



# YOUniversity

Human Computer Interaction  
2020/2021

Project and relation by:

Gianluca Pulicati 1708686

Loris D'amico - 1678203

Vasile Vladut Gorea - 1695720

Professors:

Tiziana Catarci

Valeria Mirabella

## **Contents**

<u>Chapter 0 - Abstract.....</u>	3
<u>Chapter 1 - Introduction.....</u>	3
<u>Chapter 2 - Gathering information.....</u>	5
<u>Chapter 3 - Task analysis: HTA and STN.....</u>	20
<u>Chapter 4 - Mockups and first Prototype.....</u>	26
<u>Chapter 5 - Expert Based Evaluation.....</u>	35
<u>Chapter 6 -User-based evaluation technique.....</u>	48

## Chapter 0

### **Abstract**

This document describes in detail all the phases involved in the implementation of the examination project in "Human Computer Interaction" starting from the description and the philosophy behind the idea, then continuing with the different evaluation techniques that led to the evolution of the project from a simple mockup to a complex system designed on the user.

### **Group Description**

The team of work is made up of: Gianluca Pulicati, Loris D'Amico e Vasile Vladut Gorea.

The project in every phase has been planned together following an UCD model approach for the workflow.

Each member has worked on its own part and then that part was tested by the others.

## Chapter 1

### **Introduction**

The product of our work takes the name of "YOUNiversity", a software designed for university's students. Actually the application has been designed and implemented as a tool for students of M.sc in Engineering in Computer Science, although the base of the software is easily extendable to every course of whichever university.

## **What is the situation without our system?**

To date, the only way to learn about a university course is:

1. Reading the brief description of the program proposed by the university's site;
2. Asking around;
3. Following the first 2-3 weeks of a course to understand if it is the right subject for you.

Evidently these steps result in a great deal of effort, time consuming and frustration. Especially these days, where direct interaction with other people has become more complex.

Whatever, taking advantage of the great availability of material now online, we can turn this hard situation to our advantage.

Using the product, a student can in a few days, if not hours, have a detailed view of which subjects may be of interest to him.

## **What is our product and for who?**

Our product allows university students to keep in an orderly manner everything they need to become aware and knowledgeable of the subjects to be followed and to reach the best choice for their career, especially, for example, if they are freshmen in a new university/town which makes things even more difficult.

### First enrolled students:

1. Thanks to a collection of colleagues' feedback, teaching material and video lessons, they can quickly gather useful information.
2. They have a guide in choosing courses, thanks to a suggestion mechanism of related subjects designed to build a coherent study plan.

### Graduating students:

1. They can use the app as a well organized tool for their university's studies, accessible whenever they need it, ready for when an update is needed.
2. They can find the best idea and professor for their thesis.

## **How/When are they using our product?**

A user can access the platform with his smartphone or laptop, the interface is intuitive and similar both ways.

## Chapter 2

# **Gathering information**

Below are presented the methodologies used to gather information to lay the foundation of the application itself.

## **2.1 Competitors analysis**

At the moment, there are no “direct” competitors to our application; usually the user must search information on his own, surfing through different websites and/or asking around for information which could be even conflicting among each other.

### **2.1.1 Find information**

The only official way for students to get information about courses is the website of the university and the websites of the courses. There, professors write the topics, the materials, the modality of the exam and information about the management of the course.

Pros:

- The information are reliable since they are written by the professors;

Cons:

- Some professors provide very little information, maybe not up to date.
- Student may not understand what is the topic of the course from the description;
- Cannot confront courses;
- Cannot see which courses are related;
- Cannot know the difficulty of the course;
- There aren't opinions from other students who attended the course;

## 2.1.2 Find Opinions

The university has students fill out the Student's Opinions Questionnaires (OPIS) for every course they attend before the exam. In this way the professors can collect information about what was wrong and what was good and suggestions for improving the teaching.

Pros:

- OPIS can help professors to improve their teaching.

Cons:

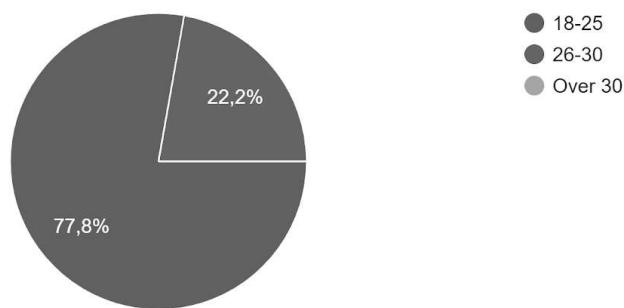
- The results of OPIS cannot be seen by the students if the professor doesn't share them.

## 2.2 Questionnaire analysis

In this section there are the questionnaire results used to collect information about the users and suggestions for our application before starting to design it.

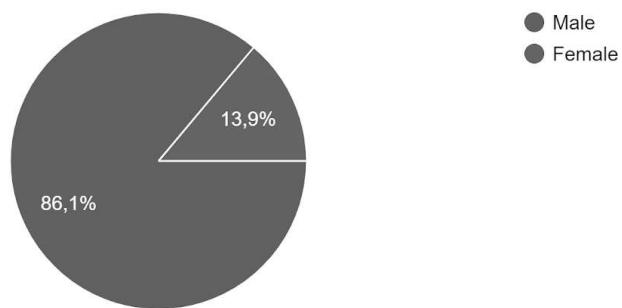
How old are you?

36 risposte



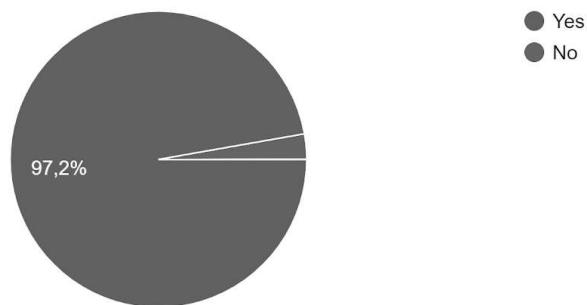
What is your gender?

36 risposte



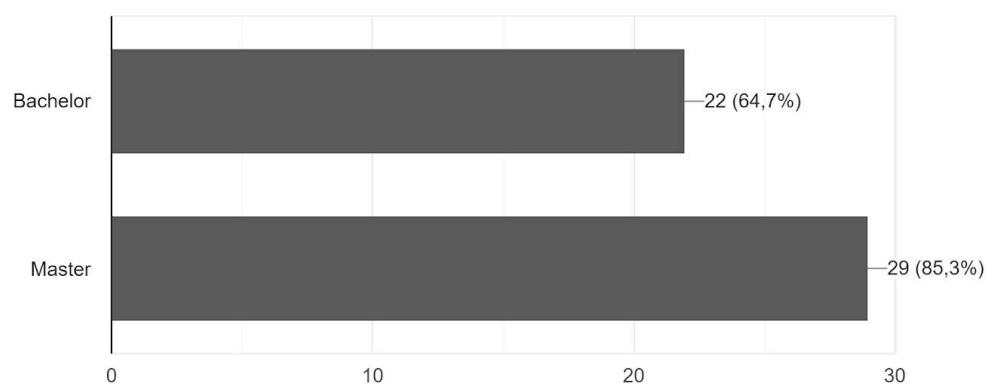
Have you ever studied in Sapienza?

36 risposte



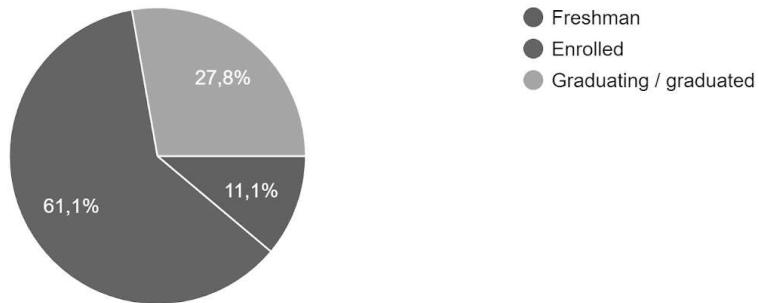
In case you studied in Sapienza, which degree did you pursue?

34 risposte



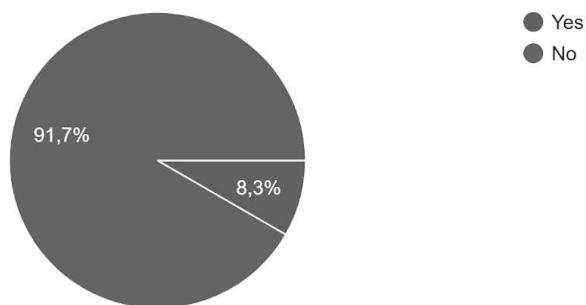
What's your current status as student?

36 risposte



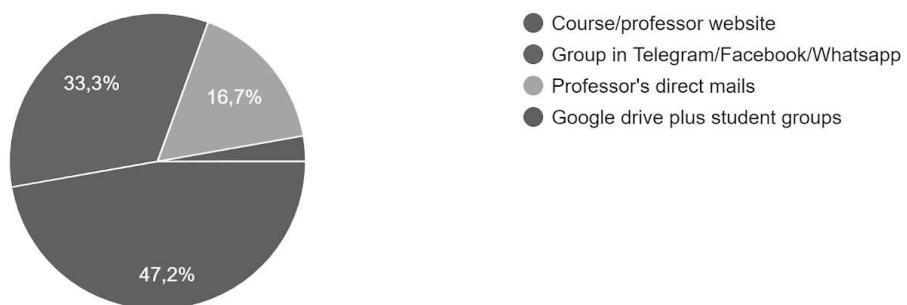
Are you a working student?

36 risposte



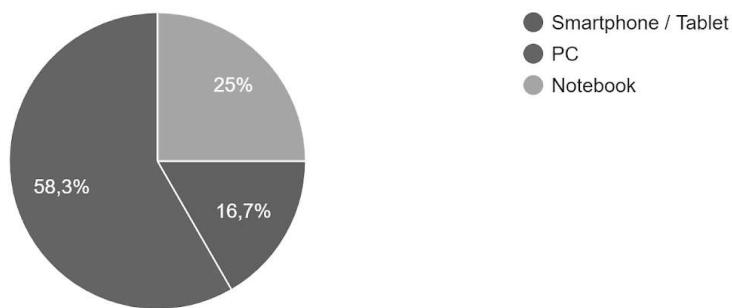
Which communication channel do you prefer to stay tuned on a course?

36 risposte



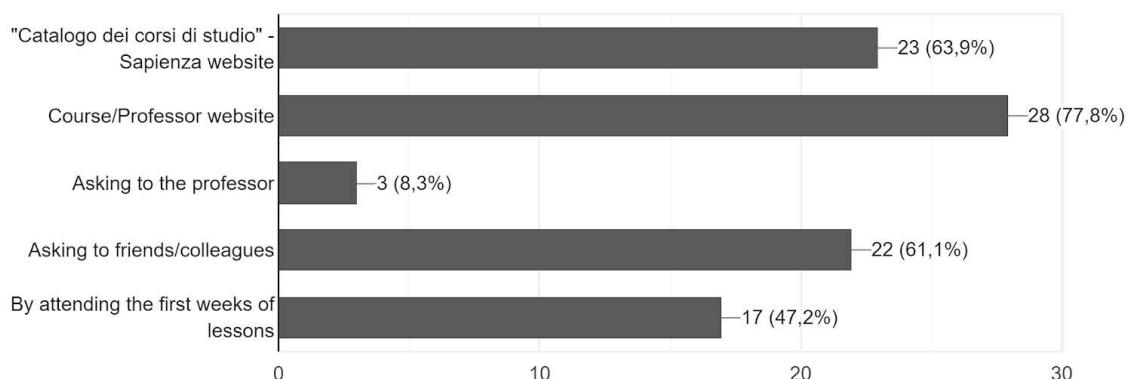
Which device do you use the most to retrieve university courses information?:

36 risposte



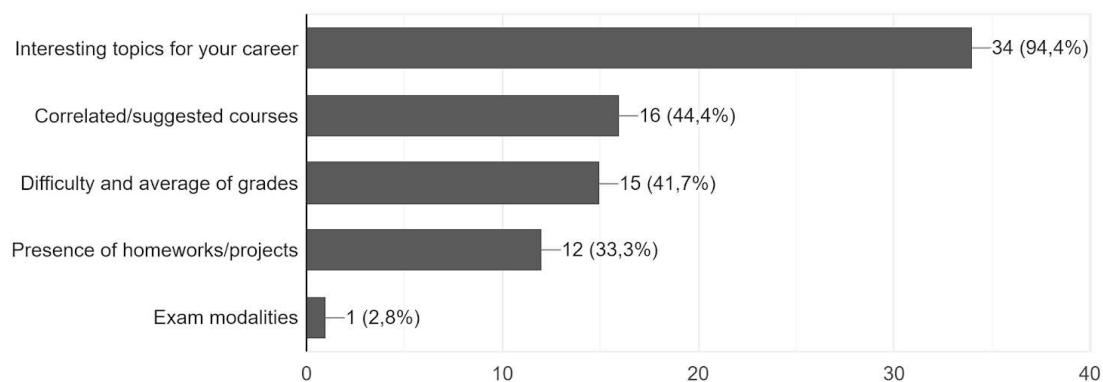
How do you get information about the courses you are interested in?

36 risposte



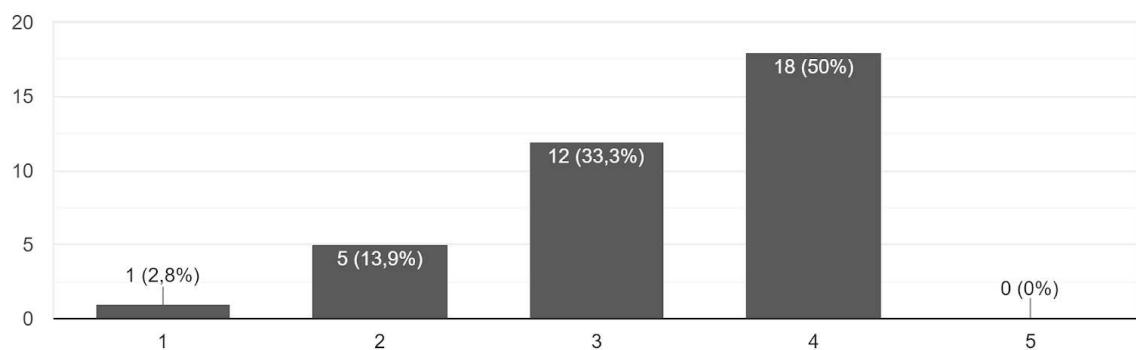
Why do you choose a course rather than another one?

