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# HELP US TECHNOLOGY: CREATED BY STUDENTS FOR STUDENTS

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# HELP US TECHNOLOGY

CREATED BY STUDENTS FOR STUDENTS

Final Year Project  
for the Bachelor of  
Science in Information Technology

by

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MAY 2020

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## ABSTRACT

HUT is an online platform created by third year students at CCT College Dublin as the Final Project for the Bachelor of Science in Information Technology. The initial idea for the project came up during a meeting in a Café where we were all debating what would be the project theme and final product. During the first group meetings in college, our group came up with several good ideas but what would benefit us all, as students, would be something related to Online Learning because during our last academic year, a global pandemic began leaving Educational institutions with no option but adhere to online learning tools.

The students involved in the production of this document, as well as in the development of the Web Application: a Question & Answer Online Platform have successfully accomplished all stages of the Systems Development Life Cycle. The project has allowed each student to use the skills in which they are better at, exploring each one's qualities and capability.

The Planning was done following methodologies of Analysis and Design for Web-based Information Systems, including the creation of a system requirements list, use cases and elaboration of ERD, UML and other diagrams.

The Application is a RESTful API having its back-end developed using Spring Framework 5, Java 8, and MySQL, while its front-end was developed with Angular 9, HTML, CSS, JavaScript and PrimeNG UI components.

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# GLOSSARY

- **HUT:** Help Us Technology.
- **PrimeNG:** collection of rich User Interface components for Angular.
- **Figma:** cloud-based design and prototyping tool for digital projects.
- **Heroku:** container-based cloud Platform as a Service (PaaS).
- **Classpath:** parameter in the Java Virtual Machine/Java compiler which specifies the location of user-defined classes and packages.

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# INTRODUCTION

In their first years in college most new students find academic tasks to be challenging and many times completely different from their previous backgrounds. We believe as students that the goal of most students is to become a successful IT professional, highly skilled and well paid in the Technology Industry. However, often times it is not always that easy, students who do not have any background or are not familiar with programming languages or other IT subjects, commonly end up struggling with learning new skills and things tend to become more difficult as the semester develops.

Students many times, especially first year students, are not aware of the tools that are available online to help them with things such as troubleshooting academic tasks that they are undertaking.

Often there are not enough resources to either exemplify or clarify better any problems or issues that students may have be it in relation to class work or at home projects. The team at HUT (Help Us Technology) asked ourselves the following question: "Who can better help with what students are struggling with in this kind of situation?" and we arrived at the simple answer, other students.

Thus we have built a Web Application to help students with any kind of issues, troubleshooting or difficulties they may have. At present the application is only available for Information Technology students, we plan to add new sections in the application and release it in the future for other areas of study. The idea is that students interact helping each other by Asking/Answering questions about common issues, doubts and troubleshooting, establishing a nice relationship and improving the way they learn through the development of the course.

Also we believe target audience will actually enjoy the experience that HUT provides, the modern and light design was developed using Angular 9 and PrimeNG elements, what makes the pages nice and easy to navigate.

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## SOCIAL LEARNING THEORY

Social Learning Theory(SLT) is a learning process which proposes that new behaviors can be obtained only by observing, imitating and modelling others. This theory states that learning is a subjective procedure that happens in a social setting and can happen absolutely through observation or direct guidance (Bandura, 1963).

The keys of Social Learning Theory are:

- 1.Learning is not just about behavior; rather, it is a psychological procedure that happens in a social context.
- 2.Learning can happen by observing a behavior and its consequences.
- 3.Learning includes perception, extraction of data from those perceptions, and making choices about the exhibition of the behavior. In this way, learning can happen without a observable change in behavior.
- 4.Reinforcement plays a role in learning but is not entirely responsible for learning.
- 5.The student is certainly not a detached beneficiary of information. Cognition, environment, and behavior all mutually influence each other. (Grusec, 1992).

Social Learning Theory draws vigorously on the idea of modeling, according to Albert Bandura (1963), there are three types of modeling improvements:

- **Live models**, where an individual is showing the desired behavior.
- **Verbal instruction**, in which an individual portrays the ideal behavior in detail and teaches the participant in how to take part in the behavior.
- **Symbolic**, in which displaying happens by methods of the media, including films, TV, Internet, writing, and radio. Encouragement can be either genuine or fictional characters (Bandura, 1972).

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## THE BENEFITS OF GROUP WORK

There are many benefits to working as part of a group. Group work can help reduce the pressure, an individual might feel when assigned an individual task and when working as part of a group the overall outcome is shared. This might help increase student engagement and shared complex understanding of material necessary for progressing.

Although the individuals in the group may have an individual responsibility, through positive interdependence there is a shared responsibility of goal achievement. This interaction overtime may also lead to other benefits, such as individuals getting to know each other better, leading to trust among everyone in the group, developing social skills and bringing a sense of community to the classroom. Students in a group activity may also feel more comfortable discussing their positive and negative task experiences with their peers, which can create a supportive and rewarding environment for the learner.

## LEARNING REWARDS

People can learn from their own mistakes, this is part of the learning process. But you might also learn something from someone else's experience in order to enhance your knowledge.

To further support what was presented previously, according to the article from The Irish Times, the student Ben Doyle says:

In a statement found in an article of The Irish Times, Ben Doyle (19) recounts his experience as a student: "My biggest struggle in first year was the academic adjustment. For the Leaving Cert, core textbooks are your bibles and you have all the resources you need to hand. In college, you have to sift through a lot of information and perspectives, come to conclusions and back it up with research and references. I found my first assignment hard; we had to think creatively and be very open-minded. I didn't do great but, assignment by assignment, I'm learning how to research and write" (The Irish Times, 2018).

The same struggles that Ben Doyle encountered are common to several students in the first semesters, considering the above mentioned a suggestion to help in the learning process we propose is the creation of an Application where all the students could access, share their experiences, ask questions and get information related to their career.



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# 1. PROBLEM DEFINITION

Nowadays the Internet has become an important element of education and communication and according to a study done by Steve Jones (2002), 73% of university students use the internet as main searching tool rather than using the library when doing Academic Assignments, either through online courses, video tutorials, articles published by experienced users on tech websites or through a question-and-answer forum which is focused on the area of study the student is enrolled, such as "Stack Overflow" for computer programming, "Quora.com" for any question about any subject at all and "Piazza", which can be described as "mix between a wiki and question-and-answer forum (Piazza, 2019).

Designed to connect students, teachers and class representatives, the platform Piazza allows the student to get the help they need as well at any time anywhere, as Pooja Nath Sankar, CEO and Founder (Piazza, 2019) claims.

Considering more and more students are choosing to use the internet as their primary research tool for college-related tasks, and that tools such as Piazza allow students to share knowledge and improve student-teacher communication, we noted that from our experience in the first years of college, we did not have access to such a tool that integrated student-to-student knowledge exchange and student-teacher communication.

According to our experience as students, in our first year in college many of us often would not know where and how to seek appropriate assistance when doing an academic assignment and seeing that some of us might not be comfortable asking questions during class, consequently we would use a search tool such as Google to search for an explanation, examples of similar problems or even video tutorials. We believe, however, that not everyone would know exactly how to find the exact assistance for the task they needed on the internet and that some of us would often end up getting ideas from online forums where they find answers to your questions but don't really know exactly how it works.

**In this scenario, how can technology help students from CCT who wants to improve their educational potential and desire to learn but don't know how/ where to find the solution for their problems ?**

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## 2. SOLUTION TO PROBLEM

We offer a questions and answers forum website as a solution to this problem. The project consists of helping students of CCT College, and will be useful inside the college and will allow students to post their college-related questions, allowing other students or teachers to answer them.

The aim of this website is to incentivise students to share their questions and knowledge with each other and learn not only with teachers in class but also learn with other students at CCT college, students who may have experienced the same problem or simply have some knowledge in the subject in question.

To encourage users to join the forum, we decided to implement a reputation system found in similar solutions such as "StackOverflow" and "Quora", where the best answer is elected giving a certain amount of points to the user who answers it and also rewarding users who ask questions, for example, a user gets 10 points for having your answer voted as the "right answer" and 1 point for every "like" he gets from other users that vote in his question. The user who asks also gets reputation points, for these will be given 3 points, the profile picture of the top 5 reputation points will be exhibited on the main page as Best active users. This also allowed us to bring in an aspect of gamification to app which has been shown and used in previous applications to encourage and enhance user engagement and the overall user experience.

In addition to this we can improve the quality of communication between students and teachers, as well as the communication and knowledge exchange among students while giving a voice for those who are not comfortable with asking questions in class, creating more and more features for the forum as the network of collaboration on the forum grows.

