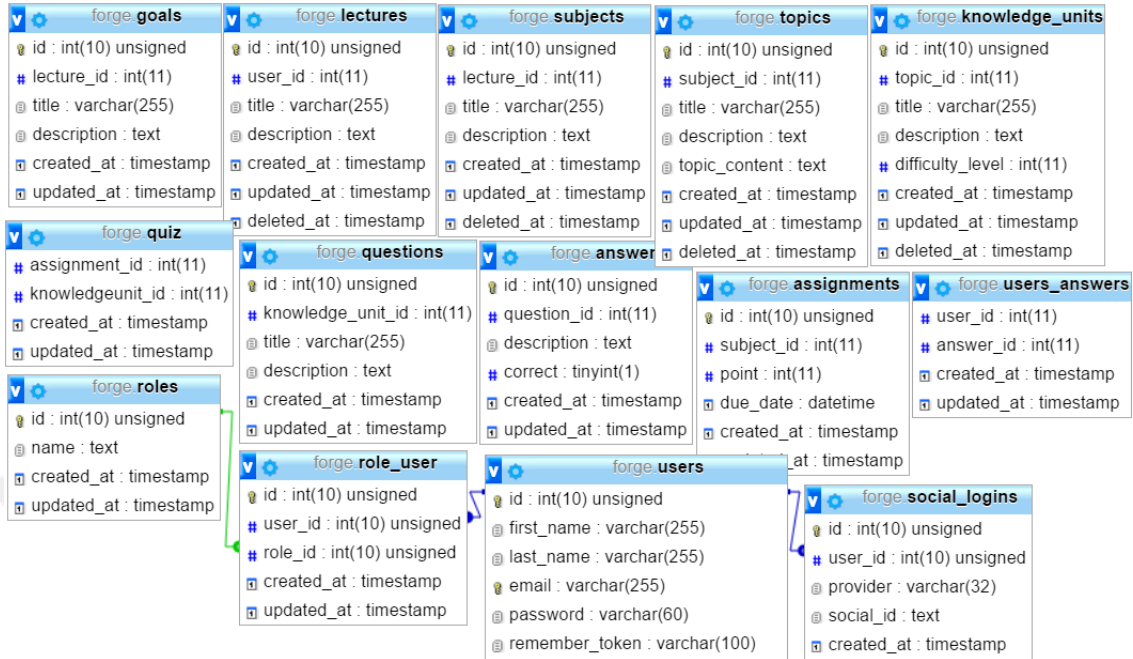
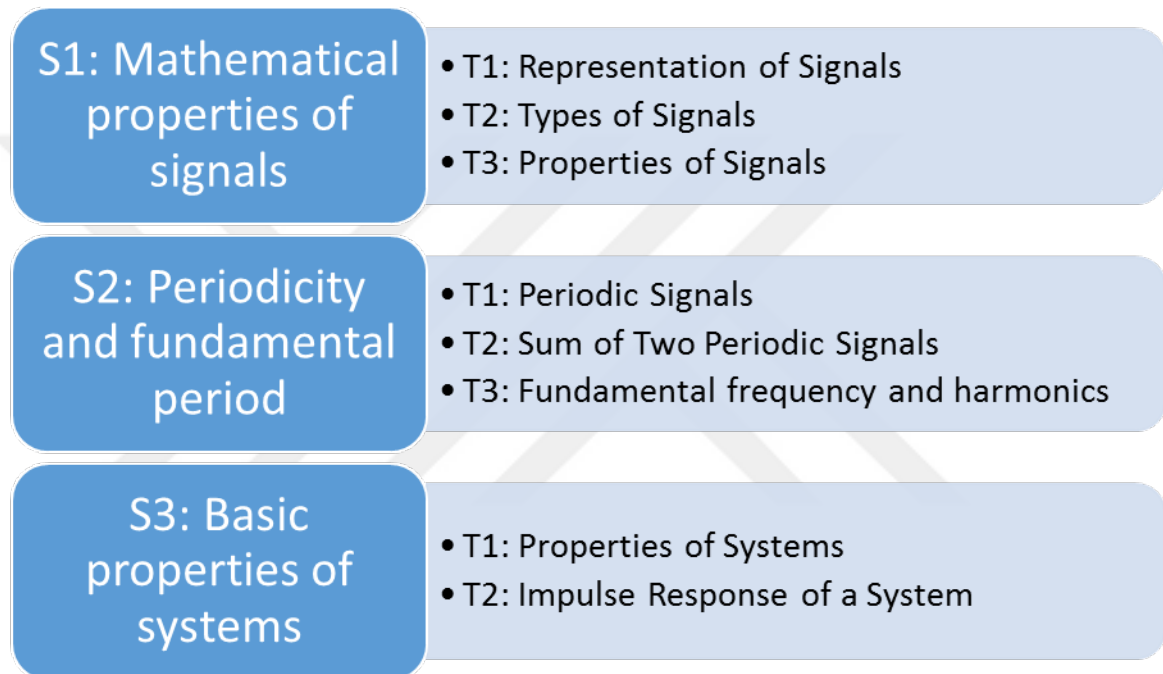**Figure 20:** Database tables and columns of the application