36 risposte



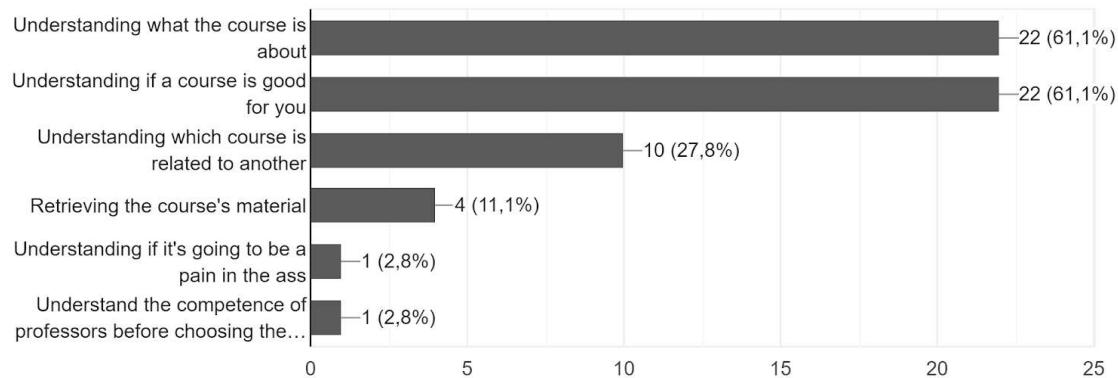
Express the level of confidence you usually have in choosing courses:

36 risposte



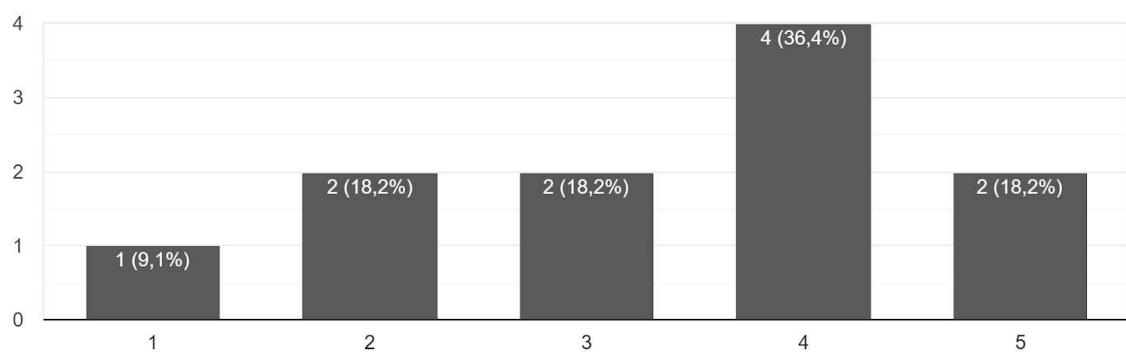
What are the main difficulties that you find in selecting courses?

36 risposte



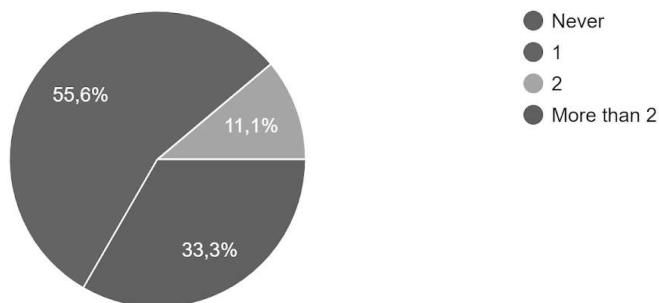
From the beginning of the lectures, how long does it take to complete your study plan?

11 risposte



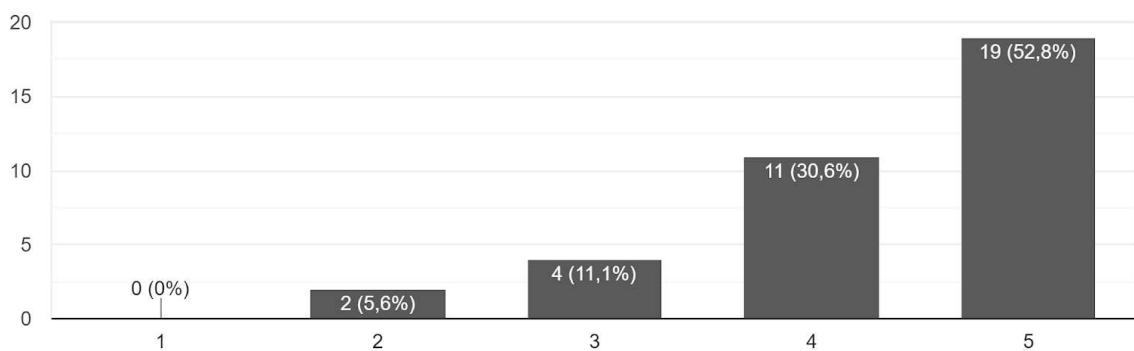
During a generic academic year, how many times do you make changes to an already submitted study plan?

36 risposte



What do you think about an application to retrieve information about courses?

36 risposte



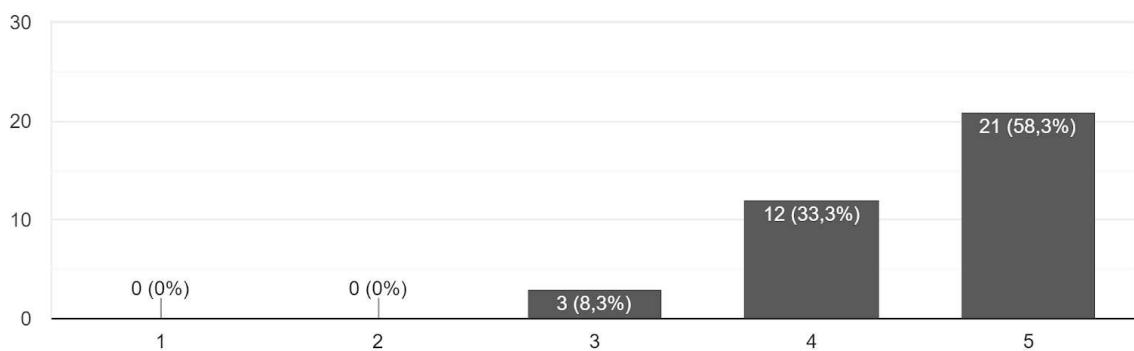
Did you find difficult to search for thesis supervisor?

36 risposte

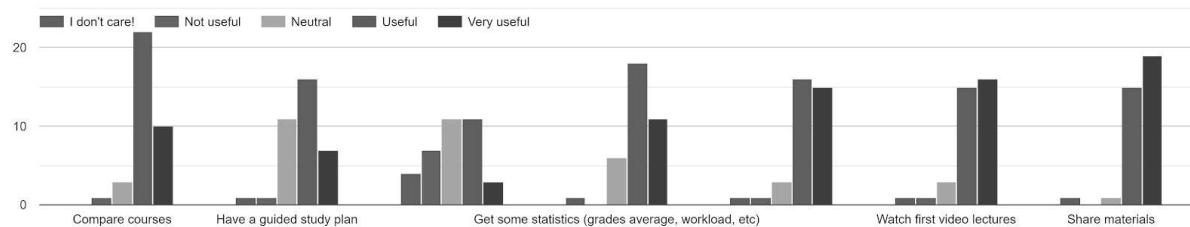


What do you think about an application to retrieve information about thesis proposal?

36 risposte

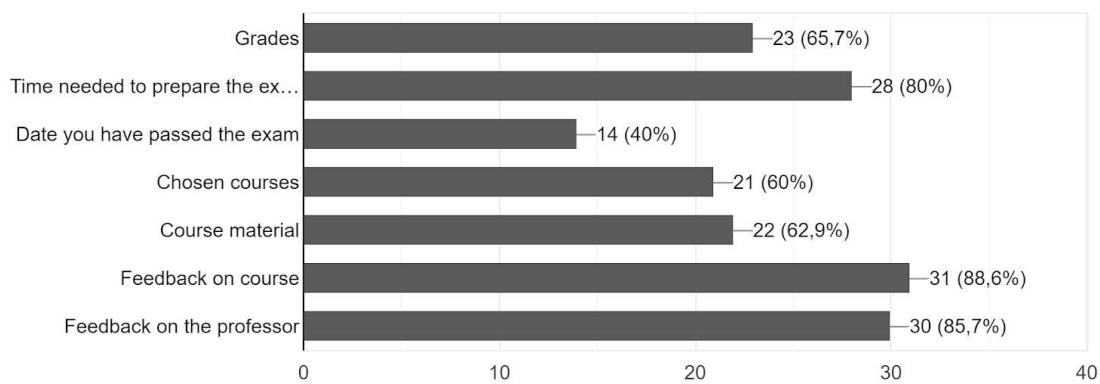


How much would these features be interesting for you?



What information would you be willing to share anonymously?

35 risposte



Where would you prefer to use such application?

36 risposte



Any other features you would see implemented?

- Please, add a correlation table between exams/study plan and work careers;
- Amazon-like course and professor voting/review system with some statistical insight into correlation between the grade of the student and his final grade at the course (I mean of course for students who got 18/30 there's going to be a bias towards bad votes);
- Of course a personal dashboard with my career situation apart from the main focus of this app (which is retrieve information about courses etc.);
- Opinions and description also by the professor;
- A chat with other colleagues, for example to find a partner for an exam project;
- Opinions of other students could be too personal and absolutely not in line with my pov;

## 2.2.1 Conclusions

From the analysis of the questionnaire results we have come to these conclusions:

- Most of the students have an age between 18 and 25;
- Almost every user studies/has studied at Sapienza;
- Most of the them are enrolled and only some of them also work;
- Most of the them use pc to to retrieve university courses information but most of them would like an app to do it;
- Most of the Sapienza's students make changes to their study plan more than once every year; this describes the confusion for this task.
- They are interested in comparing courses, having a guided study plan, a dashboard with their career situation and being able to get some statistics and opinions of colleagues;

- On the contrary, they are not interested in taking a look at their colleagues' study plan, so we discarded this service.

## 2.3 User analysis

Based on the main activity and interaction with the system, we can largely identify 3 kinds of user:

**User 1:** First enrolled student

**User 2:** Graduating student

**User 3:** Part-Time student

### 2.3.1 User profile 1: First enrolled student

Age: 18-30

Sex: Male and Female

Location: potentially from any part of Italy, but mainly in Lazio.

Likes: they are in the IT field, they like technologies and computers.

Technology: they use hardly smartphone and also laptop

Education: they are attending the university, both for the bachelor or master degree.

Study hours: 5-8 hours per day

#### Psychographics:

Fears:

- Not succeed the graduation in time;
- Wasting time in annoying stuff;
- Not creating a good group of friendly colleagues;
- Spending time in the research of something that maybe will not be useful

Ambitions: becoming a good and well formed engineer

**User needs:** the user needs to have a good strategy to make up their study plan and thesis.

**User goals:** choosing in the minor time as possible a good plan of studies.

### **2.3.2 User profile 2: Graduating student**

Age: 21 – 30

Sex: Male and Female

Location: potentially from any part of Italy, but mainly in Lazio.

Likes: they are in the IT field, they like technologies and computers.

Technology: they use hardly smartphone and also laptop to work

Education: they are attending the university, both for the bachelor or master degree.

Study hours: 5-8 hours per day

#### **Psychographics:**

Fears:

- Choose a boring thesis;
- Wasting time in annoying stuff;
- Having a thesis supervisor who does not participate at all.

Ambitions: Seeking a job very soon after graduation.

**User needs:** the user needs to have a good knowledge about the thesis argument and professors.

**User goals:** choosing in the minor time as possible a good professor, with an interesting argument.

### **2.3.3 User profile 3: Part-Time student**

Age: 21 – 30

Sex: Male and Female

Location: potentially from any part of Italy, but mainly in Lazio.

Likes: they are in the IT field, they like technologies and computers.

Technology: they hardly use smartphones and also laptops.

Education: they are attending the university, both for the bachelor or master degree.

Job: S/He is a part time student with a full or part-time job.

Work hours: 5-8 hours per day.

Study hours: 5-8 hours per day.

### **Psychographics:**

Fears:

- Not succeed the graduation in time;
- Wasting time in annoying stuff;
- Not creating a good group of friendly colleagues;
- Difficulties in attending lectures and exams;

Ambitions: To become a good and well formed engineer improving its skills and having a better job career.

**User needs:** the user needs to have a clear and structured space where they can find all the interesting material in the shortest possible time.

**User goals:** having lectures and material under control in the best available way.

### **2.3.4 Persona 1: a typical first enrolled student**

Name: Aurora Ricci      Age: 19 years

#### **Quote:**

"I like to travel, live unique experiences and share them with those who thinks like me"

"I would like to find out how to connect people's feelings, I hope it is as easy as sharing a photo"

#### **Personality:**

Judging[0] – Perceiving[100]: 35

Analytical[0] – Creative[100]: 80

Extrovert[0] – Introvert[100]: 90

#### **BIO:**

Aurora is an only child, she loves her family. Her father passed on her curiosity for computer science and her mother the curiosity for the human psyche. She likes

fitness, traveling and sharing feelings and unique moments with friends. After a long day of activities she likes to relax and hang out with friends.

**Behaviors:** Aurora likes to go out with friends, sharing her feelings and daily events on the socials.

She is fascinated in computer science and moreover on artificial intelligence. She is used to watching movies and tv series about this argument.

**Frustration:** Aurora is really worried about not having good outcomes, since she doesn't like compromise, and she doesn't want to lose her friendship relations.

**Goals:** She wants to enter the Erasmus project.

**Technology:** She is used to using the smartphone for all everyday actions.

#### **Scenario:**

It's Sunday, tomorrow lectures are going to start. Aurora, after high school graduation, has spent her summer's break in the USA. She has visited New York, she has found new friends and she would like to come back there one day. Since she returned too late, she didn't have the time to gather information and so she is without a good strategy to do that. Although she has many friends that are with her in this course and she is leaning on them in order to follow an interesting course.

### **2.3.5 Persona 2: a typical graduating student**

Name: Francesca De Paolis      Age: 25 years

#### **Quote:**

"You should, at least every day, listen to some songs, read a good poem, see a good picture, and, if possible, say a few reasonable words."

#### **Personality:**

Judging[0] – Perceiving[100]: 30

Analytical[0] – Creative[100]: 70

Extrovert[0] – Introvert[100]: 10

#### **BIO:**

Francesca lives in Rome where she shares an apartment with her friend. She is currently attending the last year of Engineering in Computer Science at Sapienza. In her free time, she likes to listen to music and some books.

### **Behaviors:**

She follows most of her lessons and she spends most of her free time on studying for the exams. When she doesn't study, she likes to relax with music or some good books.

### **Frustration:**

She is worried about finding an interesting project for her thesis since she doesn't like to work on boring topics.

### **Goals:**

Make a good project for the thesis, which she considers as a springboard for a brilliant future.

### **Technology:**

She uses the laptop to study and the smartphone for entertainment.

### **Scenario:**

It's July and Francesca has passed the last exam of her degree. She began to think about the thesis. She would like to do a project on a topic that may be useful for a future job. She talks with some professors to know the possible projects that can do but she is not sure which of them is a good supervisor that guides her during the various phases of the project. She is going to ask for opinions and advice from her colleagues. So she writes on a "telegram" group and hopes that someone will eventually respond.

## **2.3.6 Persona 3: a part-time student**

Name: Giuseppe Steppi                    Age: 27 years

### **Quote:**

"I prefer to think and plan rather than choose by instinct"

"I don't know everything, but give me any problem I will find the solution"

### **Personality:**

Judging[0] – Perceiving[100]: 80

Analytical[0] – Creative[100]: 40

Extrovert[0] – Introvert[100]: 70

**BIO:** Giuseppe is attending the first year of the master in Engineering in computer science. It was so exciting to begin a new experience after his bachelor and a couple of years in a software house. He is married and before having a child, he wants to specialize his knowledge of computer science to reach a good position in his career.

**Behaviors:** He is not afraid of hard work, and to spend all day in the office, or take the work at home. He loves his wife and he doesn't lose a chance to surprise her. He likes to have everything under control, sorted and when something is a mess he loses his focus.

**Frustration:** He doesn't like to waste time, he has the fear that working and studying may be too hard and he would take a long time to graduate. Managing all the course material without attending all the lectures could be disorienting and frustrating.