## 3. PROJECT GOALS

By developing this web application we aim to provide a solution for students who wish to assist or seek assistance from other students with regards to not just college subjects, but even further doubts that they may come across during their academic life. We want to bring more stability and self confidence to those who had little contact with technology before college, students who many times come from different and unrelated backgrounds.

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## 4. PROJECT OBJECTIVES

### 4.1 RESEARCH FOR SIMILAR SOLUTIONS

In our search we found the following question-and-answer platforms which offer similar solutions to what we are producing:

- **Stack Overflow:** [www.stackoverflow.com](http://www.stackoverflow.com)
- **Quora:** [www.quora.com](http://www.quora.com)
- **Piazza:** [www.piazza.com](http://www.piazza.com)
- **Brainly:** [www.brainly.com](http://www.brainly.com)

### 4.2 DATABASE PLANNING

The planning was done by firstly creating an Entity Relationship Diagram (ERD) applying data normalization rules following the actual construction of the database. We decide to use MySQL which is an Open Source Relational Database Management System that was designed and optimized for web applications, other reason for our choice is because of MySQL's levels of scalability, availability, performance and for being related to our academic grade.

### 4.3 DESIGN THE FRONT END

After defining Entities and their Relationship for Database we designed a two-dimensional illustration of the page's interface using the Figma Wireframing tool specifically focusing on designing a Modern and Intuitive website always thinking about the User Experience with space and prioritization of content, functionalities available, and intended behaviors. For these reasons, wireframes typically do not include any styling, color, or graphics.

### 4.4 DEFINE THE BACK END

The application was created as a Restful API using Spring Security Framework and Java 8. We decided to use the Spring Security 5 because it focus on providing both authentication and authorization to Java Applications. Spring Data is used in the application back end to handle the interaction with Database, while Spring IOC is used to handle injection dependency. The Restful API is going to respond with JSON (Java Script

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Object Notation) representation, we have also used Spring Boot Actuator which includes a series of Production-ready Features to help in the monitoring and managing of the application when pushing it to production process.

## **4.5 BUILD THE BACK END**

To build the back-end of the web application we used Maven which is a powerful project automation and management tool used mostly for dependency and documentation.

## **4.6 BACK END TESTING**

- Unit Tests
  - JUnit 5

## **4.7 BUILD THE FRONT END**

To build the User Interface of this Project we used HTML, CSS, JavaScript Framework Angular 9, Node JS, NPM packages, Angular CLI, Bootstrap and PrimeNG components.

## **4.8 CONNECT FRONT END TO BACK END**

The front-end of the application is going to consume the Restful API via HTTP requests trafficking JSON formatted data.

## **4.9 DEPLOY THE APPLICATION**

The application was deployed in Heroku which is a used to deploy, manage, and scale web applications.

# **5. RESOURCE REQUIREMENTS**




## **5.1 PEOPLE**

- Project Manager
- Front End Developer
- Back End Developer
- UX Designer







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## 5.2 SOFTWARE, TECHNOLOGIES & TOOLS






### DESIGN & DIAGRAMMING

-  Canva Design Platform (Documentation)
-  Figma Prototyping Tool (Wireframing)
-  Lucidchart Diagramming Tool




### FRONT-END DEVELOPMENT

-  Angular 9 Framework
-  Bootstrap Framework
-  CSS - Cascading Style Sheets
-  HTML - Hypertext Markup Language
-  JavaScript
-  PrimeNG UI Components




### BACK-END DEVELOPMENT

-  Intelij IDE Spring
-  Java 8
-  Maven Automation tool
-  MySQL Database Management System
-  Spring Framework 5

### TESTING, HOSTING & DEPLOYMENT

-  Cypress End to End Testing Framework
-  GitHub Repository Hosting Service
-  Heroku Cloud Platform

### PROJECT MANAGEMENT, COLLABORATION & COMMUNICATION TOOLS

-  Basecamp Project Management Platform
-  Trello Collaboration tool
-  WhatsApp Messenger

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## 6. PLANNING THE WEB APPLICATION

### 6.1 OVERVIEW

Primarily our idea is to integrate beginner students with poor knowledge in regards to IT and allow them to improve and increase their knowledge, so they can follow the whole process of learning smoothly across the course.

Students are be able to ask questions in regards to IT subjects while other students will be able to help them by answering those questions even using short videos explaining step-by-step in cases such as Software installation tutorials for example. The students who answer questions will earn points which will be displayed on *My Reputation* Section in the Dashboard page.

At present, the web application is developed exclusively for all IT students at CCT College Dublin however in the long term we are hoping to expand the project further.

### 6.2 STATEMENT OF FUNCTIONALITY

The Web Application consists of a Home page which any IT student is able to Register in order to have access to the content available related to any IT subject of his preference. Once logged in, the user is directed to the dashboard which provides at-a-glance views of key performance indicators relevant to questions and answers published by the user, User Reputation, notifications and announcements. On the subjects page you can find the latest questions answered. Questions not answered at all are highlighted so users can always see them, other features in Subjects are: a tab with all the IT subjects available, a Search bar for searching questions. Some of the questions will carry short videos as answers in order to better explain certain queries.

Others pages included in the application are About Us, Contact and Profile. A contact page was created in order to offer support for queries related to Login, Register or any other queries to the Admin of the Platform.

### 6.3 TARGET AUDIENCE

Although the platform was initially developed targeting exclusively first year CCT students of Information Technology at CCT, and considering that

profit is not the focus of this project, our team have strongly considered the possibility of launching the platform to other areas of study and possibly other institutions.

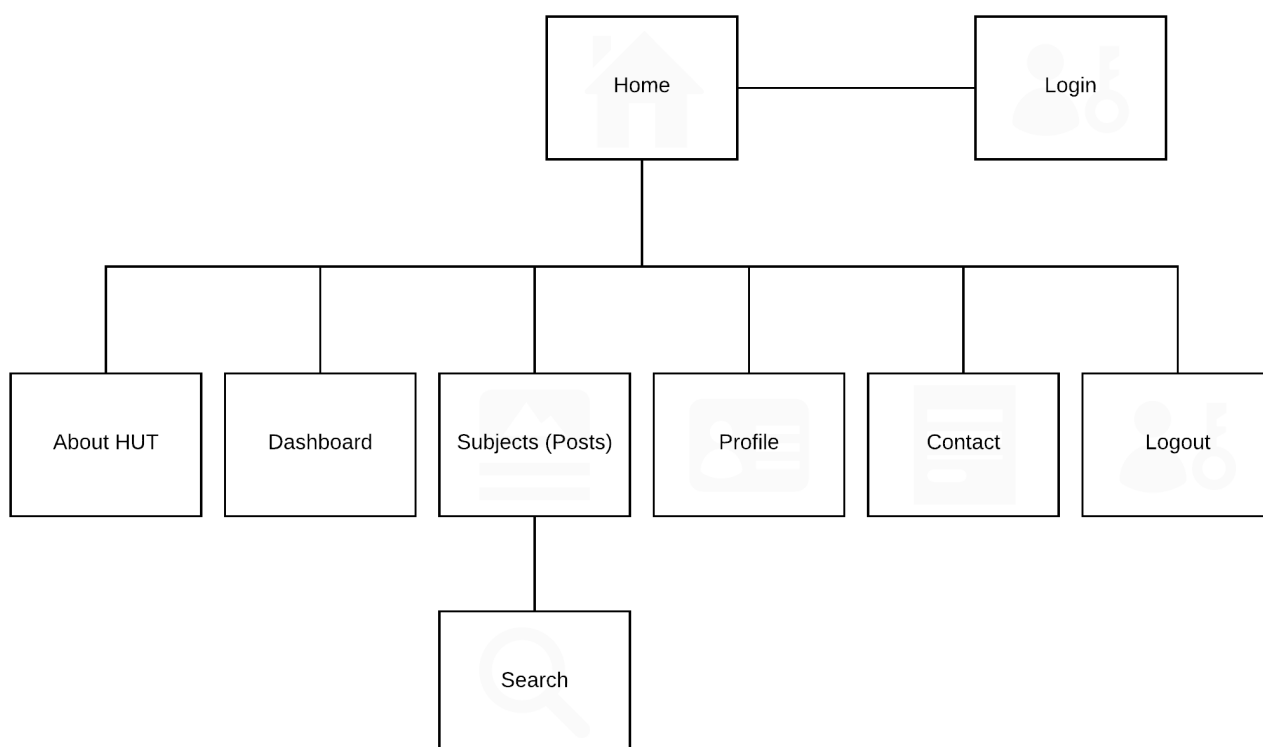
## 6.4 EDITING, UPDATES AND ADMINISTRATION

Content posted by students will be automatically approved, however, in case a post contains something inappropriate or not relevant to the platform, the moderator will be able to delete it.

When it comes to administration, the idea is to have selected veteran students to take care of the application and these will then be the administrators.