In our application, first users should login to the system by making an authentication using their email address. Then, instructors are given authorization by system admin to access lesson preparation tool and gamification toolbox. Instructors can create their course contents and knowledge unit questions using embedded text editor, or contents can be derived originally from PDF, Word or PowerPoint documents. Using images, videos and HyperText Markup Language (HTML) tags are supported to create course contents.

While creating the web application, we considered usability. We created simple, user-friendly and easy to use web application. In the web application, a JavaScript library called jQuery, front-end framework called Bootstrap and modern HTML5 elements are used.

## 3.2  Examples

In this chapter, gamification process of a course is demonstrated. For example, lets assume an instructor wants to gamify "Signals and Systems" course using lesson preparation tool and gamification toolbox. First, as seen in Figure 21 the instructor should add subjects and topics as content of the course.



**S1: Mathematical properties of signals**
- T1: Representation of Signals
- T2: Types of Signals
- T3: Properties of Signals

**S2: Periodicity and fundamental period**
- T1: Periodic Signals
- T2: Sum of Two Periodic Signals
- T3: Fundamental frequency and harmonics

**S3: Basic properties of systems**
- T1: Properties of Systems
- T2: Impulse Response of a System

**Figure 21:** Course subjects and their topics

Instructors should determine learning outcomes of the course and link them with subjects. Two Learning Outcomes of an Electrical Engineering Signals and Systems course might be:

LO1: Describe basic properties of signals.

LO2: Describe basic properties of systems.

The assignment between subjects and learning outcomes shows which subjects needs to be learned to achieve a specific learning outcome. For example, for the Signals and Systems course, subjects S1, S2 serve LO1, subjects S3 serve LO2 as shown in Figure 22.

**Figure 22:** Relationship between subjects and learning outcomes

Relationship between learning outcomes and subjects indicates that to achieve Learning outcome 1 (Describe basic properties of signals), students should learn Subject 1 (Mathematical properties of signals) and Subject 2 (Periodicity and fundamental period) similarly to achieve Learning outcome 2, students should learn Subject 3 (Basic properties of systems).

Instructors can connect subjects to learning outcomes using drag and drop feature of HTML5 and JavaScript in lesson preparation tool as can be seen in Figure 23.
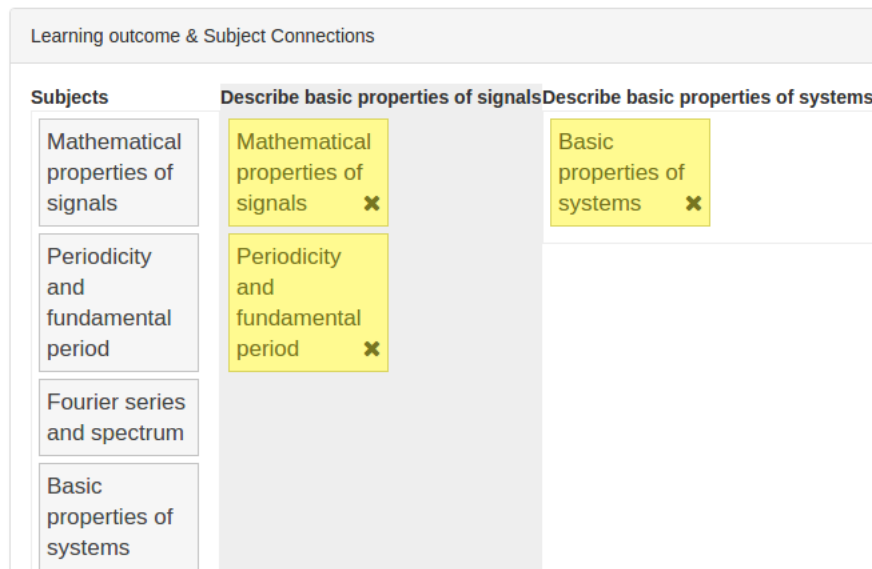


**Figure 23**: Screenshot of creating relationship between subjects and learning outcomes

Instructors can view, edit or delete subjects and learning outcomes and the relationship between them using lesson preparation tool as can be seen in Figure 24.

Subjects are the divided into topics related to the subject. Every topics has different number of knowledge units. Every knowledge unit has three level of questions. These are easy, medium and hard questions. The instructor must add easy questions for every knowledge unit. Medium and hard questions are optional.