**Goals:** Take the graduation as soon as possible.

**Technology:** He uses his smartphone a lot to work, and his laptop. He doesn't like to use these tools as a waste of time.

**Scenario:** It's February first, one week since the lectures begin, and Giuseppe has lost the presentation of a course that he was interested in. Due to the pandemic and the new university he has no friends that can pass to him some information. He is so frustrated because he wants to have a good knowledge of the major part of the courses, but his job holds him back. However he is not a compliant type, and therefore he is trying to get in touch with some students through the different social networks. Speaking with one of them he discovered that there is a telegram channel of the master course and here he is finding many people who can answer his questions. Although he prefers to try things on his skin rather than hear them.

## Chapter 3

### **Task analysis: HTA and STN**

In this section we present the HTA and STN that are related to the main tasks of our application:

- The user can collect information about courses and compare them;
- The user can collect information about realtors and topics for the thesis;
- The user can add feedback on courses and read the feedback of colleagues.
- The user can add his courses to a personal “My Selection” page.

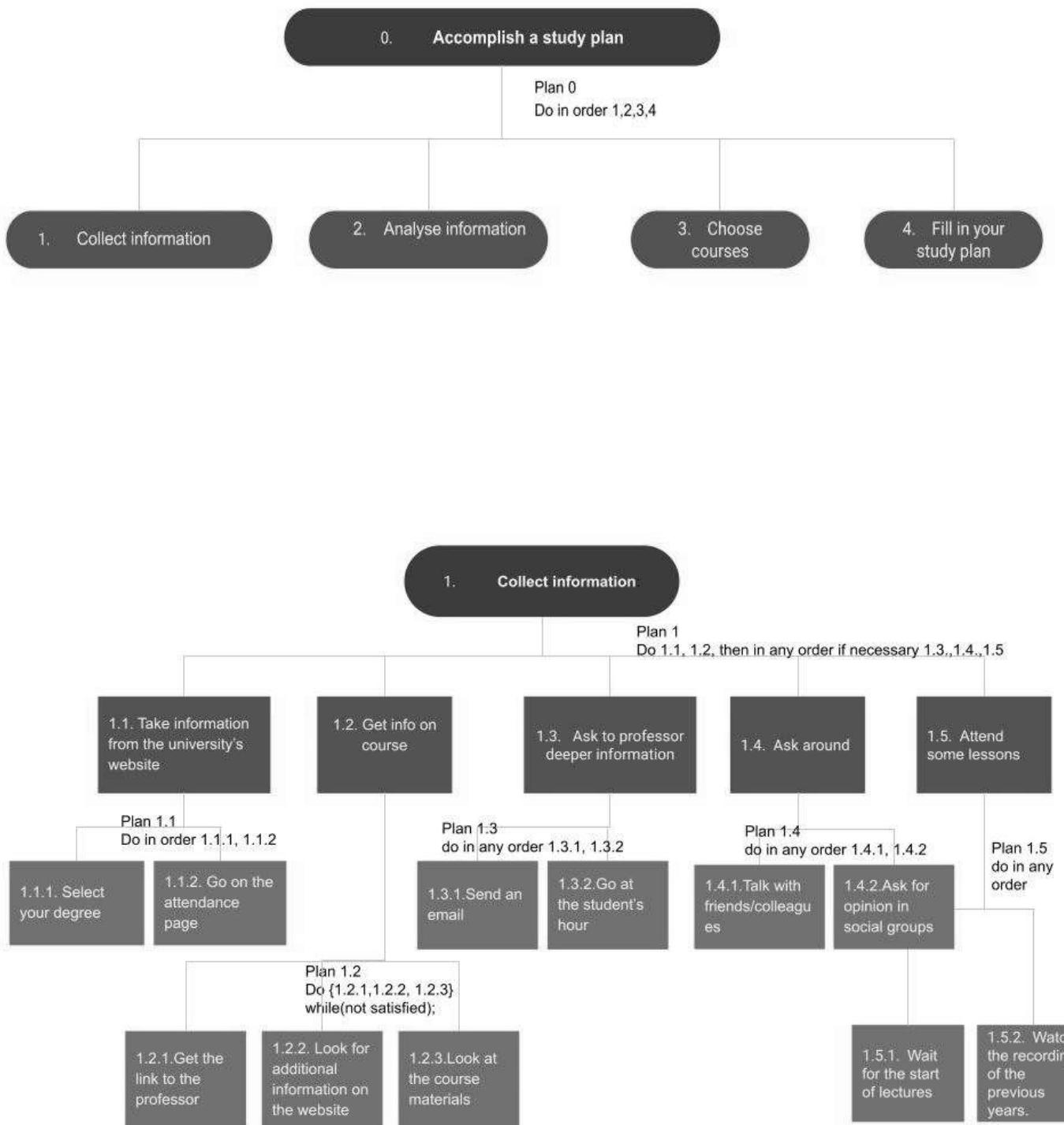
Hierarchical Task Analysis (HTA) is a task description methodology. HTA is used to produce a complete description of tasks in a hierarchical structure of goals, sub-goals, operations and plans.

A State Transition Network (STN) is a schema that is developed from a set of data and graphs the flow of data from particular data points (called states or nodes) to the next ones.

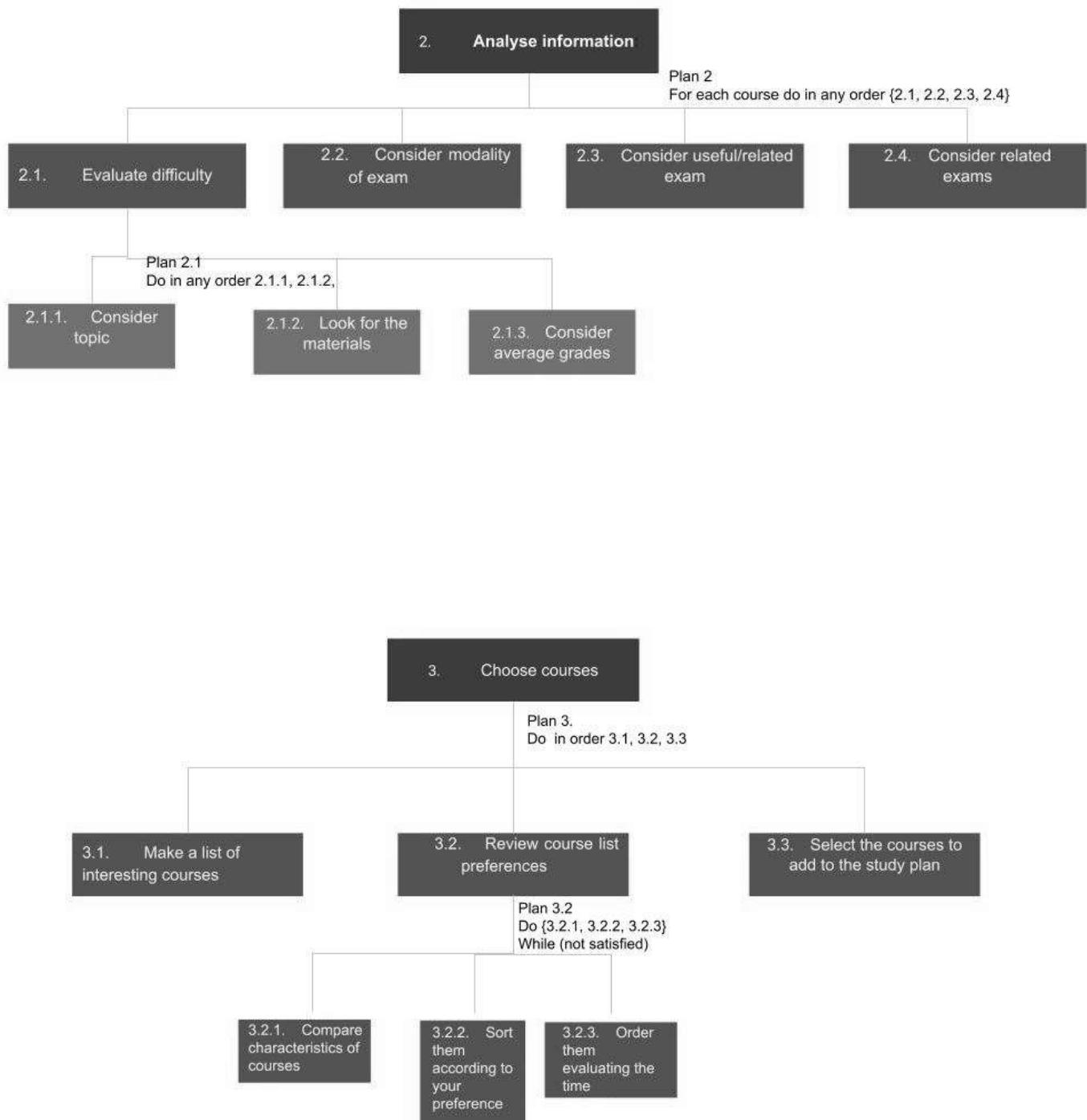
#### **3.1 Collect information about courses**

In order to perform this task, the user must first login. Then from the homepage he can choose “Courses” and in order to either search among all courses and collect information, or can choose to “Compare” multiple courses in order to have a summary of the information all in one page.

He can also add courses to his favorites (“My Selection”).



!\*website\*!