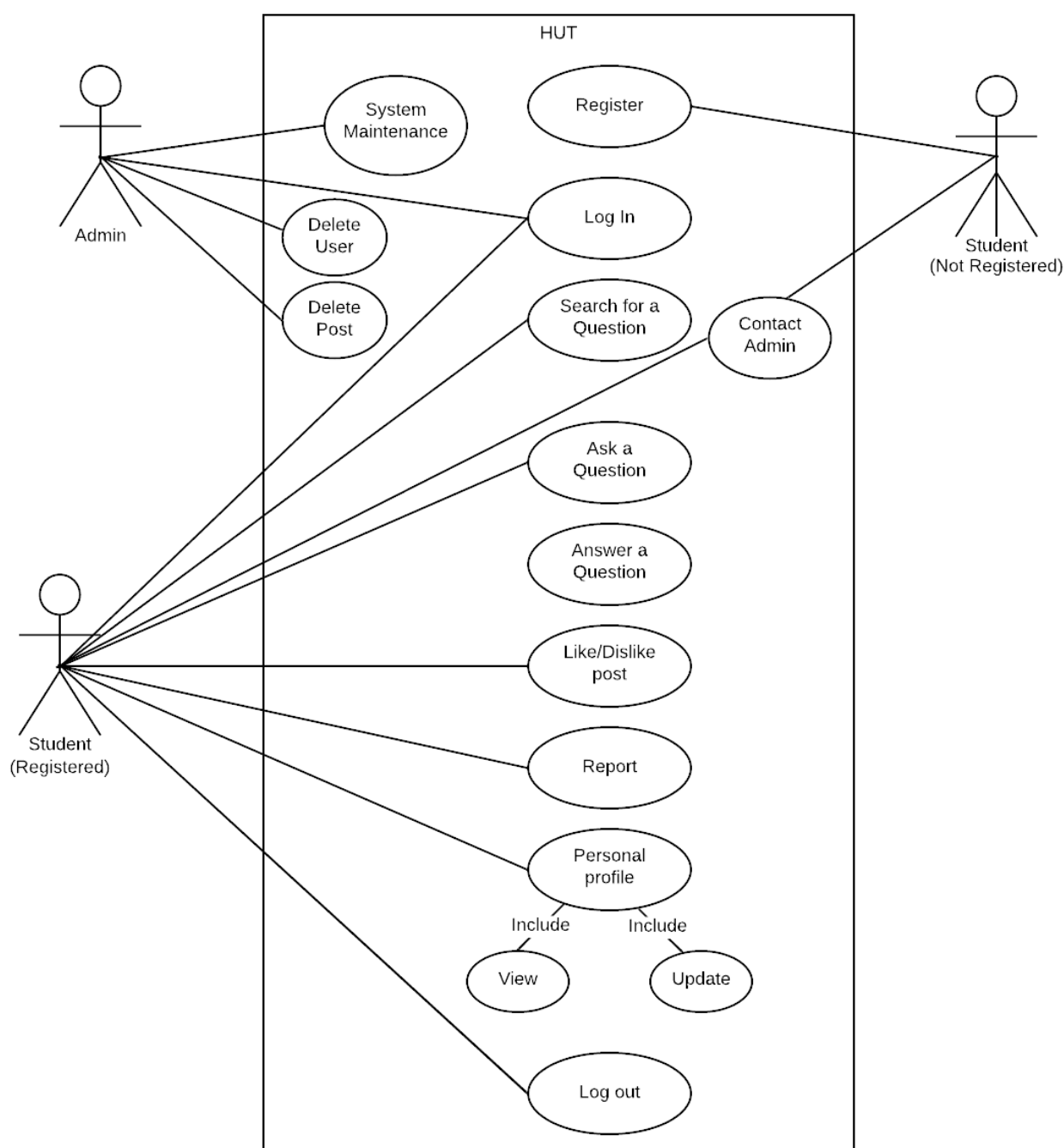
## 6.5 SITEMAP

The application's site map was created even before any conceptual design was defined, it helped us to clarify among the team what the site's goals would be. This strategy helped us ensure that every page of the application is reinforcing our goals.



## 6.6 SYSTEM DESIGN

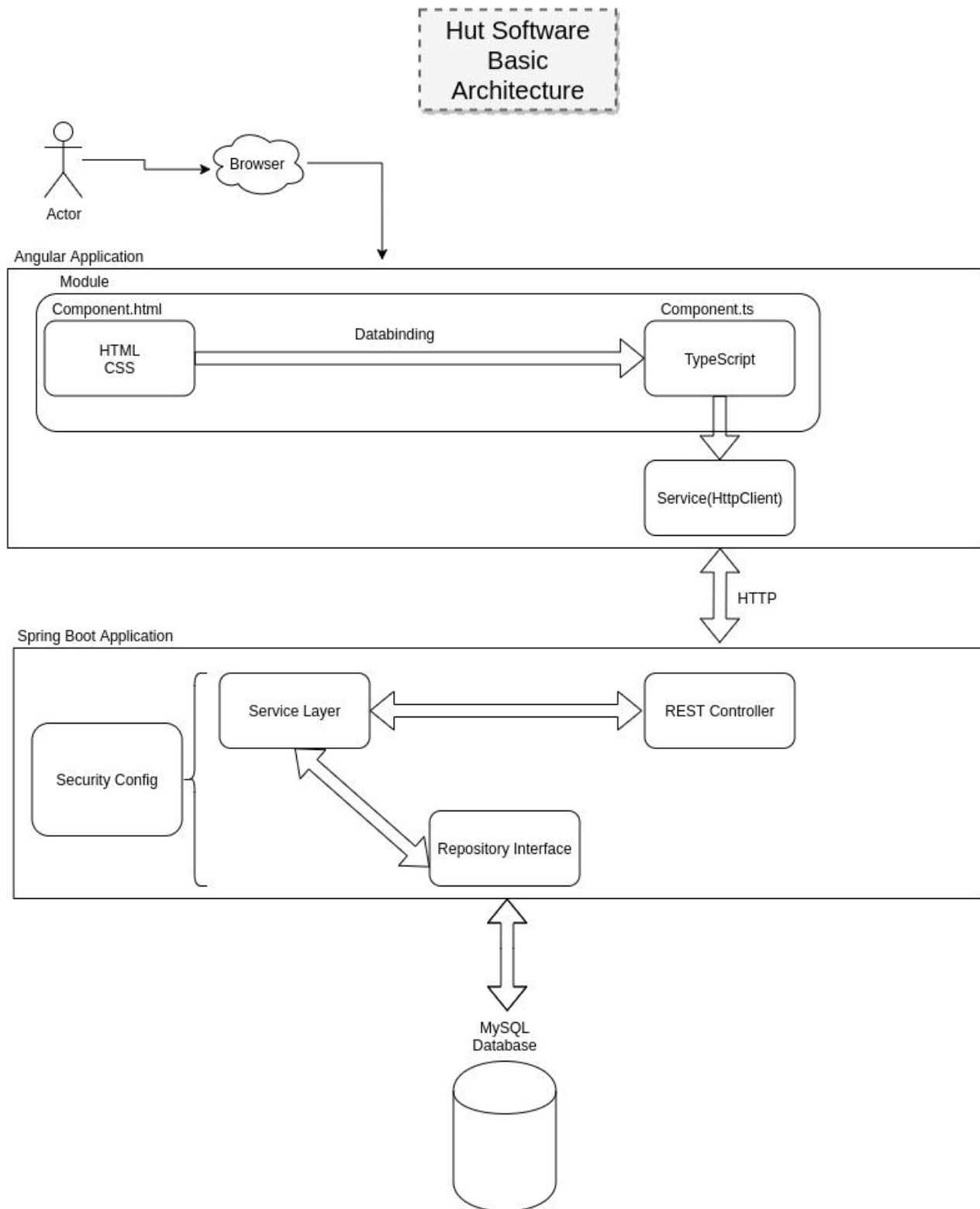
HUT is an online tool that offers students another choice to facilitate the learning process, some resources such as question and answers will be available initially to any CCT College student, although the user who wants to ask a question on the website will have to register first. Then the user will be able to use all application's feature, such as ask/answer a question, search for a question, like/dislike an answer or question, and report to admim. The following UML Use-Case Diagram outline the main features of the web application:





## 6.7 SYSTEM ARCHITECTURE DIAGRAM

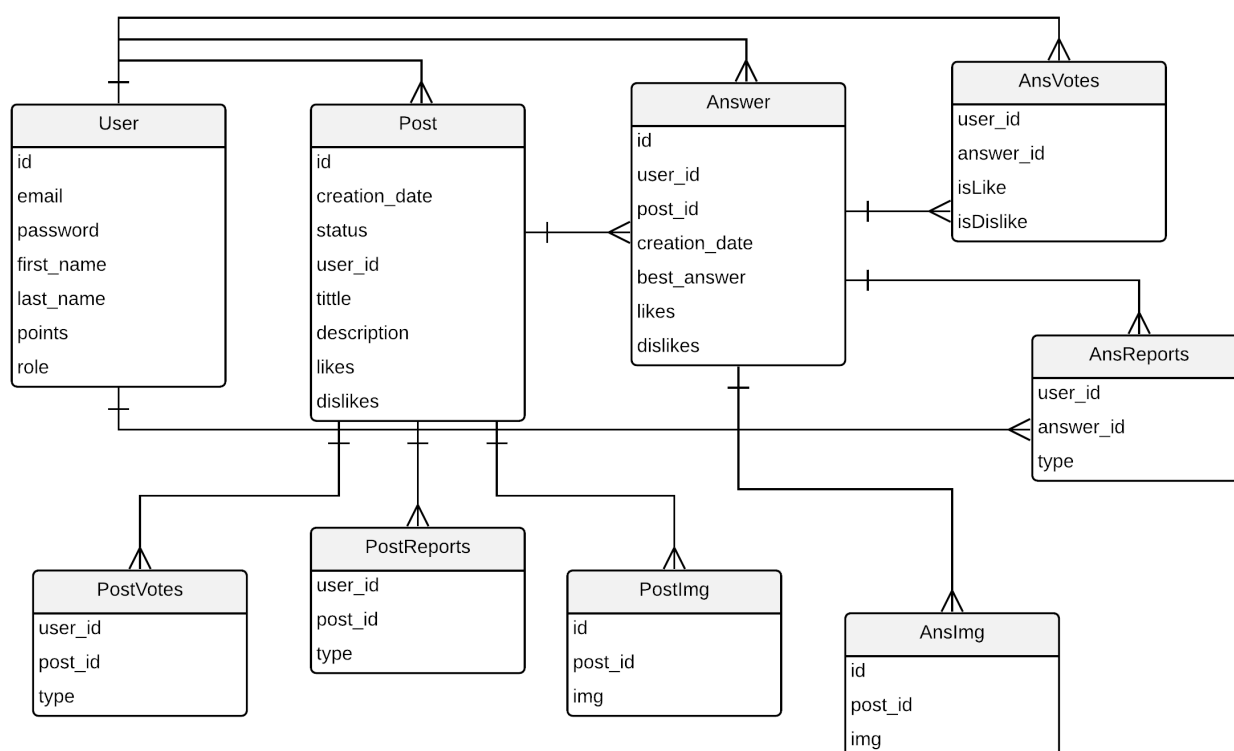
The following diagram expresses the basic architectural structure of the web application.



## 6.8 ENTITY RELATIONSHIP DIAGRAM (ERD)

The database was designed with MySQL on Heroku Cloud Platform. MYSQL was the team's choice as the back-end relational database because it is an open source Database Management System (DBMS) which can be downloaded and used for free. It occupies very little disk space and can easily be installed in any operating systems.

The ERD Diagram bellow presents the database structure of the system showing its tables and their relationships.



## 6.9 SUMMARY SCHEDULE - GANTT CHART

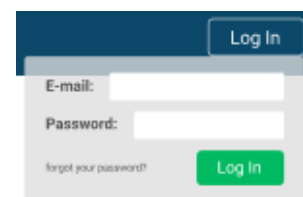
			SEMESTER 5 - 2019												SEMESTER 6 - 2020																					
			OCTOBER				NOVEMBER				DECEMBER				JANUARY				FEBRUARY				MARCH				APRIL				MAY					
PHASE No	PHASE	FIRST DAY OF EVERY WEEK(SUNDAY):	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10	17	24
1	MEETINGS WITH SUPERVISOR	-Meetings with Supervisor																																		
2	PROJECT PLANNING	-Group Formation and Initial Ideas -Project Kick-Off Meetings																																		
3	STORYBOARDING	-First Project Sketch -Research about Learning Process -Research about similar applications																																		
4	SEMESTER 1 DOCUMENTATION	-Self-Evaluation -Proposal Project																																		
5	FEEDBACK - PROPOSAL	-Review & Proposal fixes																																		
6	DEVELOP THE WEB APPLICATION	-Develop Back End -Develop Front End -Tests																																		
7	DESIGN LOGO	-Design Logo																																		
8	SEMESTER 2 DOCUMENTATION	-Self-Evaluation Report -Presentation - Test -Group Project Report -Final Presentation & Demonstration																																		

## 7. UI/UX DESIGN

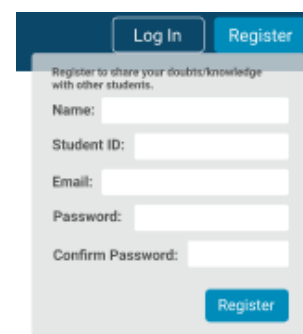
A great way to start planning the layout and conceptual design of the Web Application is by defining a two-dimensional illustration of the page's interface. Wireframes are usually a low-fidelity design layout of the page which is about to be developed. However in this project, by using the wireframing tool called Figma, our team have accomplished to develop the platform following loyally the conceptual design. In this section, we also outline the features found in each page.

### 7.1 HOME PAGE

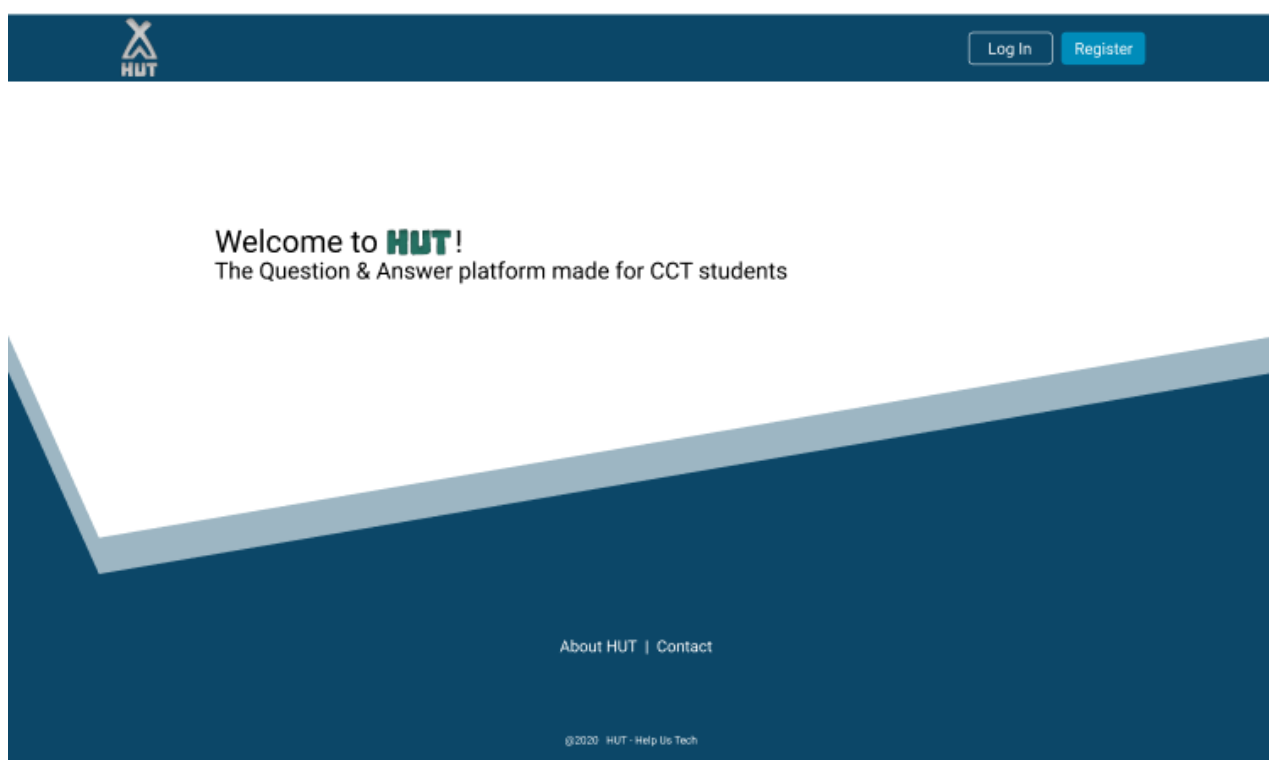
- Login - users already registered just need to press and fill up a dialog with:
  - email
  - password
- Register - new users must fill up a form on dialog box with their personal information:
  - name
  - student ID
  - email
  - password
  - password confirmation



A login dialog box with a dark blue header containing a 'Log In' button. The main area is light gray and contains two input fields: 'E-mail:' and 'Password:'. Below the password field is a link 'forgot your password?' and a green 'Log In' button.