**Figure 24:** Screenshot of course listing part of the lesson preparation tool

After adding course content, questions and learning outcomes. Instructors can gamify their course using modules in gamification toolbox. Instructors can do this by enabling one or several gamification modules for their course and can measure the "gameness" of a gamified lesson using gameness index to determine whether he/she has gamified his/her lesson enough as can be seen in Figure 25.
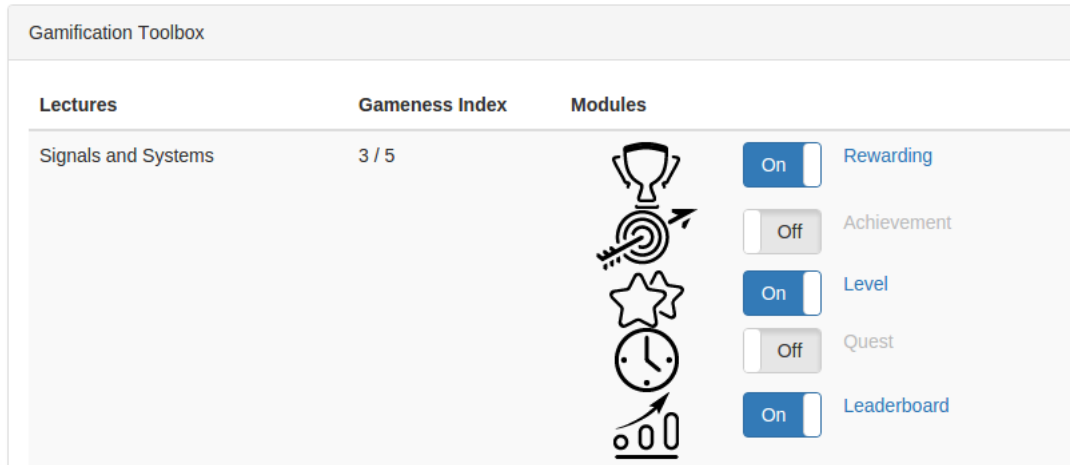
**Figure 25:** Screenshot of gamification toolbox

When students are included in the system, they can see their profile page and choose their avatar using learning tool as can be seen in Figure 26. Avatars are customizable pictures to represent a student in the system. They are unique representations for a student and powerful gamification mechanics for engagement.

Each time learning tool is opened by students, the portal will show the points, badges and, other information related to the student who opens it. Students will always know how effective they are and, hopefully, will want to improve.
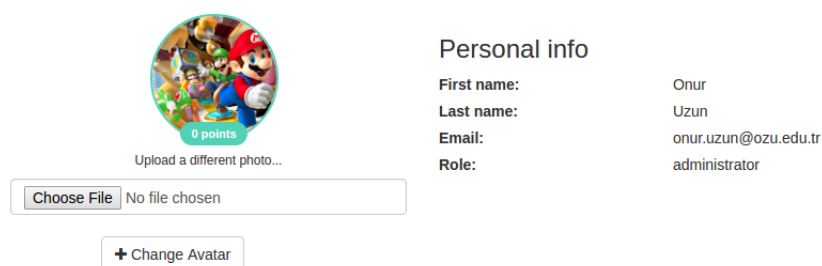


**Figure 26:** Screenshot of a profile page

Students can see course list in the menu and select desired course and access its

content, knowledge units and navigate as desired as can be seen in Figure 27. They can access all the knowledge units and its questions (easy, medium and hard).

If rewarding module is enabled the successful completion of tasks or specified activities can be rewarded with points. Students can solve knowledge unit questions or quizzes to collect points. Points are also used to list the most successful students on the leaderboard. In a course, such a comparison can increase the motivation to be better.
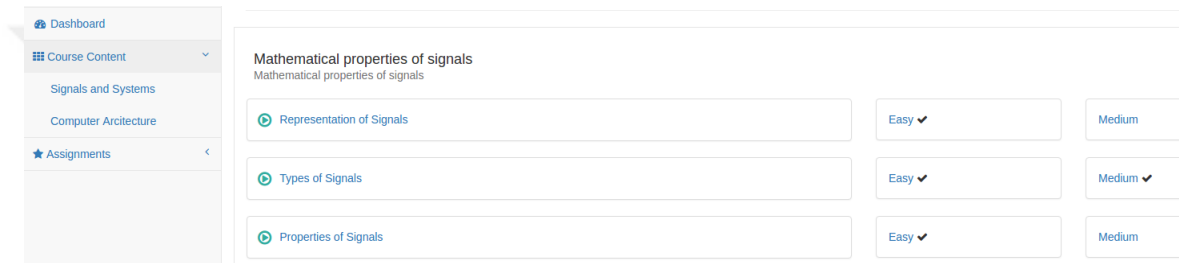


**Figure 27:** Screenshot of course subjects, topics and knowledge units listing page

In learning tool, if quest module is enabled, pop-up quizzes will be shown to students between topics. Some advanced topics related with level of students will be available as students level up by solving knowledge units.