#### 4. Fill in your study plan

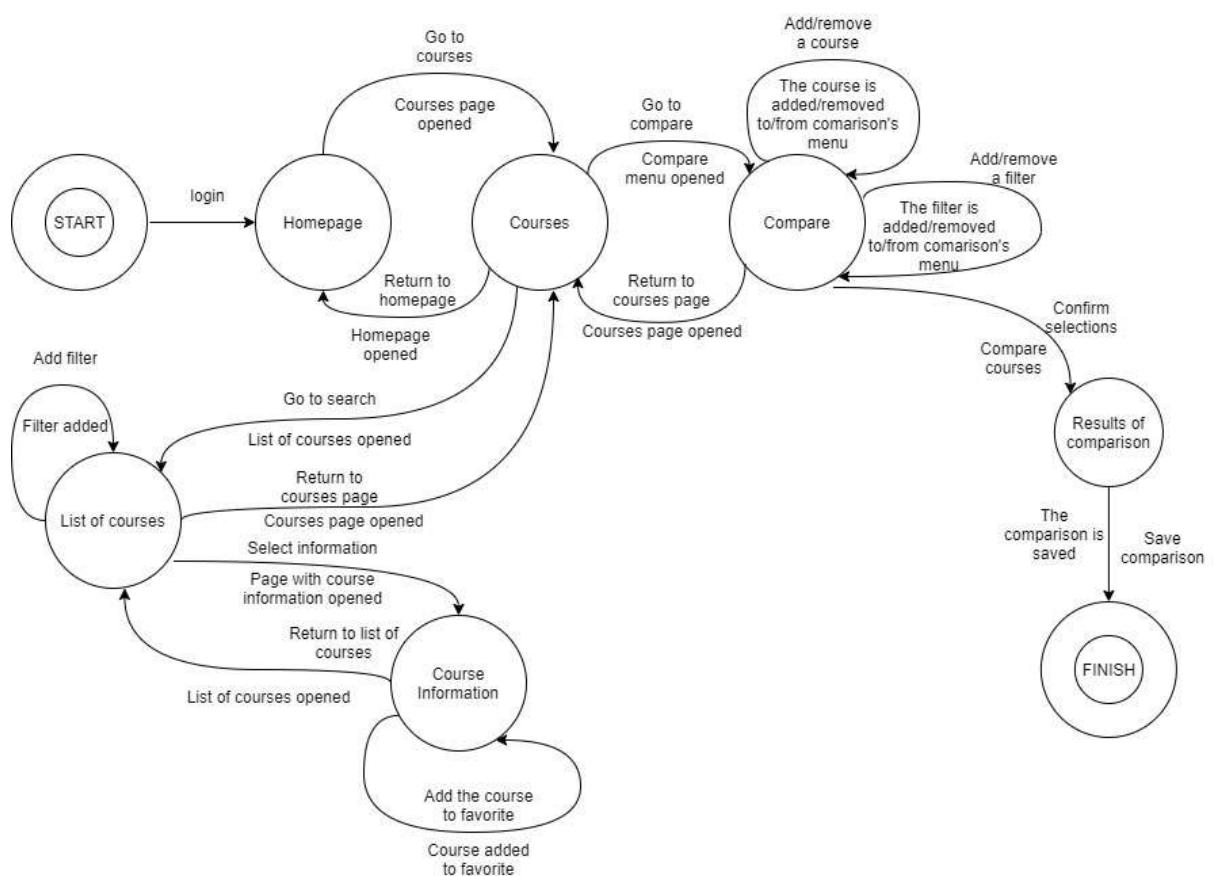
Plan 4  
Do 4.1, 4.2, 4.3, 4.4

4.1. Go to the site of your University

4.2. Compile your study plan

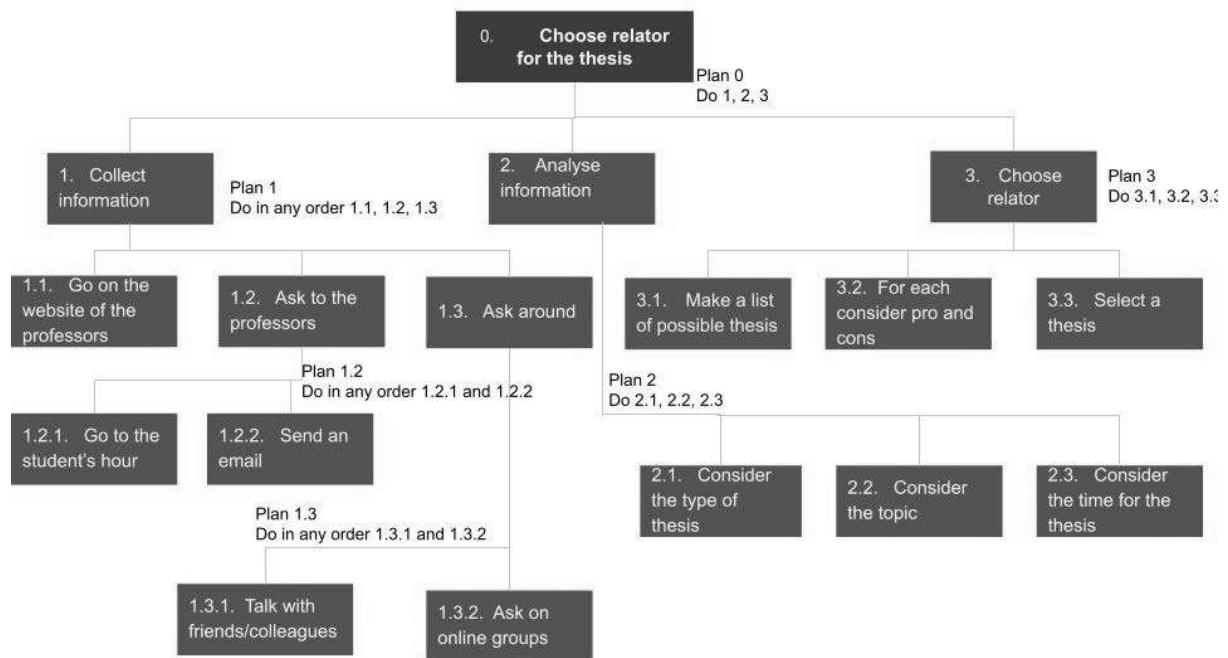
4.3. Send your study plan

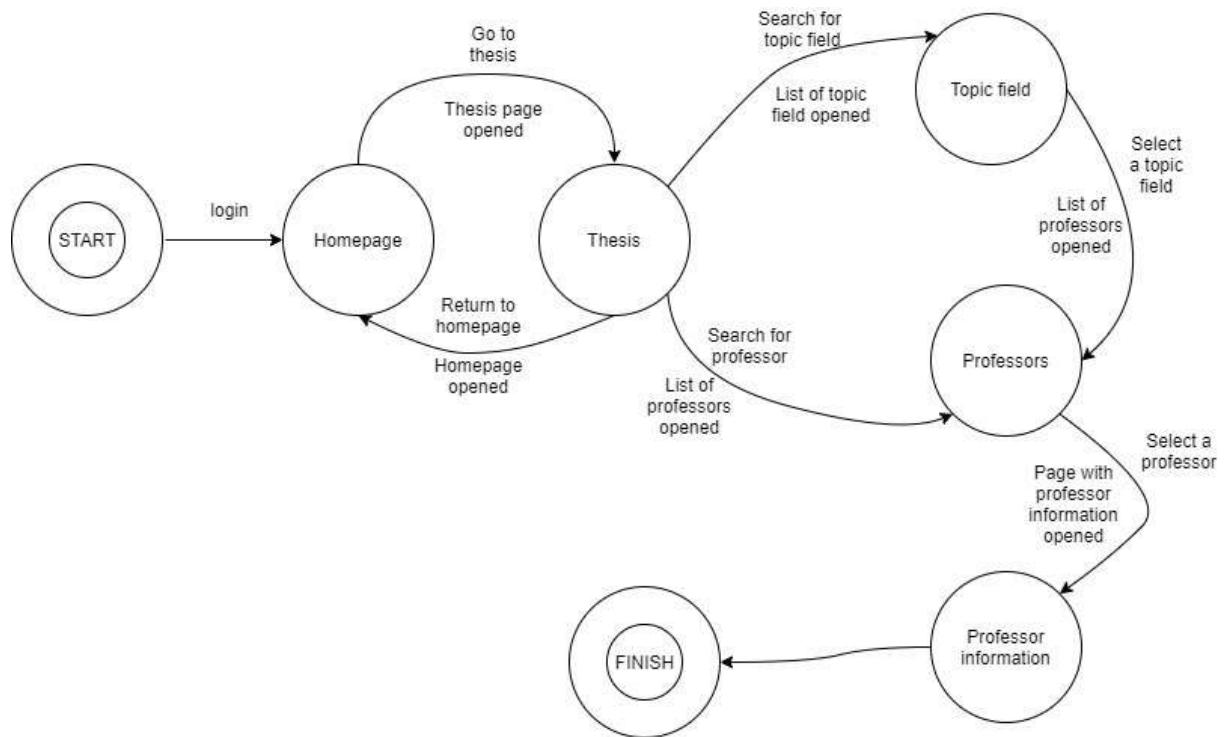
4.4. Make eventual changes



## 3.2 Collect information about thesis

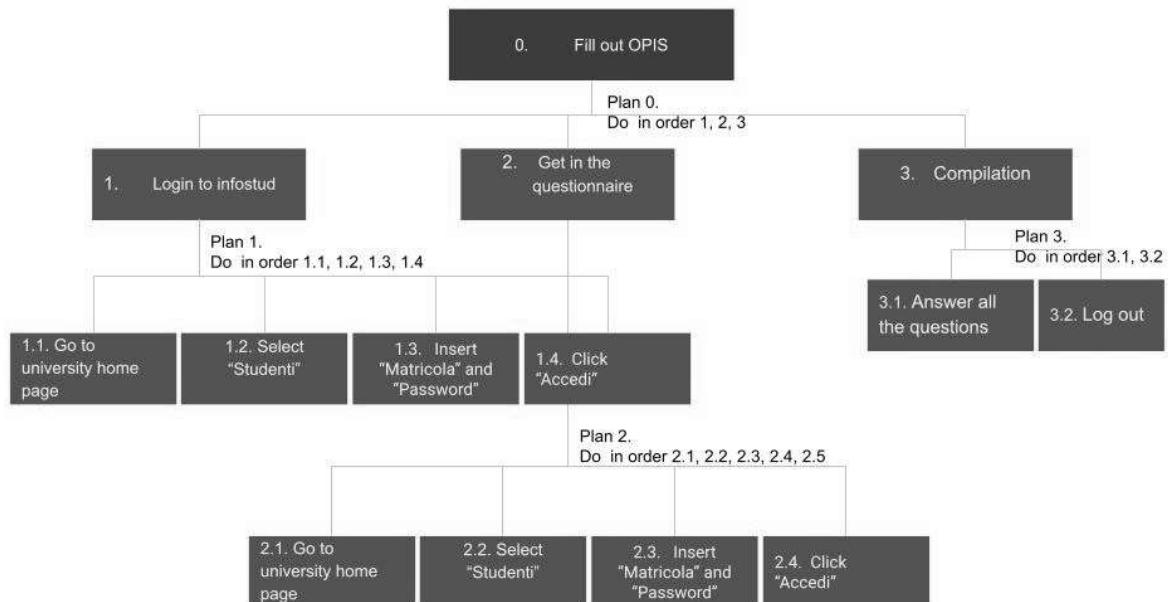
In order to perform this task, the user must first login. Then from the homepage he can choose “Thesis” and then can either select a professor to see his information or can select the main topics (and then the professor).

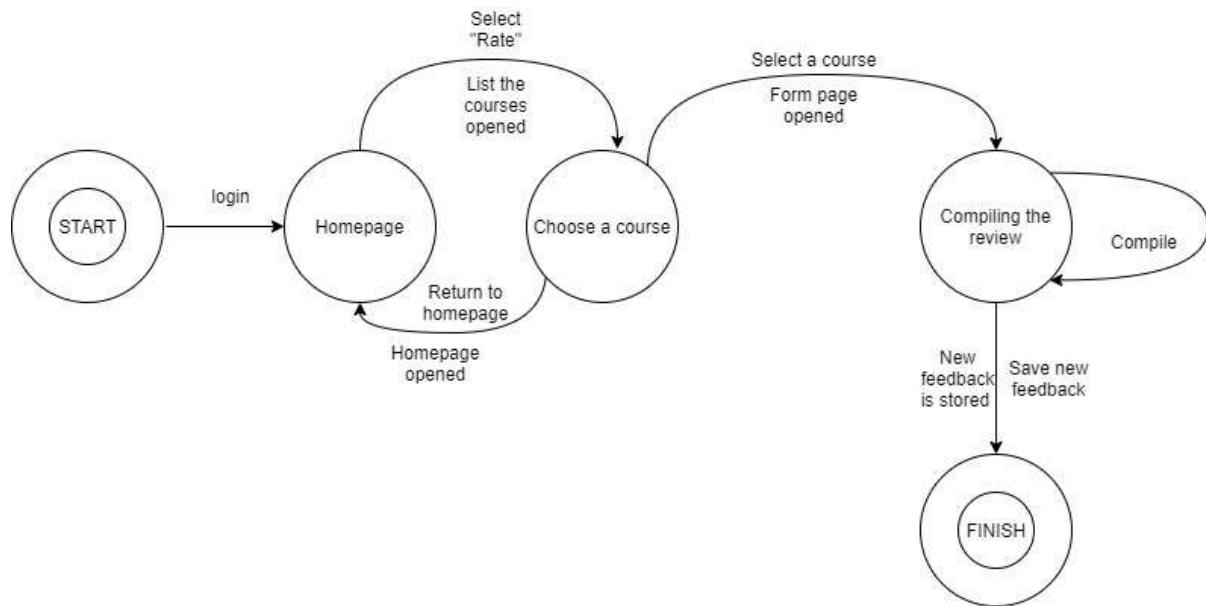




### 3.3 Add a feedback on a course

In order to perform this task, the user must first login. Then from the homepage he can choose “Rate” where he can select a course to rate or can manage his own feedback left previously.





## Chapter 4

# Mockups and first Prototype

## 4.1 Main functionalities

In this chapter we are going to present the mockups of our first prototype. The mobile application is designed for students in order to help them to choose the courses to do and the thesis supervisor. They can also write their opinion about a course or a thesis supervisor in order to help their colleagues. The actions presented in this section are:

1. **Log in / Sign up:** in order to use the up the user must do the login with his credential or must fill the form of sign up to create an account;
2. **Report a problem of the application:** from the homepage click on about and select the kind of error bug/content and the section;

3. **Manage personal information:** from the homepage click on profile and can select to manage the personal information, the credential, the picture and the exams he took;
4. **Collect courses information:** from the homepage click on courses and select to search for a course or to compare some courses. From search can select a course from the list where they are grouped on topic field and can also add/remove the course to/from favorite. From compare can choose some courses from the list to compare and select the information that you want to compare; the user can also filter out the courses according to a particular study plan field;
5. **Rate a course:** from the homepage click on rate and select a course from the list to add your feedback or switch to my reviews to manage your feedbacks;
6. **Collect thesis information:** from the homepage click on thesis and select a topic field and the the professor or switch to professor rating and select the professor;
7. **Manage favorite courses and comparison:** from the homepage click on my selection and choose to reopen the saved comparison and the favorite courses or to remove them.

#### **4.1.1 Log in / Sign up**



YOUUniversity

Log In

Sign Up

Enter email or username

Password



[Forgot password ?](#)

Remember me in future



Log In

OR



YOUUniversity

Log In

Sign Up

About you:

Name \_\_\_\_\_

Surname \_\_\_\_\_

Age \_\_\_\_\_

E-mail \_\_\_\_\_

Create your username and password:

Username \_\_\_\_\_

Password



Confirm password



Sign up

OR



#### 4.1.2 Report a problem of the application

The image displays two wireframe mobile phone screens side-by-side, illustrating a user interface for reporting problems.

**Left Screen (About Section):**

- About:** Home icon.
- INFO:** Information icon (i).
- This App has been designed for master engineering in computer science student. In order to make the choice of your study plan as weighted, fast and conscientious as possible.
- Developers:** Developers icon.
- Gianluca Pulicati
- The best choice of the professional.

**Right Screen (Report a problem Section):**

- About:** Home icon.
- INFO:** Information icon (i).
- This App has been designed for master engineering in computer science student. In order to make the choice of your study plan as weighted, fast and conscientious as possible.
- Developers:** Developers icon.
- Gianluca Pulicati
- The best choice of the professional.
- Report a problem:** Bug icon.
- Kind of error:** Buttons for "Bug" and "Content".
- In which section:** A dropdown menu.
- Describe the problem:** Text input field with placeholder "Report here...".
- Report:** A large black button.
- A vertical list of report categories is visible on the right side of the screen, including: Rate a course, Thesis, Compare courses, My selection, and Profile.

### 4.1.3 Manage personal information

**Profile**

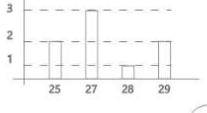


Mario Rossi   
203910  
Username  
Sapienza  
Engineering In Computer Science  
[Credentials](#) 

**Exams taken** 

- Data mining 27/30 21/01/20
- Software engineering 29/30 15/02/20
- Data management 28/30 09/09/19
- Machine Learning 25/30 11/09/19

**Average mark**  27.5



Degree evaluation prospective:  108

**Edit Profile**



**Change your data**

Name:	Mario
Surname:	Rossi
Date of birth:	27/07/1998
Matricula:	203910

**Confirm**

**Edit Credentials**



**Change your data**

Username	<input type="text"/>
Current Password	<input type="password"/> 
New Password	<input type="password"/> 
Repeat new Password	<input type="password"/> 

**Confirm**

**Exam**



**Add an exam** 

**Exams taken**

- BIG DATA COMPUTING** 
- Data Mining** 
- Large Scale Data Management** 
- Data Management** 

**Exam**



**Add an exam**

**Name of the exam** 

**When and How?**

**Data**  **Mark** 

**submit**

#### 4.1.4 Collect courses information

**Courses**

**Search**  
Dive into the several courses, choose your favourites, go in the detail.

**Go Search**

**Compare**  
Select different courses, group them with special filter and see which one is tailored for you.

**Go Compare**

**Search**

**Mandatory**

- DISTRIBUTED SYSTEMS AND COMPUTER AND NETWORK SECURITY

**Course Name**

**General** Exam Statistics Feedback Career

**Professor Name**

Sito: aris.me/index.php/data-mining-2020  
e-mail: aris@diag.uniroma1.it

**Useful links**

Telegram: goToTelegram  
GitHub: GitHub.com  
First Lectures: YouTube.com

**Preparatory**

Python Skills;

**Course Name**

Data Mining has been added to "My Selection"

**Professor Name**

Sito: aris.me/index.php/data-mining-2020  
e-mail: aris@diag.uniroma1.it

**Useful links**

Telegram: goToTelegram  
GitHub: GitHub.com  
First Lectures: YouTube.com

**Preparatory**

Python Skills;

**Compare Courses**

Highlight suggested study plan

**Mandatory**

- Algorithm Design
- Data Management
- Distributed Systems and Computer and Network Security
- Software Engineering
- Artificial Intelligence I
- Machine Learning
- Network Infrastructure
- Neural Networks

**Algorithms**

- Big Data Computing

**Compare Courses**

Highlight suggested study plan

YEAR	SEMESTER	
BDC	II*	I*
DMI	II*	I*
LSD	II*	II*
DM	I*	II*

## 4.1.5 Rate a course

**Rate A Course**

Choose a course:

Search... 

Distributed Systems  
Computer and Network security

Algorithm Design

Data Management

Software Engineering

Formal Methods

Capacity Planning

Digital Entrepreneurship

Rate  My reviews 

**Course Name**

**Disclaimer**

YOUniversity is a tool managed by the users. To keep the app clean and useful for everyone please insert only true information. Thank you!

**Exam**

Did you pass the exam?  

When and How?

Session  Appello  Mark 

How long does it takes to prepare it?

Number  Period 

Leave a suggest to pass the exam:

**My Reviews**

Choose a rate:

Search... 

last reviewed course  

Data Mining  

Large Scale Data Management  

Data Management  

Rate  My reviews 

## 4.1.6 Collect thesis information

The wireframe illustrates a user interface for collecting thesis information, consisting of four main screens:

- Thesis**: A search screen with a search bar and a list of research topics: Algorithm Design and Engineering, Algorithms and Data Science, Artificial Intelligence and Knowledge Representation, Artificial Intelligence and Robotics, Bioengineering and Bioinformatics, Combinatorial Optimization, and Computer Networks and Pervasive Systems.
- Thesis**: A detailed view of a thesis entry for Massimo Mecella, showing a search bar, a list of professors (Massimo Mecella, 8/10; Maurizio Lenzerini, 9/10; Stefano Leonardi, 6/10), and a "Rate" button.
- Thesis Professor Rating**: A detailed view of professor ratings. It shows Massimo Mecella with a rating of 8/10, Maurizio Lenzerini with 9/10, Tiziana Catarci with 10/10, Andrea Marrella with 9/10, Stefano Leonardi with 6/10, and Luca Becchetti with 9/10. Each rating includes a "Rate" button.
- Student's feedback**: A card for Luigi Peppenero with a rating of 8/10. The feedback text reads: "I've done an experimental Thesis with him. He followed me in every phase of the project. I've spent 6 months to accomplish the work. I suggest him, if you want to going in deep in developer and java application."

#### 4.1.7 Manage favorite courses and comparison



## Chapter 5

### **Expert Based Evaluation**

The evaluation techniques tests usability and functionality of the system and evaluates both design and implementation. They occur in laboratories and/or fields in collaboration with users. They should be considered at all stages in the design lifecycle.