A register dialog box with a dark blue header containing 'Log In' and 'Register' buttons. The main area is light gray and contains a heading 'Register to share your doubts/knowledge with other students.' followed by five input fields: 'Name:', 'Student ID:', 'Email:', 'Password:', and 'Confirm Password:'. A blue 'Register' button is at the bottom right.



## 7.2 DASHBOARD

Once logged in, some key performance indicators are displayed:

- navigation Bar - displays username, link to Profile page (user picture) to update any personal user information, and Logout button to end session;
- on the left hand side of the page, a button with a dialog box displaying all the IT subjects where users can navigate through for specific content;
- a search bar placed in the middle of the page right below the navigation bar is where users can search for questions and it is where they can publish a new question in case they do not find what they are looking for;
- a calendar will be positioned on the right hand side to display announcements such as free courses, live tutorials, study groups, and any other events published by veteran students in order to bring some more knowledge for those interested;
- in the center of the page, another section called New Questions displays the latest questions made by other students stating whether or not it has been solved, and in case it has been answered points will be earned by the students who did answer it. (Points earned by Answers and Best Answers).



## 7.3 SUBJECTS

When a subject is selected on the subjects tab, the user is provided of :

- **List of Questions** - each question contains:
  - answer check (whether is a new question or it has answers);
  - posted by (author);
  - answered by (author);
  - best Answer check (sign as solved if Best answer has been chosen).

The screenshot shows the HUT website interface. At the top, there is a dark blue header with the HUT logo on the left, a user profile icon and 'Welcome Celso!' in the center, and a 'Log Out' button on the right. Below the header, there is a search bar with the placeholder text 'What are you looking for?'. To the left of the search bar is a hamburger menu icon. Below the search bar, there is a 'Programming' tab. Under this tab, there is a table of questions. To the right of the questions, there is an 'Announcements' section with a calendar for January 2019 and a list of announcements. A yellow line connects the hamburger menu icon to the 'SUBJECTS TAB' label. Another yellow line connects the search bar to the 'SEARCH RESULT SECTION' label.

Question	Posted by	Date
How to connect my Java application to the Dat...	Celso Martins	04/03/20
Abstract Class.....	Vinicius M.	04/03/20
Design Patters - how to make factory patterns.....	Guilherme T.	03/03/20
Can anybody help me with my assign..... (Solved!)	Fabiana F.	02/03/20

**Announcements**

JANUARY 2019

Java Angular class with Fabiana Friedrich - 27/03/20...  
 Network - Study group - Wednesdays  
 Maths - Study Group - Thursdays  
 Web Design extra class with Guilherme Tenorio  
 Live tutorial - Linux on Virtual Machine with Michael...

See All

◦ **SUBJECTS TAB**

◦ **SEARCH RESULT SECTION**

The screenshot shows the 'SUBJECTS' tab. It has a list of subjects: Networking, Programming, Maths, Operating Systems, Web Development, Web Design, and Databases. 'Programming' is selected and highlighted in blue.

The screenshot shows the 'Search Results for: Clone'. It displays two results:

(1) Questions found:  
 How to **clone** a VM? .....by Vinicius Martins

(2) Announcements found:  
 Tutorial - How to **clone** a Virtual Machine.....by Celso Martins

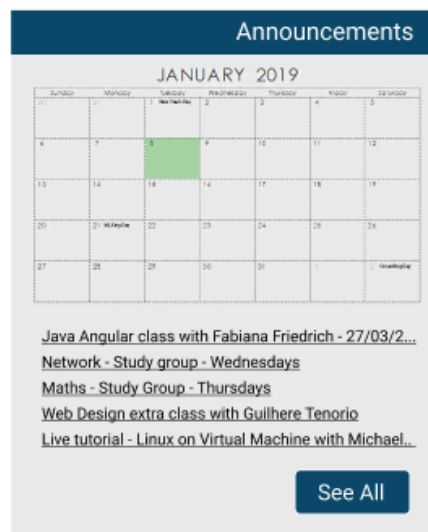
Couldn't find what you were looking for?

Make a Question!

◦ **NEW QUESTION DIALOG**

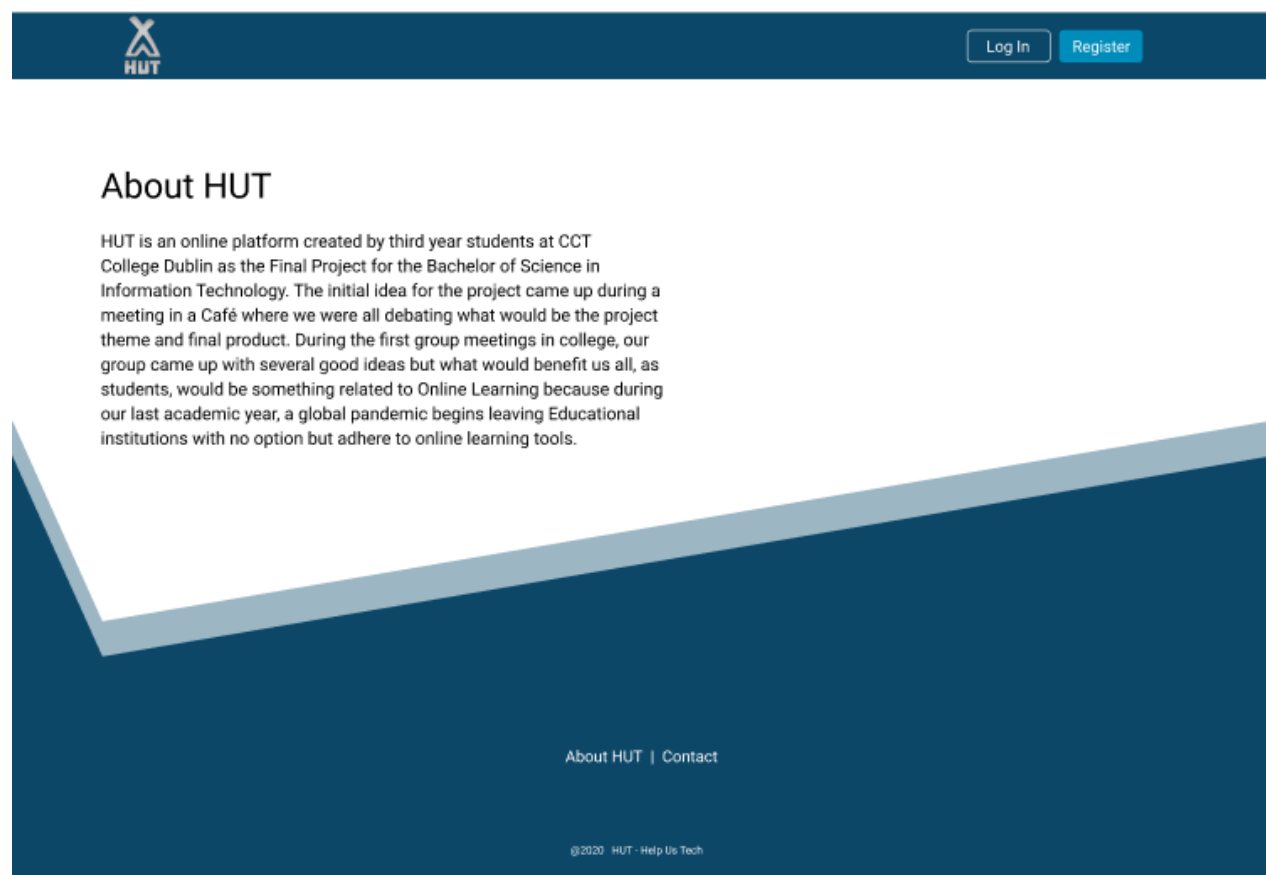
The screenshot shows the 'NEW QUESTION' dialog. It has a dropdown menu for 'Please Select a Subject:' with 'Networking Forensics' selected. Below it is a 'Title:' field with the text 'Install new version of packet tracer in Linux'. There is a large 'Description:' text area. At the bottom right is a 'Post' button.

- **Announcements** - Announcements about upcoming events such as Live video tutorials and study groups attached corresponding dates, containing information such as:
  - title;
  - date and time;
  - event planner's name.