Knowledge units have assignments include multiple-choice questions with one or more correct answers. As can be seen in Figure 28, students receive immediate feedback when they solve an assignment. When students solve an assignment, they can see correct answers and how many points they earned. In Figure 28, selected choices are student's answers and choices that have green background are correct answers.

The learning tool provides flexible timeline informations which can be used to show stundets' activities. Activities can be used to show all the behaviours taking place as well as all the points and rewards being earned and contents being unlocked. Activities can be filtered to display only behaviours or rewards as well as being filtered by a specific student.



You completed this knowledge unit and earned **2** points.

2 questions

1. How can we calculate the average value of a signal?

   ⦿ $\dot{x} = \lim\limits_{\substack{t_1 \to -\infty \\ t_2 \to \infty}} \frac{1}{t_2 - t_1} \int\limits_{t=t_1}^{t_2} x(t)\,dt$

   ○ $P(t) = |x(t)|^2$

2. How can we calculate the energy and power of a signal?

   ✔ $E = \lim\limits_{\substack{t_1 \to -\infty \\ t_2 \to \infty}} \int\limits_{t=t_1}^{t_2} |x(t)|^2\,dt$

   ☐ $x(t) = x_e(t) + x_o(t)$

   ☐ $P(t) = |x(t)|^2$
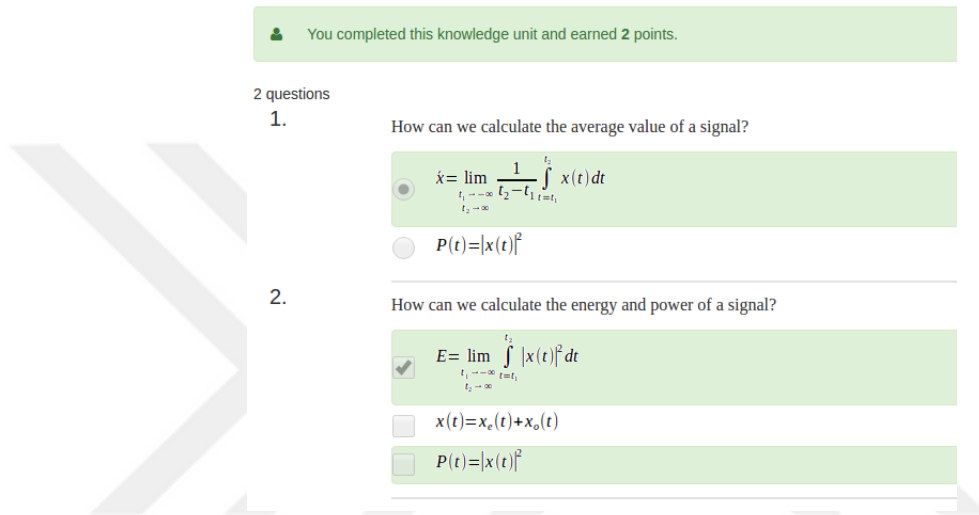
Figure 28: Screenshot of an assignment solved by a student

# CHAPTER IV

# CONCLUSION AND FUTURE WORK

## 4.1 Specific outcomes of the thesis

The gamified lesson preparation system presented in this thesis constitutes a complete gamified learning solution that can be used to author and gamify the content, hold assignments, provide performance evaluation. The highlights include the practical solutions brought to the problems of gamified content authoring for both presentations and evaluation tools.

## 4.2 Contribution of the thesis to the literature

The main contribution of this thesis work is to provide a user friendly environment for instructors to gamify their courses and for students to learn those gamified courses.

## 4.3 Future work

As future directions, we consider supporting additional game mechanics for gamified courses, question types other than multiple-choice for assignments. In addition, tests with real learners are also planned for an evaluation of the system.

We planned a case study where participants (students) are divided into two groups. The students in the first group will learn with gamified learning material in a gamified course, the students in the second group will attend a non-gamified course. We will try to evaluate the learning performance and satisfaction of the learners after the completion of a standard (non-gamified) versus a gamified course. Below variables will be used for the evaluation of the two group of students.

- Achieved learning results

- Time spend on learning materials

- Learners' satisfaction with the course

In the research, we will try to obtain students' and instructors' opinions and suggestions to improve the gamification toolbox, lesson preparation and learning tools and design of gamified courses.

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# VITA

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