The goals of the evaluation are to assess extent of system functionality, assess effect of interface on user and identify specific problems.

#### **5.1 Heuristic Evaluation**

Heuristic evaluation is a method for structuring the critique of a system using a set of relatively simple and general heuristics. It was proposed by Nielsen and Molich. With this technique the design is examined by experts to see if these are violated.

##### **5.1.1 Heuristics**

1. **Visibility of system status:** the design should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time;
2. **Match between system and the real world:** the design should speak the users' language. Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions, making information appear in a natural and logical order;
3. **User control and freedom:** users often perform actions by mistake. They need a clearly marked "emergency exit" to leave the unwanted action without having to go through an extended process;

- 4. Consistency and standards:** users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform and industry conventions;
- 5. Error prevention:** good error messages are important, but the best designs carefully prevent problems from occurring in the first place. Either eliminate error-prone conditions, or check for them and present users with a confirmation option before they commit to the action;
- 6. Recognition rather than recall:** minimize the user's memory load by making elements, actions, and options visible. The user should not have to remember information from one part of the interface to another. Information required to use the design (e.g. field labels or menu items) should be visible or easily retrievable when needed;
- 7. Flexibility and efficiency of use:** shortcuts — hidden from novice users — may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Allow users to tailor frequent actions;
- 8. Aesthetic and minimalist design:** interfaces should not contain information which is irrelevant or rarely needed. Every extra unit of information in an interface competes with the relevant units of information and diminishes their relative visibility;
- 9. Help users recognize, diagnose, and recover from errors:** error messages should be expressed in plain language (no error codes), precisely indicate the problem, and constructively suggest a solution;
- 10. Help and documentation:** it's best if the system doesn't need any additional explanation. However, it may be necessary to provide documentation to help users understand how to complete their tasks.

## 5.2 Expert report with Heuristic Evaluation

The evaluation was done by our professor Valeria Mirabella and it has been reported that the following heuristics have been violated:

Frame	Heuristic violated	Severity	Description / Comment
Compare courses	Aesthetic and	3	The page is full of

	minimalist design		information that could be not relevant for the specific comparison and rarely needed
Compare courses	Recognition rather than recall	3	Minimize the user's memory load in comparison guiding the task (for example with a wizard).
All (see for example Exam in Profile)	Visibility of system status	2	Consider adding some additional information like breadcrumbs
All	Flexibility and efficiency of use	3	In order to speed up the interaction consider the possibility to save comparisons.

The "severity" number identifies:

- 0 = I don't agree that this is a usability problem at all;
- 1 = Cosmetic problem only;
- 2 = Minor usability problem;
- 3 = Major usability problem;
- 4 = Usability catastrophe.

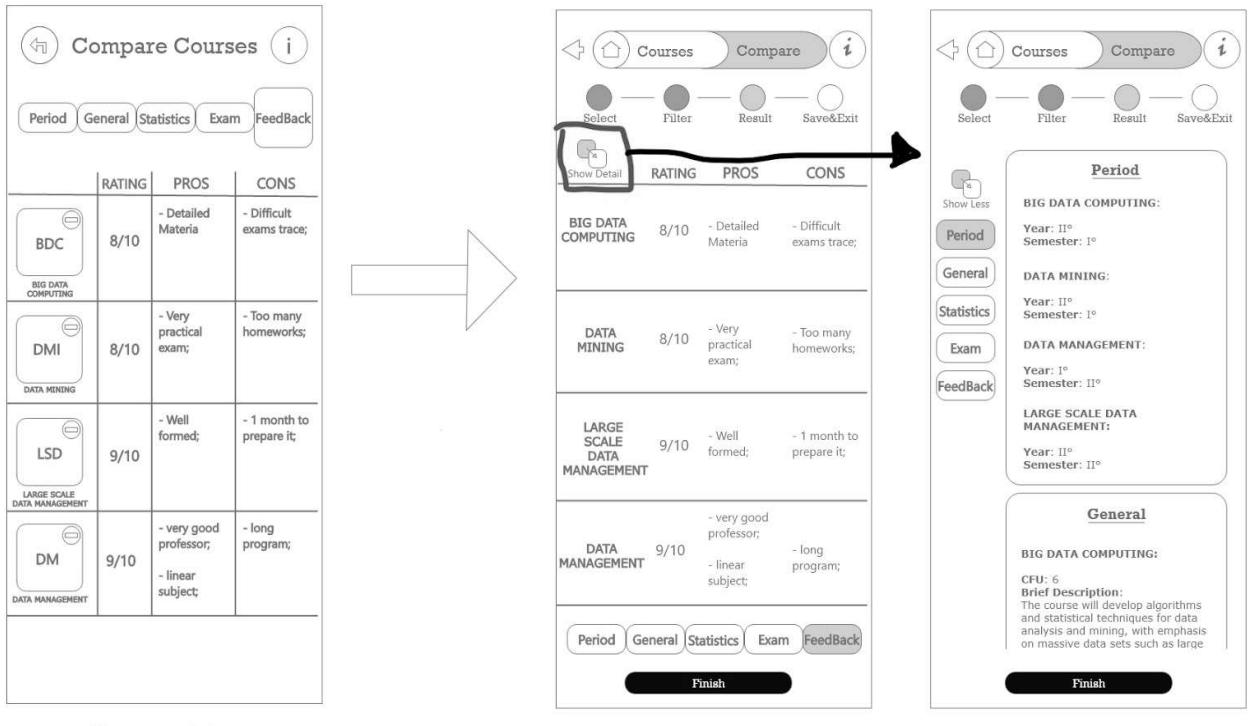
## 5.3 Correction of the detected violations

After receiving the expert-based evaluation with the heuristics violated in Prototype 1 we made some changes to solve these issues.

### 5.3.1 Problem 1

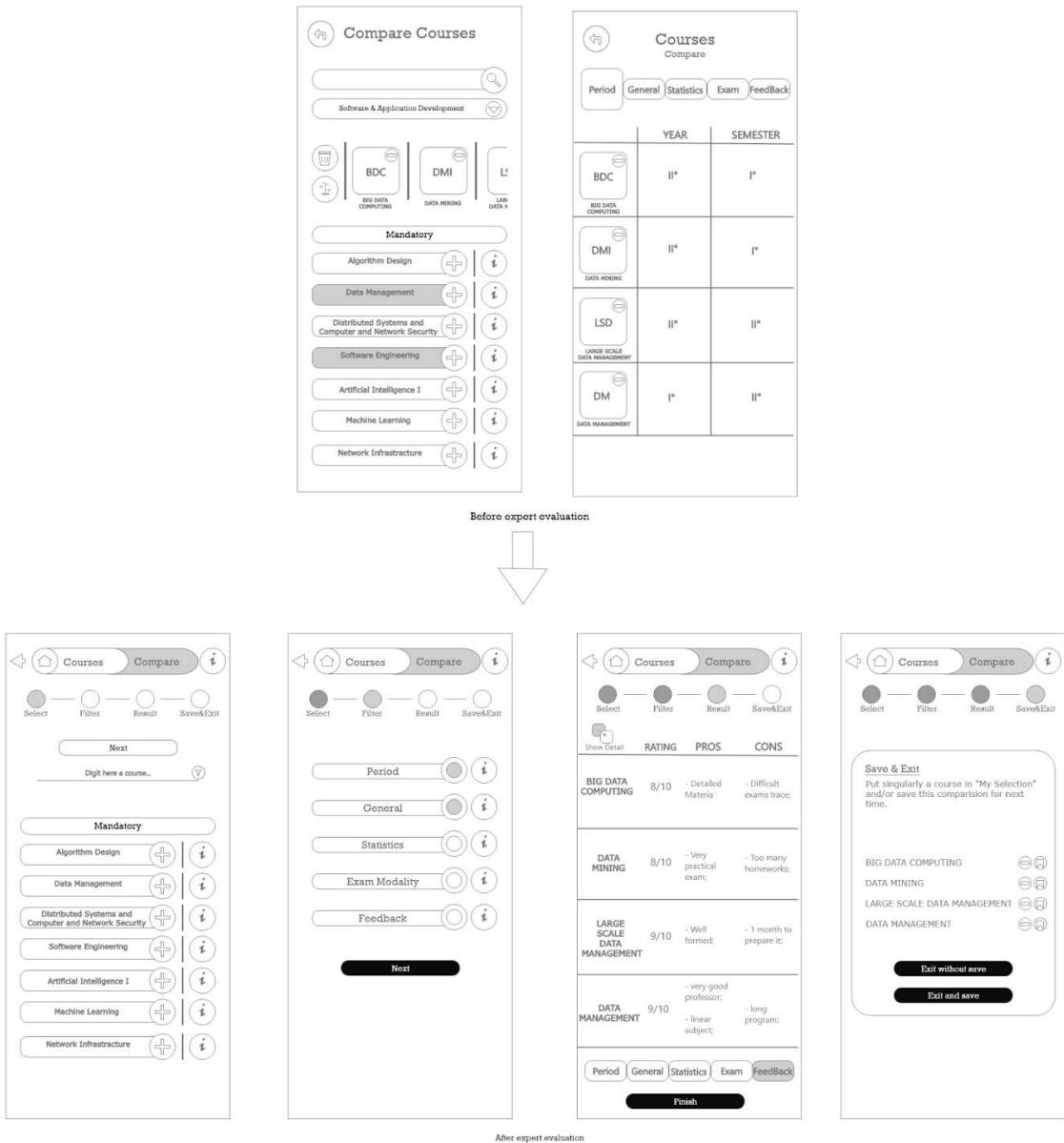
The first problem was in the frame "Compare courses", it has violated the heuristic "Aesthetic and minimalist design" and it has a severity with number 3. The problem was in the table with the results of the comparison between courses. We decided to create two tables, the first with little important

information and the second with more information. The user can switch between the two tables with a button.



### 5.3.2 Problem 2

The second problem was in the frame "Compare courses", it has violated the heuristic "Recognition rather than recall" and it has a severity with number 3. In order to solve this problem, we added a wizard with four steps at the top of the page. In the first set the user can select the courses to compare. In the second step he can choose the information of comparison. In the third step he can see the result. In the last step he can save the courses of comparison to compare them later.



### 5.3.3 Problem 3

The third problem was in all the frames, it has violated the heuristic “Visibility of system status” and it has a severity with number 2. In order to solve this problem we decided to add breadcrumbs in all pages.

The diagram illustrates a user interface transformation process. It features two wireframe-style mobile screens side-by-side, connected by a large, hollow arrow pointing from left to right.

**Left Screen (Before expert evaluation):**

- Header: "Exam" with a back arrow icon.
- Section: "Add an exam" with a text input field.
- Section: "Name of the exam" with a text input field and a clear/cancel button.
- Section: "When and How?" with two sub-sections: "Data" and "Mark". Each has a date/time picker input field labeled "dd/mm/yyyy" and a dropdown menu icon.
- Button: "submit" at the bottom.

**Right Screen (After expert evaluation):**

- Header: "Profile Exams" with a back arrow icon and a "Exams Taken" badge.
- Section: "Modify" with a text input field.
- Section: "Name of the exam" with a text input field and a clear/cancel button.
- Section: "When and How?" with two sub-sections: "Data" and "Mark". Each has a date/time picker input field labeled "dd/mm/yyyy" and a dropdown menu icon.
- Button: "submit" at the bottom.

Before expert evaluation

After expert evaluation

### 5.3.4 Problem 4

The fourth problem was in all the frames, it has violated the heuristic “Visibility of system status” and it has a severity with number 3. In order to solve this problem we decided to add the possibility to save the courses of comparison.

## 5.3 Cognitive walkthrough

Cognitive walkthrough was proposed by Polson and evaluates design on how well it supports users in learning tasks. It is usually performed by an expert in cognitive psychology that “walks though” design to identify potential problems using psychological principles.

For each task walkthrough considers:

- What impact will interaction have on the user?
- What cognitive processes are required?
- What learning problems may occur?

The analysis focuses on goals and knowledge: does the design lead the user to generate the correct goals?

## 5.4 Expert report with cognitive walkthrough

In this case the evaluation was done by our professor Valeria Mirabella on two tasks:

- Compare Courses;
- Modify a review.

For each action in our list the expert answered the following questions:

1. Is the effect of the action the same as the user's goal at that point?
2. Will users see that the action is available?
3. Once users have found the correct action, will they know it is the one they need?
4. After the action is taken, will users understand the feedback they get?

### 5.4.1 Task 1

Compare Courses: You have already done the login and you are in the Home Page

**Action 1:** Press the button to go to the courses

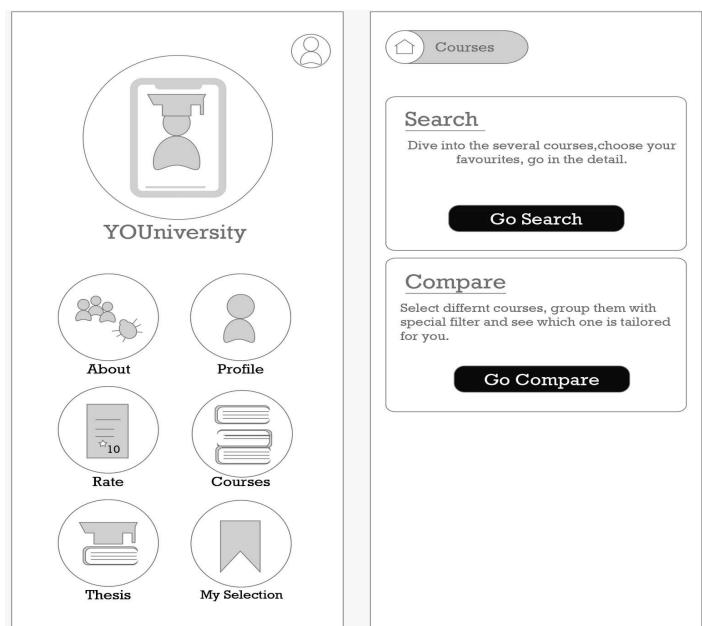
**Resp 1:** The page “Courses” is opened, showing two possibilities “Search” and “Compare”.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



**Action 2:** Press the button to open the comparison

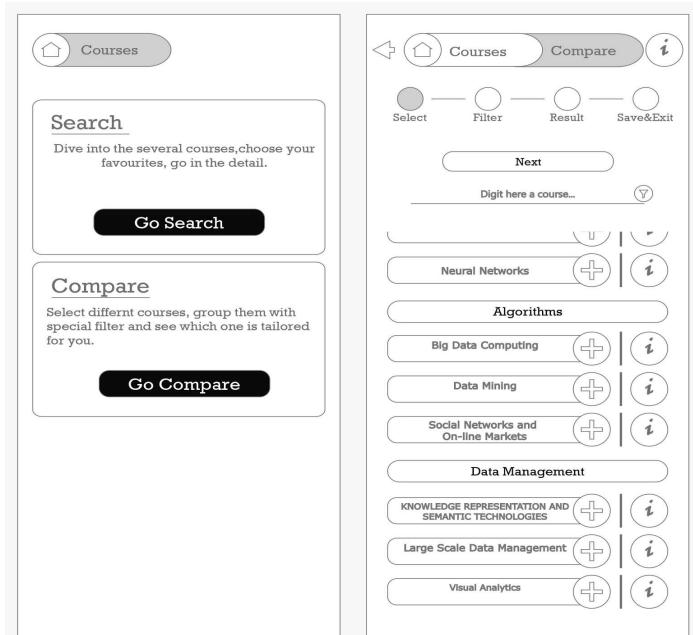
**Resp 2:** The page of “Compare” is opened. It shows a wizard page with the step on the top of the page. The first section of the wizard is “Select”, it shows the list of all the courses under their categories, a search bar at the top and a filter button.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



**Act 3:** Press the button icon of filtering.

**Resp 3:** a scroll menu is opened on the same page.

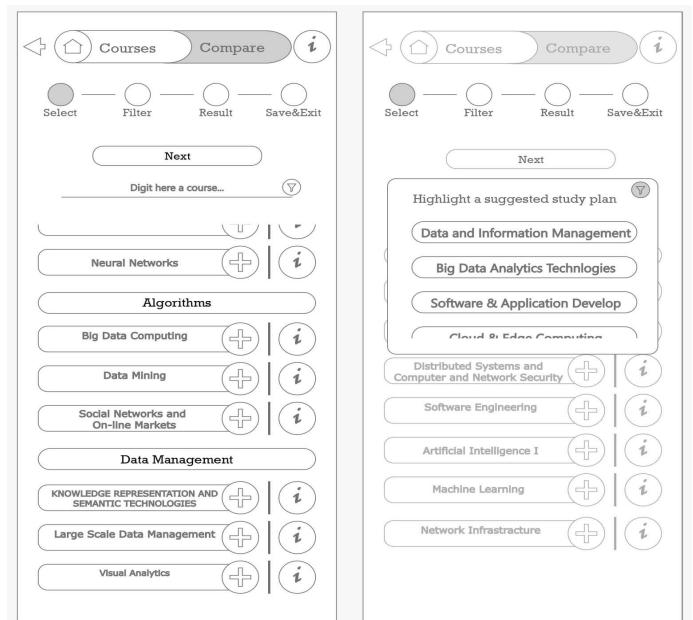
Q1: Yes

Q2: Yes

Q3: The icon is clear but not evident. It is reasonable that the user could have some difficulties.