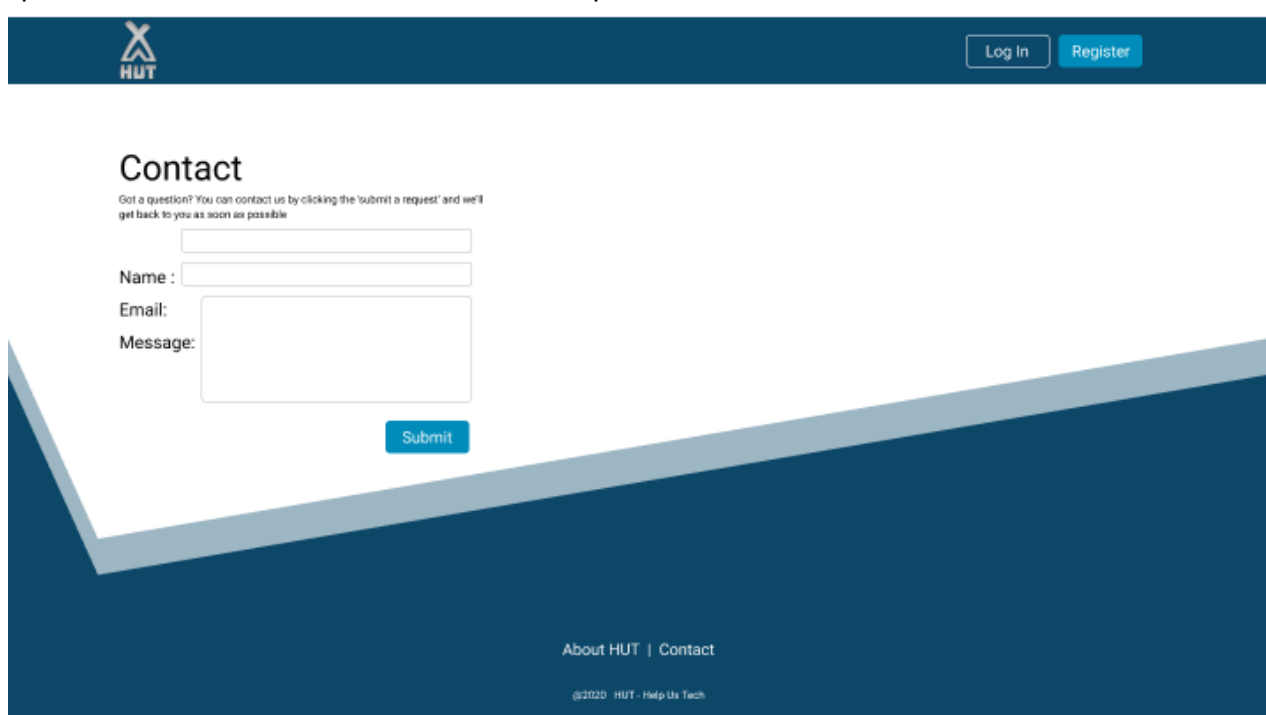
## 7.4 ABOUT HUT

This page aims to give the public an insight into what exactly the platform does, who is it made for, who are the people involved in the process of creation and what problem we aim to solve.



## 7.5 CONTACT

In order to provide the user with some sort of support, we decided to create a contact page, therefore the user can contact the Admin for any questions or issues related to the platform.



The screenshot shows the 'Contact' page of the HUT platform. At the top, there is a dark blue header with the HUT logo on the left and 'Log In' and 'Register' buttons on the right. The main content area has a white background with a dark blue footer. The 'Contact' section includes a title, a brief message, and a form with fields for Name, Email, and Message, followed by a 'Submit' button. The footer contains links for 'About HUT | Contact' and a copyright notice.

**Contact**

Got a question? You can contact us by clicking the 'submit a request' and we'll get back to you as soon as possible

Name :

Email:

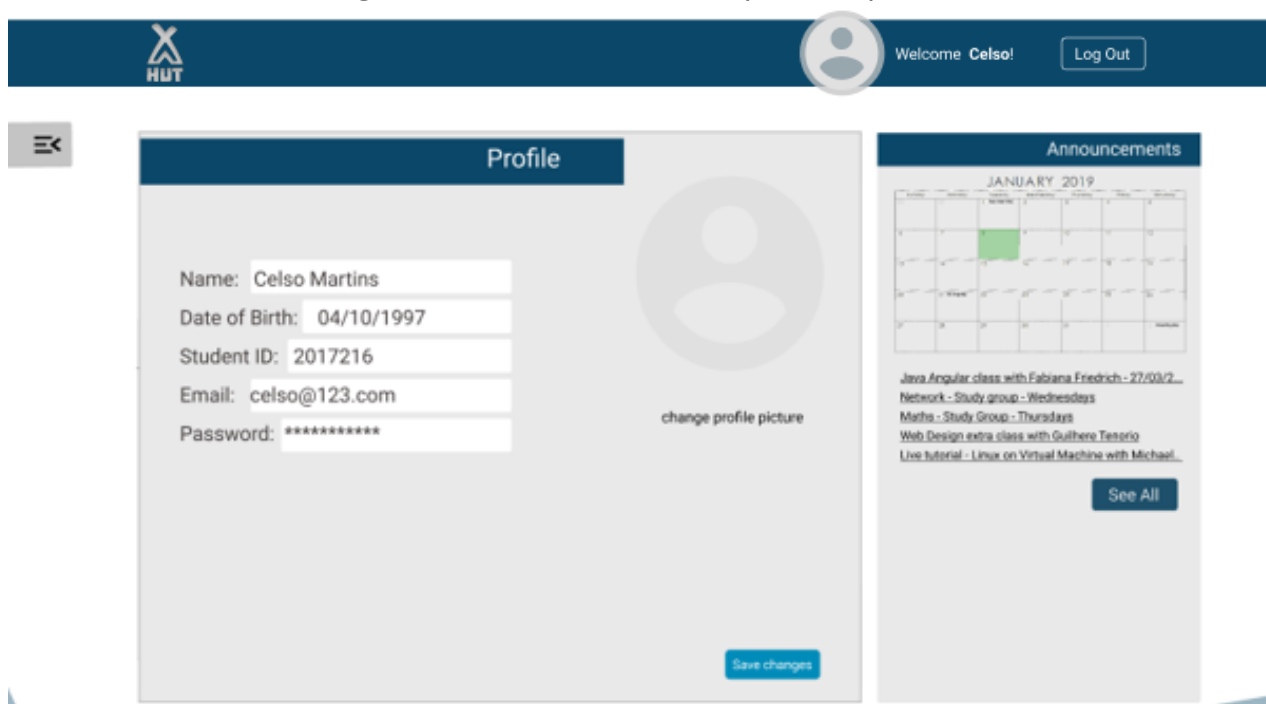
Message:

About HUT | Contact

@2020 HUT - Help Us Tech

## 7.6 PROFILE

This page displays personal data related to the account Logged In and allows users to change information and/or profile picture.



The screenshot shows the 'Profile' page of the HUT platform. At the top, there is a dark blue header with the HUT logo on the left, a user profile icon in the center, and 'Welcome Celso!' and 'Log Out' buttons on the right. The main content area has a light gray background with a dark blue footer. The 'Profile' section includes a title, a form with fields for Name, Date of Birth, Student ID, Email, and Password, followed by a 'Save changes' button. The 'Announcements' section includes a title, a calendar for January 2019, a list of announcements, and a 'See All' button.

**Profile**

Name: Celso Martins

Date of Birth: 04/10/1997

Student ID: 2017216

Email: celso@123.com

Password: \*\*\*\*\*

**Announcements**

JANUARY 2019

Java Angular class with Fabiana Friedrich - 27/03/20...

Network - Study group - Wednesdays

Maths - Study Group - Thursdays

Web Design extra class with Guilherme Tessari

Live tutorial - Linux on Virtual Machine with Michael...

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## **7.7 OTHER FEATURES**

### **7.7.1 VIDEO**

Any user can upload a video in order to either answer a question in a way to guide students or upload as a small tutorial for a particular subject. Videos must contain:

- title;
- subject related;
- duration - (from 1 to 3 minutes max);
- number of views.

### **7.7.2 REPUTATION POINTS**

Users can get reputation points whenever their question or answer is upvoted, e.g., A question may be upvoted by users who have the same problem, and an answer is likely to be upvoted when it solves or helps to solve the problem. To stimulate the use of the platform, users will earn points according to their activities:

- Upvotes per post (Question/Answer);
- Answers with upvotes;
- Answers marked as Best Answer.

### **7.7.3 DOWNVOTES**

A question or an answer can be downvoted when it is not relative to the content of the page, in other words, when an answer to a question does not make sense or it is inappropriate, as well as when a question is out of the academic context, e.g., "My phone stop working". The users will be able to decide whenever a question or answer needs to be removed by downvoting it.

- In case a question or answer receives up to 5 downvotes it will be automatically deleted by the application.
- Users can report questions or answers that are inappropriate or irrelevant to the forum and these will be sent to moderators to evaluate the content.

### **7.7.4 ONLINE COURSES**

Students and teachers will be able to give online courses through video lessons or screencast about content related to the academic course that are taught in class or even about some content that are not in the academic curriculum but will add to the knowledge of the students.