Q4: Yes

**Solution for q3:** we decided to make the icon of filtering bigger.



**Act 4:** Select “Software and Application Development” as filter.

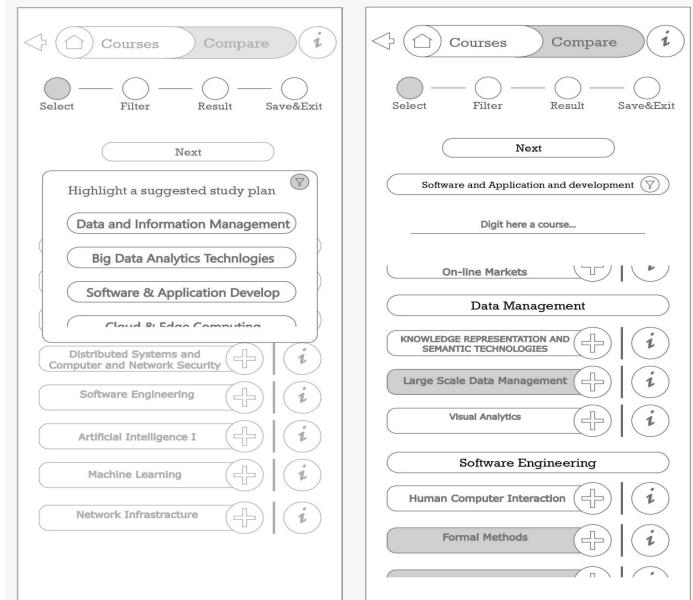
**Resp 4:** The courses related to the “Software and Application Development” filter are highlighted.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



[Iterative action]

**Act 5:** Select one by one the courses that are requested by clicking to the Add button of a course label.

**Resp 5:** The course chosen is highlighted and displayed at the top of the page.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes

**Act 6:** Press the button to continue.

**Resp 6:** The page passes to the next wizard step "Filter", displaying selectable checkbox filters.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes

[Iterative Action]

**Act 7:** add the filters by clicking the relative checkboxes.

**Resp 7:** The page shows the filters selected.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes

**Act 8:** Press the next button.

**Resp 8:** The system moves in the Result wizard state. It shows a table where in the rows

there are the courses and in the column there are the sections of the relative focused filter.

At the bottom of the table there is a navigation bar for the filter. A Button that can shows more details.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes

The screenshot shows a 'Courses' interface with a 'Compare' button. Below it is a table with four columns: WRITTEN, ORAL, HW, and PRJCT. The table lists three courses: 'BIG DATA COMPUTING' (V, V, 3 - F, 1 - M), 'DATA MINING' (F, V, 4 - F, 1 - M), and 'LARGE SCALE DATA MANAGEMENT' (V, V, 2 - F, 1 - M). At the bottom of the table is a navigation bar with buttons for 'Show Detail', 'WRITTEN', 'ORAL', 'HW', 'PRJCT', and a large black 'Next' button.

	WRITTEN	ORAL	HW	PRJCT
BIG DATA COMPUTING	V	V	3 - F	1 - M
DATA MINING	F	V	4 - F	1 - M
LARGE SCALE DATA MANAGEMENT	V	V	2 - F	1 - M

**Act 9:** Press the button to continue.

**Resp 9:** The system moves to the last wizard point "Save & Exit", it shows the list of courses

with a delete and prefer icon, then two buttons to express the last action.

Q1: Yes

Q2: Yes

Q3: There is no button or similar labelled as "Continue". The user will use the "Finish" button.

Q4: Yes

The screenshot shows a 'Courses' interface with a 'Compare' button. Below it is a table with four columns: WRITTEN, ORAL, HW, and PRJCT. The table lists three courses: 'BIG DATA COMPUTING' (V, V, 3 - F, 1 - M), 'DATA MINING' (F, V, 4 - F, 1 - M), and 'LARGE SCALE DATA MANAGEMENT' (V, V, 2 - F, 1 - M). At the bottom of the table is a navigation bar with buttons for 'Show Detail', 'WRITTEN', 'ORAL', 'HW', 'PRJCT', and a large black 'Next' button. To the right of the table is a 'Save & Exit' section with instructions: 'Put singularly a course in "My Selection" and/or save this comparision for next time.' Below this are four icons for each course: a delete icon (⊖) and a prefer icon (⊕). At the bottom are two buttons: 'Exit without save' and 'Exit and save'.

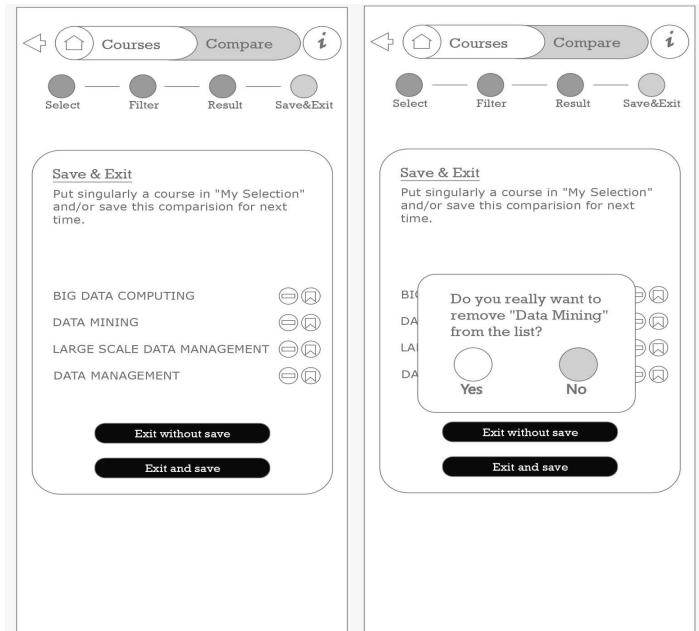
**Solution for q3:** we decided to add the "Continue" button.

**Act 10:** Press the delete button icon of the course of "Data Mining"

**Resp 10:** The system shows you a pop-up asking for confirmation of your action, with YES and NO button.

Q1: Yes

Q2: Yes



Q3: It is not clear which button is the one that will delete "data Mining" from the selection.

Q4: Yes

**Solution for q3:** we decided to change the button to delete a course with a "recycle bin" icon.

**Act 11:** Press YES button.

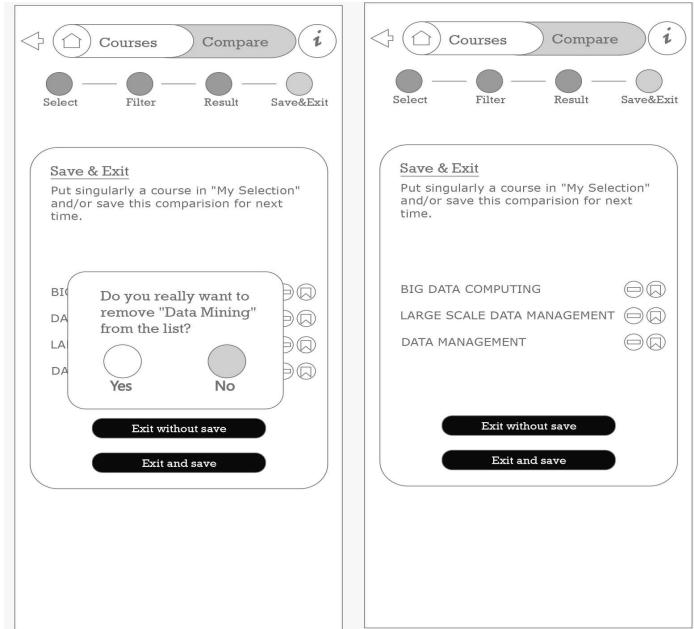
**Resp 11:** The system shows the modification.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



**Act 12:** Press the button to save the comparison.

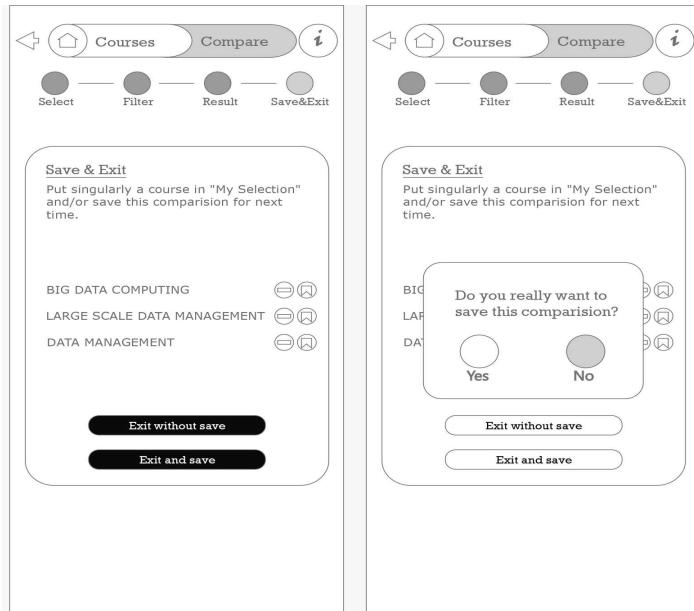
**Resp 12:** The system shows you a pop-up asking for confirmation of your action, with YES and NO button.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



**Act 13:** Press YES button.

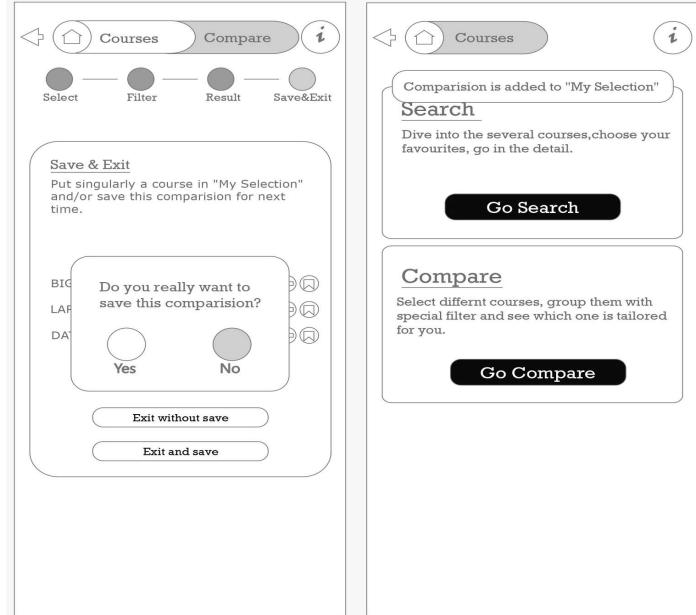
**Resp 13:** The system comes back to the Courses Compare section and shows a pop-up toast that notify the action taken.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes



## 5.4.2 Task 2

Modify a review: You have already done the login and you are in the Home Page.

**Act. 1:** Press the button to rate a course.

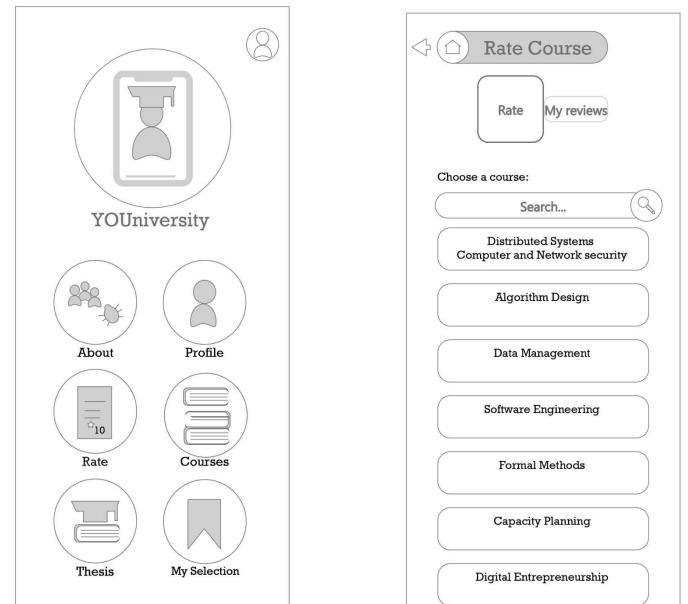
**Resp. 1:** The page “Rate course” is opened, showing two possibilities: “Rate” and “My reviews”.

Q1: Yes

Q2: Yes

Q3: The user could be in doubt if access the Course or the Rate section

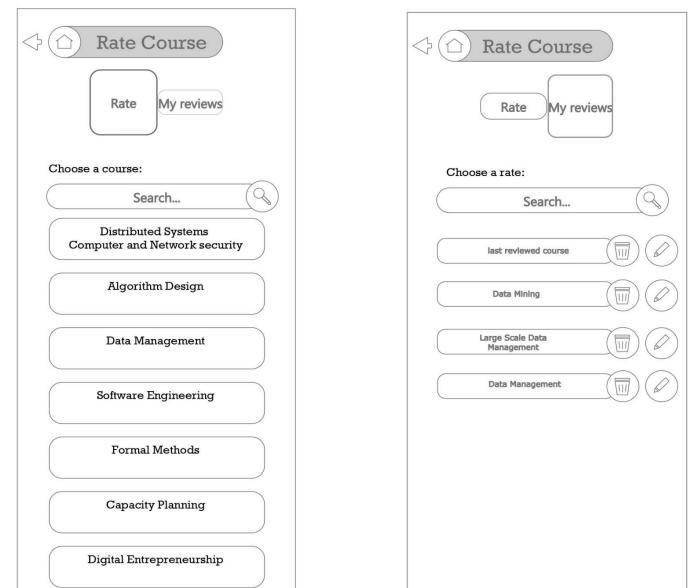
Q4: Yes



**Solution for q3:** we decided to rename the page “Rate course” with “Rate” and the text “Choose a course” with “Choose a course to rate”.

**Act. 2:** Press the button to switch to my reviews.

**Resp. 2:** The page switches to the “My reviews” section and shows all the reviews made by you.



- Q1: Yes  
 Q2: Yes  
 Q3: Yes  
 Q4: Yes

**Act. 3:** Press the button to modify the course “Data management”.

**Resp. 3:** The review page of “Data management” is opened with all the information that you already inserted.

- Q1: Yes  
 Q2: Yes  
 Q3: Yes  
 Q4: Yes

**Act 4:** Click on the text bar of the “pros” section and write your comment.

**Resp. 4:** The text is written in the text bar.

- Q1: Yes  
 Q2: Yes  
 Q3: Yes  
 Q4: Yes

**Act. 5:** Click the button to submit.

**Resp. 5:** A pop-up that asks you “Are you sure?” is opened.

- Q1: Yes  
 Q2: Yes  
 Q3: Yes  
 Q4: Yes

**Act. 6:** Click on the “yes” button.

**Resp. 6:** The rate is stored and the “Rate course” page is opened which shows a pop-up toast that notifies the action taken.

Q1: Yes

Q2: Yes

Q3: Yes

Q4: Yes

The image contains two side-by-side screenshots of a mobile application. The left screenshot shows a 'Disclaimer' section with a message about the app being managed by users and asking for true information. Below it is an 'Exam' section with a question 'Did you pass the exam?' and 'Yes' or 'No' buttons. A text input field for comments is labeled 'Leave a comment on the course:' with the placeholder 'I Enjoyed This Exam'. A rating section says 'Rate the course: 9'. A 'Pros:' section lists 'The Professor Explains Very Well' and 'The Topics Are Very Interesting'. A final section asks 'Are you sure? Did you read twice all your comments?' with 'Yes' and 'No' buttons. The right screenshot shows a similar interface but with a different course category. It has a header 'Rate Course' with a toast message 'The review on Data management has been changed'. Below it is a search bar 'Search...' and a list of categories: 'Data Management' (with trash and edit icons), 'Software Engineering' (with trash and edit icons), 'Data Mining' (with trash and edit icons), and 'Large Scale Data Management' (with trash and edit icons).

## Chapter 6

### **User-based evaluation technique**

Evaluation has three main goals: to assess the extent and accessibility of the system's functionality, to assess users' experience of the interaction, and to identify any specific problems with the system.

### **Participant**

Given that our application is designed for students by students, we have the fortune to test our application with the ideally final users.

We had a group of 10 people, with an average age between 23-27 each of them are students attending a bachelor or a master not only in Sapienza but also from other universities.

Three of them are fresh enrolled students, one of them has a part time job and the other are in the middle of their career.

## Ambient

We decided to execute the different experiments in video-calling, recreating a laboratory environment, without distractions and annoying noise. This was also forced due to the particular situation we are living in this time.

### **How the tests were done:**

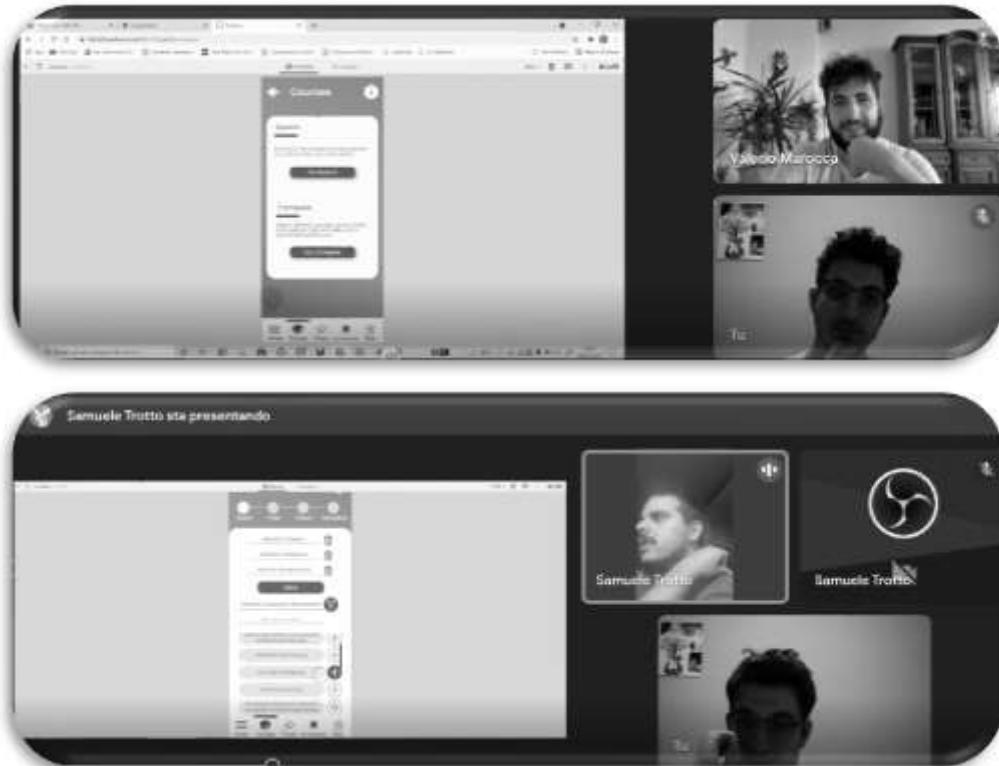
The aim of this test is to test the learnability and the usability of the application.

Since the group of users is small and we want to execute three kind of test on them we have followed this schedule:

1. Doing the Think Aloud at first: leaving the user alone with the application asking him to describe “loud” every thinking and feeling he had while processing the task.
2. Doing the Post Walkthrough: we have written an interview, and after the Think Aloud test, we asked the same questions to every user. (Questions reported below)
3. Doing the Cooperative Evaluation: we have asked the users to take some actions with us and commenting as if they were the developers: what were their thoughts and ideas about the implementation.
4. Finally, we did the Controlled Experiment: We performed a within groups solution for this test. People who said “A version” during the precedent runs now saw the “B version” and so forth. Given that, we then collected all the data and performed the ANOVA test.

## Think Aloud + Post Walkthrough

We took the Think Aloud in a controlled environment, trying to reduce every kind of bother but at the same time trying to reproduce a sort of interval between a task and another one, or during the task itself.



### We asked for executing the following 3 main tasks:

1. Compare courses.
2. Rate a course.
3. Search for thesis supervisor.

### Task 1 - Compare Courses:

- a. "You want to document yourself about the differences between Formal Methods and Large-Scale Data Management about the period of when they take place. Once done, you want to know in depth the feedback of other students about these courses."

b. "Now you want to know what courses belong to "Software and Application development" field, choose 4 of them to compare and then you want to save that comparison for next time."

### **Task 2 –Thesis:**

c. "You have just finished your course of study; you have presented your thesis and you are so happy that you want to share your good vibes with other colleagues. Leave a comment on your speaker 'Massimo Mecella'."

d. "Now think that you have done your last exam on Cloud Computing and you appreciated that exam so much that you want to know which professor is available for a thesis in this field. Search for that professor and get his contacts."

### **Task 3 – Rate:**

e. "Take your time to review a course that really made you struggle and tell everybody the reason why this course was so hard for you. Leave a pertinent review."

### **Post Walkthrough**

Later on, we asked some questions inherent to the specific behaviour and choices taken by the single user. These questions were like:

- "Why did you click on this thing?"
- "What were you looking at?"
- "What did you expect clicking on that?"

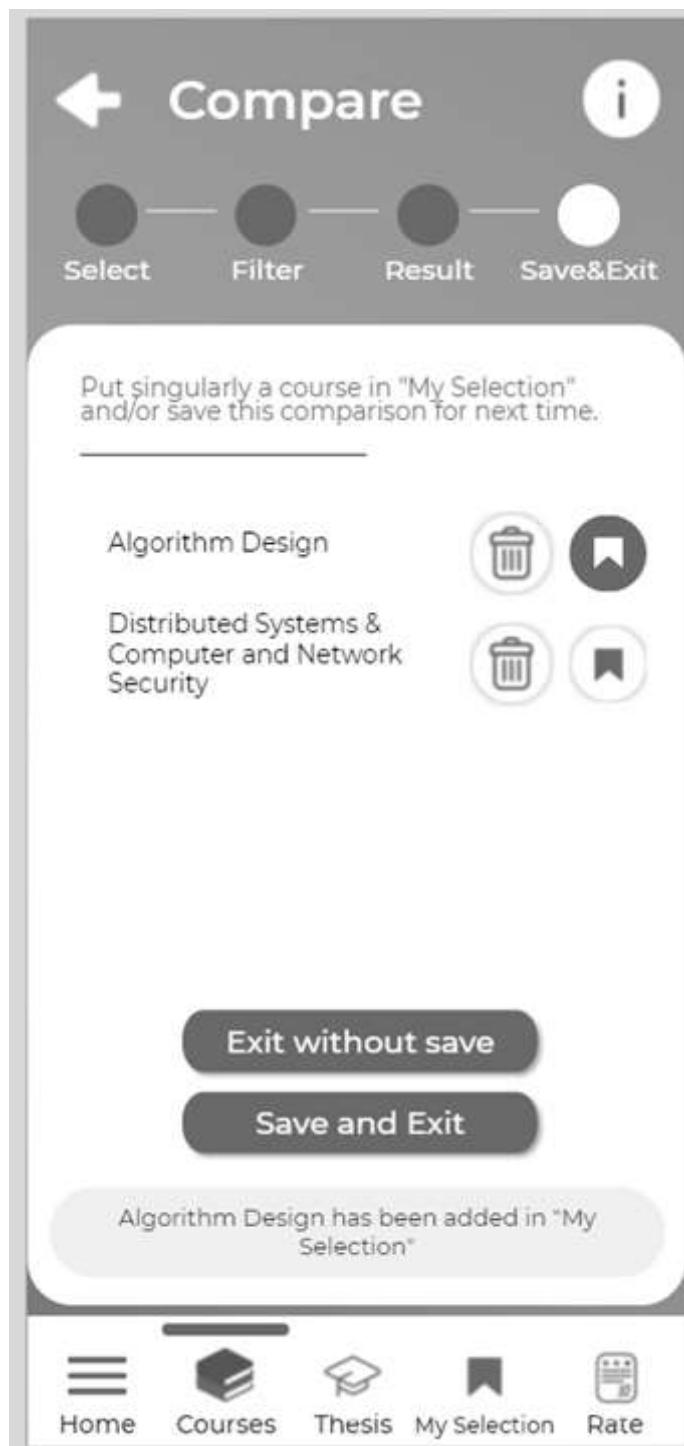
### **Think Aloud Results**

Thanks to these questions, we have noticed different software bugs and, even more important, we noticed graphical details that did not work well and seemed to be confusing for the user.

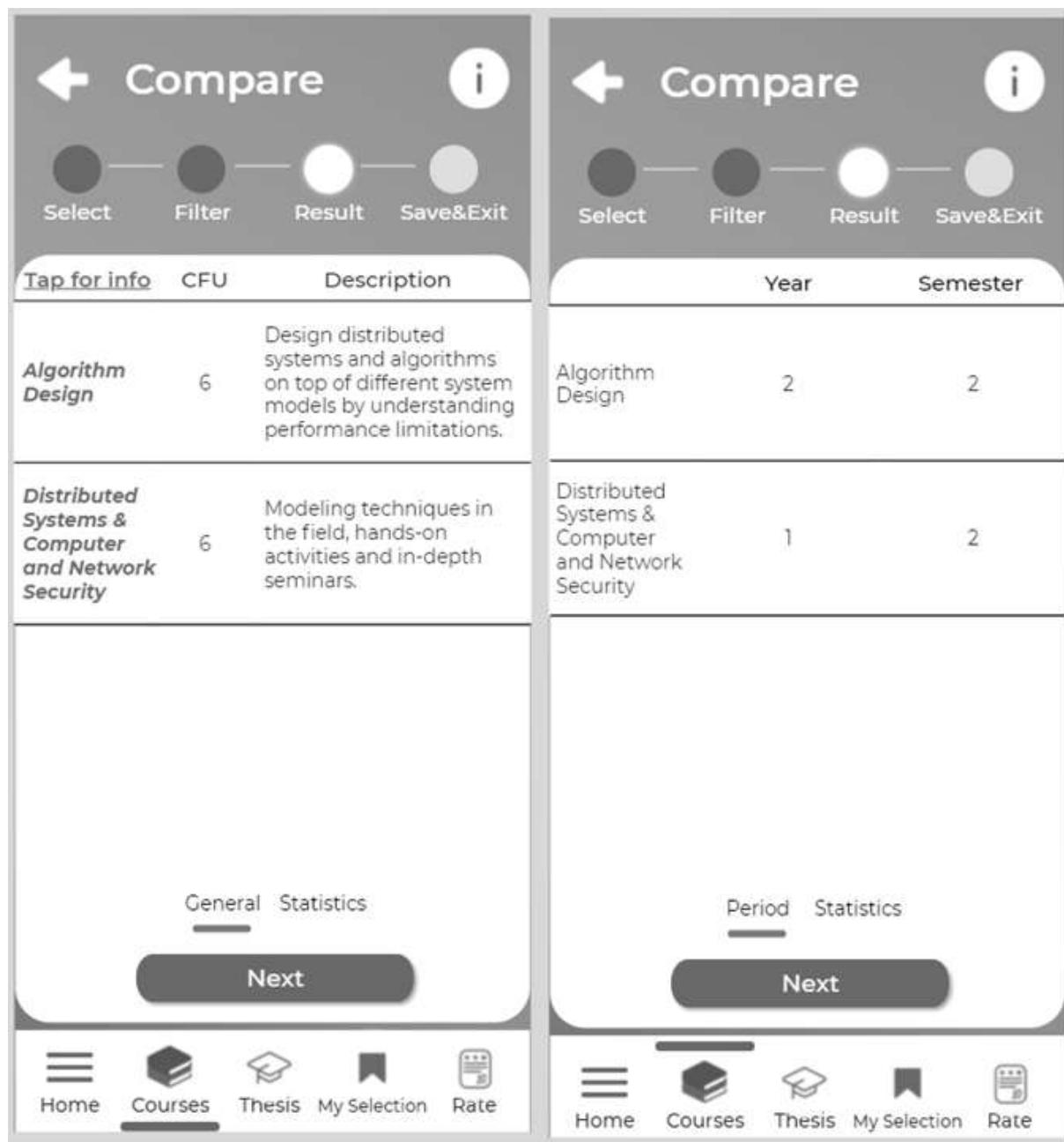
The improvement that we have done were:

1. Adding a course to “My Selection”: We had only an icon “Bookmark” as button, to represent the adding action. The user did not get the purpose and did not recognise what happened once it was clicked.