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## 8. FRONT-END DEVELOPMENT

### 8.1 ANGULAR 9 FRAMEWORK

Angular was the team's choice for being an open-source front-end framework developed by Google for creating dynamic, modern web apps. Since 2009 this framework has gained good visibility on the market for bringing up ensuring lighter and faster applications once the eliminate all of unnecessary code.

Angular helps build interactive and dynamic single page applications (SPAs) with its compelling features including templating, two-way binding, modularization, RESTful API handling, dependency injection, and AJAX handling. Designers can use HTML as template language and even extend HTML' syntax to easily convey the components of the application. You don't need to rely on third-party libraries to build dynamic applications with Angular. Using this framework in your projects, you can reap multiple benefits.

One of the biggest advantage of Angular is that it is supported by Google. The best part about it is Google's Long-Term Support (LTS). This sheds light on Google's plan to stick with it and further scale up the Angular ecosystem. Google apps also use this framework and their team is very optimistic about Angular's stability.

Angular applications are developed using TypeScript language, a superscript for JavaScript ensuring higher security as it supports types such as primitive and interfaces bringing a better performance once it helps to catch errors when writing and also are able to debug the code if needed in the browser or an editor of your preference.

In addition to this you do not need to waste time in program to control what loads first in your application. Angular will look after that, once it uses HTML to define the UI of the application for being a easier language to understand and also is a declarative and intuitive language.

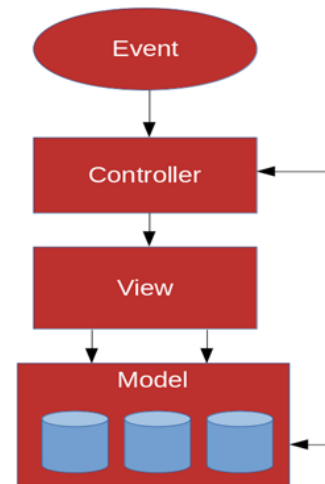
Angular also uses POJO (Plain Old JavaScript Object), which provide all the convectional JavaScript functionalities that is required to add or remove any properties needed.

In Angular, the testing process is quite straight forward. Basically AngularJS separate everything in modules making easier to use when need to loads whatever services are necessary while performing automatic testing.

When MVC Architecture becomes a subject Angular by default has the

original MVC (Model-View-Controller) software architectural setup. However, it is not according to the established standards. Angular does not ask developers to split an application into different MVC components and build a code that could unite them.

- **Model:** It is the lowest level of the pattern responsible for maintaining data.
- **View:** It is responsible for displaying all or a portion of the data to the user.
- **Controller:** It is a software Code that controls the interactions between the Model and View.



## 8.2 PrimeNG UI COMPONENTS

PrimeNG is a library of User Interface elements specially created to work with Angular. Although we have also made use of Bootstrap, the major components of HUT Web Application were implemented using this Angular module because it offers more features than bootstrap when it comes to implementation of components such as dialog box, panel, multi-select, input fields, notification messages and other input elements. To better explain how such elements were added to our web application, see bellow the implementation process of the Panel located in Subjects:

- **IMPORT IN ANGULAR**

```
import {PanelModule} from 'primeng/panel';
```

- **ADDING THE COMPONENT TO THE PAGE**

The component Panel is defined with p-panel element.

```
<p-panel header="Subjects" [toggleable]="false">
  Content
</p-panel>
```

---

## 9. BACK-END DEVELOPMENT

### 9.1 SPRING FRAMEWORK

The application is using Action-based approach with Spring Framework on the back-end layer and Angular 9 on the front-end layer. We did choose these tools because they are considered the most popular frameworks at present and they work very well together when implementing Restful API + User Interface.

Using the Action-based approach of Spring we have certain benefits such as dividing the implementation of back-end and front-end layers, and we can choose different frameworks to implement the User Interface once the back-end is going to be separately and the communication between these layers are done by HTTP requests.

#### 9.1.2 THE DAO PATTERN WITH JPA AND SPRING

The back-end of the application was implemented following the Data Access Object (DAO) Pattern which is a structural design pattern that basically allows the separation of the application layer from the persistence layer.

Spring Framework is very useful when it comes to the implementation of back-end because it "wires" different components together. In this project, we have chosen to use from Spring framework family, the Spring Boot, by using Spring Initializr to start the project with the correct dependencies, Spring security to implement authentication + JWT token, Spring Data JPA handle the relational entities models and of course to connect to our MySQL database.

Due to the complexity of building the back-end of an API, this task would have been quite challenging without the use of JPA because we would need to analyse the platform functionalities, break it into different iterations, and implement their CRUD operations one by one. However using JPA which stands for Java Persistence API, has helped us to speed up the process of mapping the application classes into the MySQL tables of our application, and in our personal opinion, the use of Java Persistence API have made the back-end development much easier and faster than writing plain DML queries.

## 9.2 APACHE MAVEN

Maven is an excellent tool developed by the open-source web server Apache, which automates tasks such as downloading project's dependencies, compiling source code into binary code, putting additional jars files on a classpath, packaging compiled code into deployable formats such as JAR, WAR, and ZIP files, it also automates the deployment process of these artifacts to an application server or repository. It has basically helped us with all hard work related to the building and management of our application.

The fundamental element of Maven is the Project Object Model (POM) which is an XML file containing essential information about the project's configurations which is used to build the application. Here are some of the main dependencies added to POM.xml file of HUT:

- **SPRING BOOT**

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
```

- **MySQL CONNECTOR**

```
<dependency>
  <groupId>mysql</groupId>
  <artifactId>mysql-connector-java</artifactId><scope>runtime</scope>
</dependency>
```

- **JPA**

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
```

### 9.2.1 SPRING BOOT MAVEN PLUGIN

This plugin is responsible for creating executable files such as jar and war which contain all the application's dependencies:

```
<plugin>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-maven-plugin</artifactId>
</plugin>
```

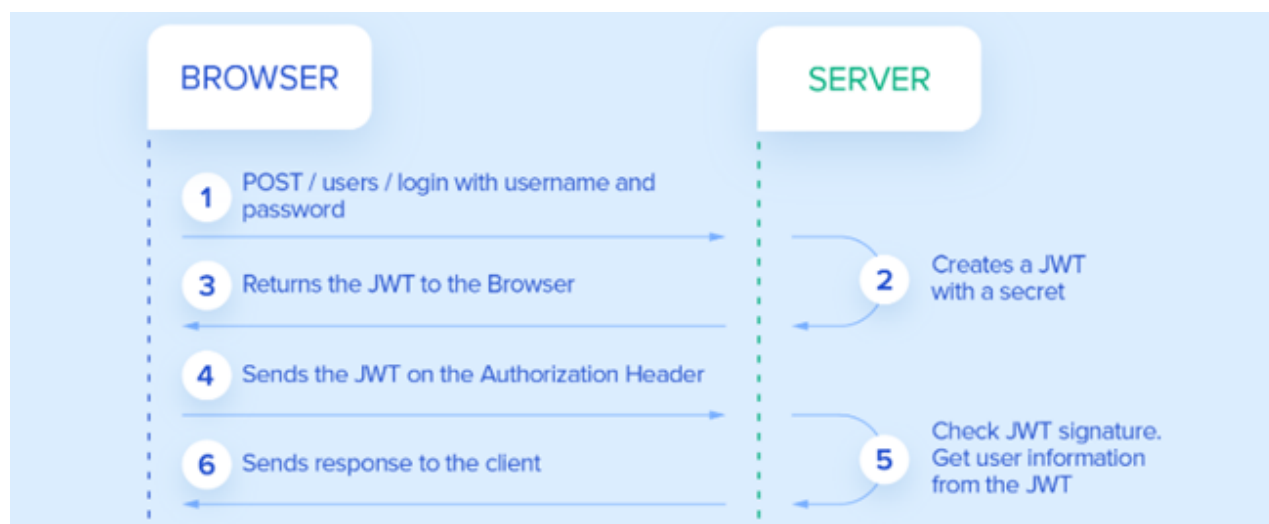
## 9.3 JWT AUTHENTICATION

According to Dejan Milosevic, security is the enemy of convenience, and vice versa. This statement is true for any system, virtual or real, from the physical house entrance to web banking platforms. Engineers are constantly trying to find the right balance for the given use case, leaning to one side or the other. Usually, when a new threat appears, we move towards security and away from convenience. Then, we see if we can recover some lost convenience without reducing the security too much. Moreover, this vicious circle goes on forever(Dejan Milosevic, 2015).

JWT (JSON Web Token) is the missing standardization for using tokens to authenticate on the web in general.

It is robust and can carry a ton of data, but is still simple to use even though its size is relatively small. Like any other token, JWT can be used to pass the identity of authenticated users between an identity provider and a service provider. It can also carry all the user's case, for example authorization data, so the service provider does not need to go into the database or external systems users roles and consents for each solicitation.

Here is how JWT security is designed to work:



1 - Clients logs in by sending their credentials to the identity provider.

2 - The identity provider verifies the credentials; if everything is OK, it retrieves the user data, generates a JWT containing user details and permissions that will be used to access the services, and it also sets the expiration on the JWT.

3 - Identity provider signs, and if necessary, encrypts the JWT and sends it to the client as a response to the initial request with credentials.

4 - Client stores the JWT for a limited or unlimited amount of time, depending on the expiration set by the identity provider.

5 - Client sends the stored JWT in an Authorization header for every request to the service provider.

6 - For each request, the service provider takes the JWT from the Authorization header and decrypts it. Based on this data solely, it can accept or deny the client request. The only requirement is that the identity and service providers have an agreement on encryption so that service can verify the signature or even decrypt which identity was encrypted.

In the code bellow we can see a class where the JWT was implemented in our project:

```
34     public String generateToken(Authentication auth){
35         String authorities = auth.getAuthorities().stream()
36             .map(GrantedAuthority::getAuthority)
37             .collect(Collectors.joining());
38
39         return Jwts.builder().setSubject(auth.getName())
40             .claim("roles", authorities)
41             .setExpiration(new Date(System.currentTimeMillis() + jwtExpirationInMs))
42             .signWith(SignatureAlgorithm.HS512, jwtSecret).compact();
43     }
44
45     public Authentication getAuthentication(HttpServletRequest request){
46         String token = resolveToken(request);
47         if(token == null){
48             return null;
49         }
50         Claims claims = Jwts.parser().setSigningKey(jwtSecret).parseClaimsJws(token).getBody();
51         String username = claims.getSubject();
52         final List<GrantedAuthority> authorities = Arrays.stream(claims.get("roles").toString().split(","))
53             .map(role -> role.startsWith("ROLE_")?role:"ROLE_"+role)
54             .map(SimpleGrantedAuthority::new)
55             .collect(Collectors.toList());
56         return username!= null ? new UsernamePasswordAuthenticationToken(username, null, authorities): null;
57     }
58
59     public boolean validateToken(HttpServletRequest request){
60         String token = resolveToken(request);
61         if(token == null){
62             return false;
63         }
64         Claims claims = Jwts.parser().setSigningKey(jwtSecret).parseClaimsJws(token).getBody();
65         if(claims.getExpiration().before(new Date())){
66             return false;
67         }
68         return true;
69     }
70
71     private String resolveToken(HttpServletRequest req){
72         //Bearer key...
73         String bearerToken = req.getHeader(jwtHeaderString);
74         if(bearerToken!=null && bearerToken.startsWith(jwtTokenPrefix)){
75             return bearerToken.substring(7, bearerToken.length());
76         }
77         return null;
78     }
79 }
```

---

## 10. DEPLOYMENT PROCESS

Heroku is a very popular Platform as a Service (PaaS), according to an article published on Mentormate.com (Rusev & Gadzhev, 2018), the cloud service platform which offer a free service model is mostly focused and perfect for small scale projects.

During the planning of the project, the team thought about the platform in which the application would be deployed and because we have previously used Heroku in one of the Web Development Assignments during our last academic year, we have decided to use it to deploy and manage the application in the cloud because it is flexible and easy to use, also because the deployment process is very simple to do.

We kept the front-end and back-end of our web application in separate GitHub repositories because it is considered to be good practices, also it basically modularizes the project, not to mention that we wanted to give a more professional look to the development and deployment process. Once we had the application fully functional in both front and back-end, we deployed both repositories to one single domain on Heroku.

- **API (BACK-END)**
  - <https://github.com/fabianafriedrich/hut-api.git>
- **UI (FRONT-END)**
  - <https://github.com/fabianafriedrich/hut-ui.git>
- **HEROKU:**
  - <https://hut-cct-ui.herokuapp.com/>

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## 11. COLLABORATION AND TEAM WORK

During the whole process we have used tools to help our group stick together in order to always keep in touch and up to date about every single step that we were making during this journey of development of this web application. We shared any and all kind of ideas and contents for the project through Basecamp, Trello and WhatsApp Messenger. Basecamp is a tool introduced by the college which we were able to build a To Do list helping us to better see in a space time how and where we were in terms of developing wise. We also could keep in touch with our Project Supervisor (Ken Healy), who was always on hand to help and he could also follow the project and check if we were up to date with the deadlines.

WhatsApp Messenger has also allowed us to remain in contact continuously as well as make quick group announcements in relation to the project.

We knew the entire project could not be develop without proper meetings so we could better analyse and express ourselves. Unfortunately, we had some issues half way through the project due to COVID-19, a global pandemic which was obviously unexpected. This made it difficult and almost impossible to meet in person and forced most of us to stay in quarantine and lead to some working even harder during this fragile and hard period of the year.

### 11.1 INDIVIDUAL CONTRIBUTION

#### 11.1.1 CELSO MARTINS - 2017216

In this project, my contribution involved all UI/UX design, including the conceptual design and wireframing of the platform. Many of the specification requirements were written by me, and I was also responsible for the research of some technologies for the front and back-end development of the web application, such as PrimeNG UI Components, the use of JPA following the DAO pattern, Spring framework and Apache Maven. I believe my contribution to both research and writing of this documentation added a lot to my knowledge about front and back end development of a web application, not to mention the research part about deployment and security.

I was also responsible for all the documentation design, formatting, grammar correction and referencing.



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### **11.1.2 FABIANA FRIEDRICH - 2017184**

I was responsible for planning the database, development of the back-end API and the front-end UI.

The application is using Spring Framework on the back-end layer, MySQL database, Flyway database version control to handle and organize database migrations, and Angular 9/TypeScript on the front-end layer. I used for the security layer Spring security to implement authentication + JWT token, Spring MVC to handle HTTP requests(GET/ POST/ PUT/ DELETE), Spring Data JPA handle the relational entities models and to connect MySQL database.

Thus, using the approach Action-based from Spring I did implement back-end and front-end layers separately, the first one to expose API endpoints to be consumed by the UI application. The communication between these layers was done by HTTP requests, sending and receiving JSON.

I did deploy the application on Heroku to make sure the application is 100% available. First I deploy the API back-end and after that deploy the UI front-end separately.

### **11.1.3 GUILHERME TENORIO - 2017160**

I was responsible to keep track of the group timetable and then to produce our Gantt chart according to ours tasks and meetings, I also researched and wrote a good portion of the documentation (Social Learning Theory, Benefits of group work, and some more). Unfortunately due to recent circumstances, Covid-19, I got really caught up with work(restaurant) which became really busy and stressful during the last two months but I believe that in the end, among all the CA's and online classes, I managed to work well with my colleagues to deliver a job well done.

### **11.1.4 VINICIUS MARTINS - 2017256**

The process of research and documentation was one of my duties in this project together with my peer Celso Martins. Researches in regards to the technology for the back and front end, database and testing. I have also collaborated some content of my own such as diagram and texts in regards to the web application and the documentation itself. In charge of realizing tests for the back end, which unfortunately was not fully implemented in the project due to some of the group issues that we came

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across along the way. I've realized some study about the software chosen to make those tests which is Cypress, it was fun and pleasant to work. The quarantine and COVID-19 situation going on made us going through a lack of communication between us and some of the requirement for the project failed. We hope to keep going with the web application and step-by-step implement everything as planned and end up with the website up and running in service to all students.

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## 12. CONCLUSION

The delivered final product demonstrates that HUT is a platform of learning with the purpose of share knowledge among students, providing improvement of communication and educational resources along with the college.

HUT is an opportunity of enhancement for both teaching and Learning in Higher Education. One way of investing in people and increase knowledge educational. Although there are many comparable web applications running online, we were expecting to challenge ourselves and come up with unique ideas for innovation. In fact, there are still features to be implemented and others to be improved. Some of the technologies applied in the project were discovered through several researches during this last academic year, which took a lot of dedication and hard work. Those researches had a positive impact in our academic life, making us better understand a real world case scenario.

We faced some difficulties along the way, mostly difficulties related to the development of both front and back-end of the web application. However, working as a team we were able to finish and deliver everything in time. In addition, it is hoped that the team continues to progress with the development of the platform encouraging other students to proceed and evolve their ability to learn.

“Using knowledge does not consume it. Transferring knowledge does not result in losing it. Knowledge is abundant, but the ability to use it is scarce. Much of an organization’s valuable knowledge walks out the door at the end of the day.” Kimiz Dalkir, Director at McGill School of Information Studies and Knowledge Management in Theory and Practice, 2nd ed. (2011).

The internet is becoming even more present as the years progress, we are more and more forced to be connected, we are connected all the time, does not matter how or where. This is a new era that began not long time ago and our goal is to help new students to become future professionals.

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