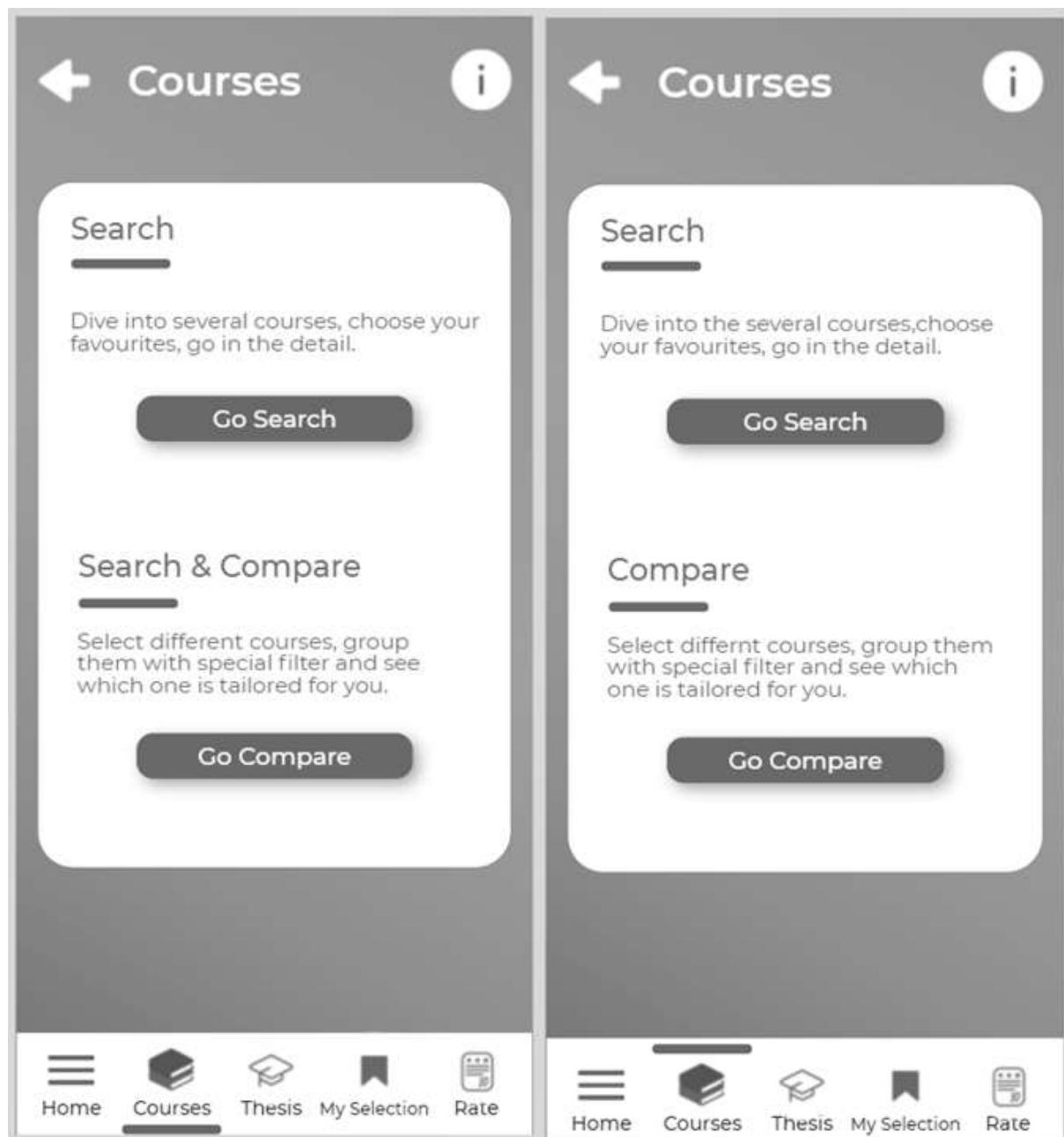
Adding a “Toast notification” we fixed this problem.



2. Show more detail In Compare section: the user didn't get that clicking on the name label of the course there would be shown more details. We fixed this problem by improving the visibility of the link action, changing the colour and the graphic detail



3. Search and Compare: in the Courses page users did not distinguish between them, they confused the task of comparing courses with search courses because of the action itself: "In order to compare you need first of all to search for courses". To cover this problem we then edited and improved the description of the two tasks in "Search" and "Search & Compare" respectively for the section of selecting a course and comparing.



4. In compare section and similars: the filter button and functionality were not noticed: to cover this problem we upscaled the icon size and added a shadow to the button. Then we added a new description replacing the previous one.

### **Cooperative Evaluation**

We used this technique in order to know suggestions and understand how the user feels the experience while navigating the application and how they would improve it.

For example, we had some extra features in the application that we were not sure were necessary:

Compare courses:

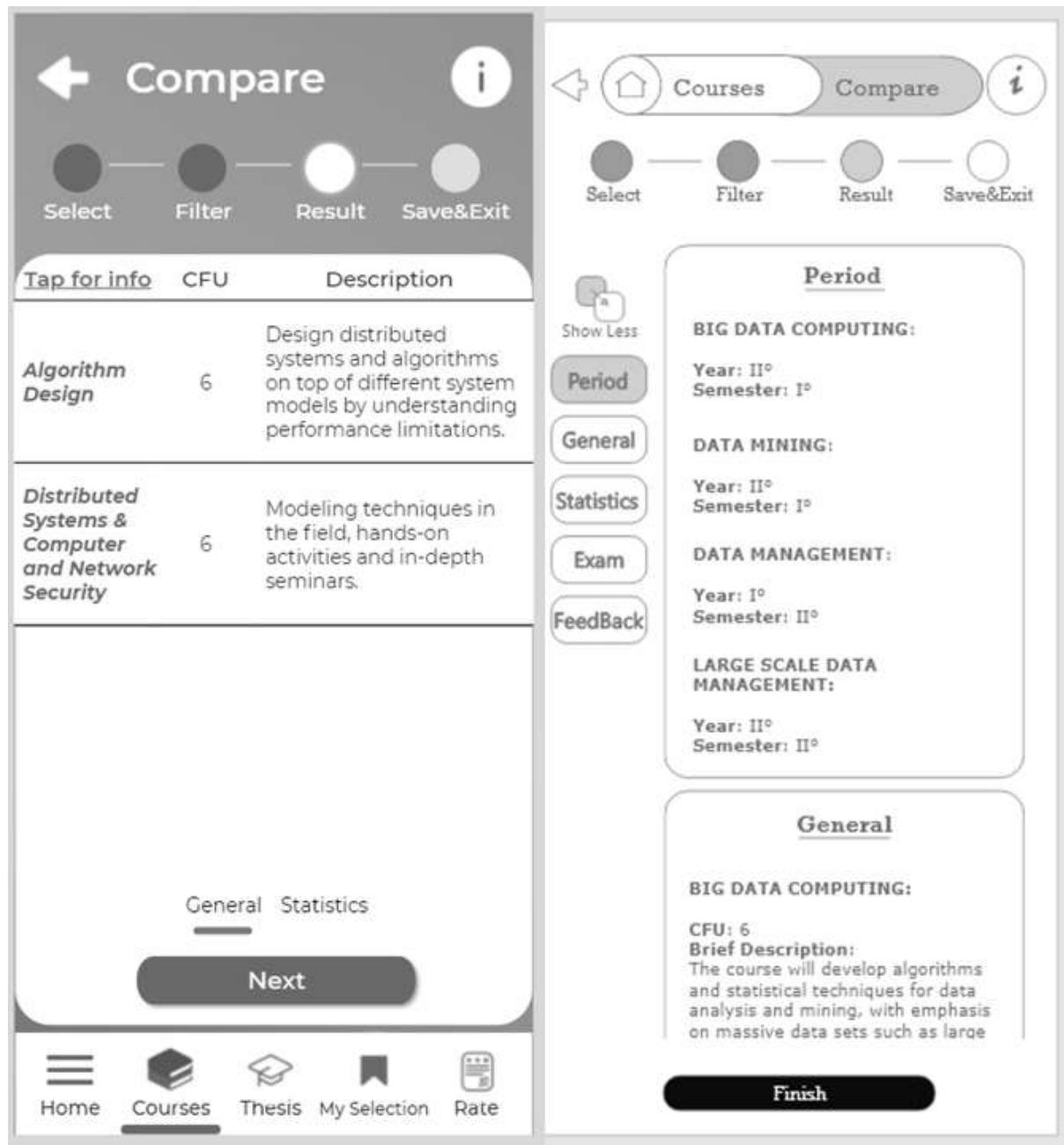
Is the double option viewing the data really needed?

In the compare section we had multiple options to show the results of a compare operation: the table and a more detailed scrollable page.

To the users we asked:

- a. Given that you can simply tap on a course name and get all the details of it on its section, would you use this “More detail” section? How often?
- b. If this section was not present, would you miss it?

Results: the whole team answered, “It is a good feature, but I would rarely use it.”.



### Navigation bar:

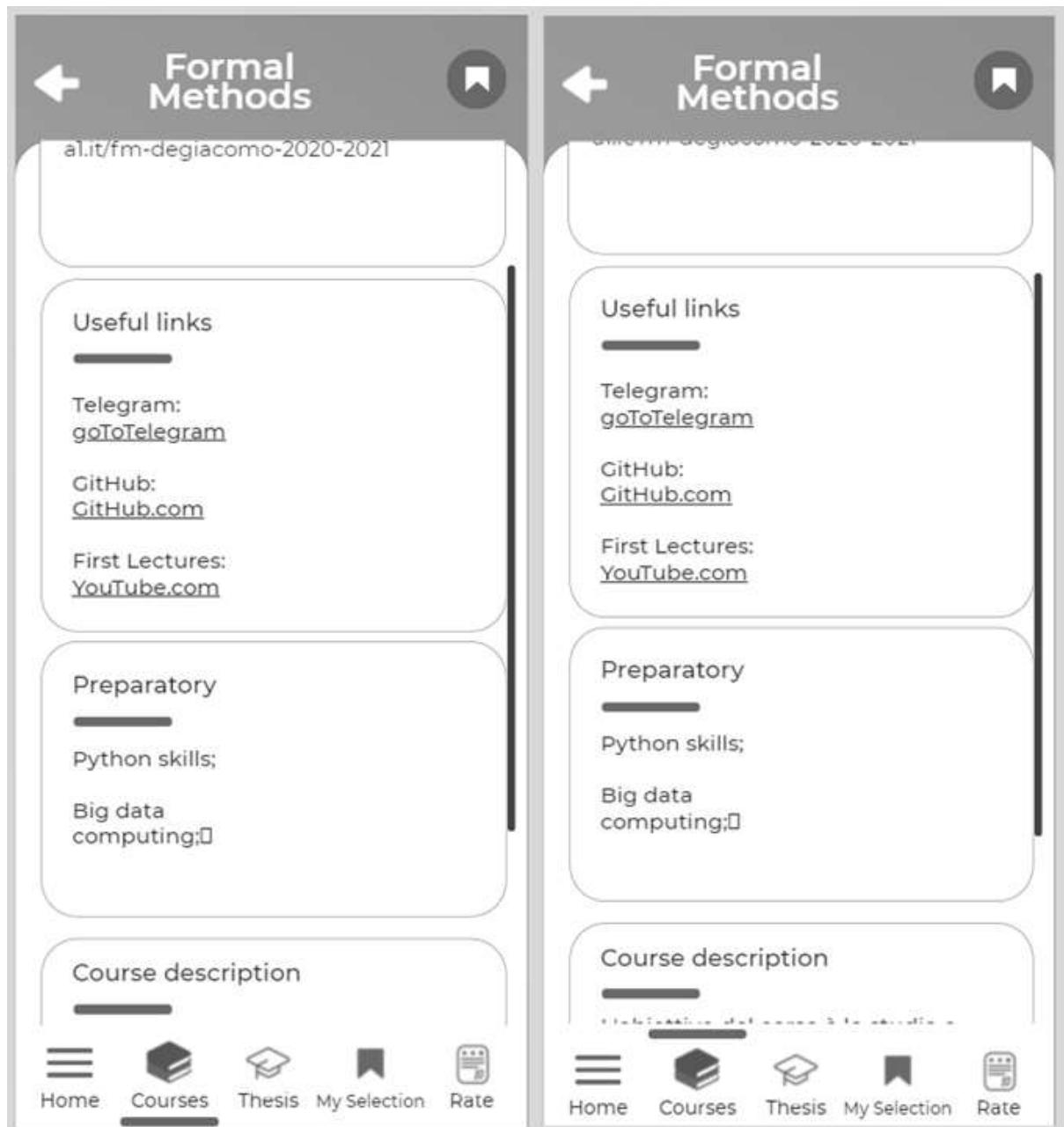
The navigation in the app is done through a navigation bar located at the bottom. We designed the icons to describe the intention of the relative sections. Moreover, we had a cursor on top of the bar that states the user (and app) current position and state in the system.

We asked:

- c. “What do you think about the navigation bar? Is that cursor enough?”

Results: The general answer was positive, but some of them said that: "the cursor positioned on top could be confused in the content of the page".

We then moved the bar below the sections' icons.



#### Info button:

We talked about having a brief tutorial in the heading of each page once the user logged in the application for the first time.

We asked:

- d. Would you put a tutorial at the beginning of this page?
- e. Would you skip this intro?

The major part of the answers were like:

"These things annoys me, I would probably skip them and if I couldn't reach a goal I would watch them, they are quite frustrating."

## **Controlled Experiment**

By this experiment we wanted to check:

1. The ability to understand navigation bar icons immediately, in comparison with the icon plus the title label below it.
2. If the new graphic with the navigation bar would be effectively the best choice in terms of efficiency and speed over the standard home page.
3. First impact usability VS slide show information: if the user commits less errors if he sees a brief help slide show.

Datas gathered:

In order to do this test, we accumulate datas by computer Logging: datas were collected by the Axure application which allows to trace all the activity done by the user.

The datas collected were: Clicks, Actions, times.

Variables:

There are two main types of variables: those that are 'manipulated' or changed (known as the independent variables) and those that are measured (the dependent variables).

Independent variables are those elements of the experiment that are manipulated to produce different conditions for comparison.

Each of these variables can be given as number of different values, level of a variable; each value that is used in an experiment is known as a level of the variable.

Dependent variables are the variables that can be measured in the experiment, their value is 'dependent' on the changes made to the independent variable. Common choices of dependent variables in evaluation experiments are the time taken to complete a task, the number of errors made, user preference and the quality of the user's performance.

### Hypothesis:

A hypothesis is a prediction of the outcome of an experiment. It is framed in terms of the independent and dependent variables, stating that a variation in the independent variable will cause a difference in the dependent variable. The aim of the experiment is to show that this prediction is correct. This is done by disproving the null hypothesis, which states that there is no difference in the dependent variable between the levels of the independent variable.

Formulation of our hypothesis in terms of independent variables:

1. Labelled icons VS icons: The user understands where to go and where he is through a navigation bar with labelled icons rather than solely icons.
2. Home page menu VS navigation bar: The user is more efficient and faster in navigating the application through the navigation bar, rather than a home page menu
3. First impact usability VS slide show information: The user commits less errors if he sees a brief help slide show.

The methods used are:

1. Between groups for item 1: We presented to the two groups both interfaces separately.

2. Within groups for item 2: We thought that the two conditions were not related in terms of “transfer of learning” since what was changing was the entire design of the application.
3. Between groups and within subjects for item 2: here the transfer of learning phenomenon is present, but it is also what we want to test, we want to know how efficient the help is. Therefore we divided the two groups in 1 and 2, then we showed them alternative A and B and later B and A.

### Dependent variables:

For all the items we have taken under consideration the following dependent variables: accuracy, speed:

1. Errors: “number of useless tap”;
2. Speed: “time to reach the goal”.

Because of the discrete domain of the independent variables, we can use the ANOVA (ANalysis Of VAriance) as a statistical technique, therefore we are assuming the dependent variable as Normally distributed.

### The ANOVA test:

You would use ANOVA to help you understand how your different groups respond, with a null hypothesis for the test that the means of the different groups are equal. If there is a statistically significant result, then it means that the two populations are unequal (or different).

We performed the ANOVA test using Excel:

1. Labelled icons VS icons:

The test concerned: find the way to reach “Rate a professor for the thesis”

We have taken the time to reach that goal.

labeled icons vs icons

Group 1   Group 2

14	19
15	16
15	20
14	30
14	18

Analisi varianza: ad un fattore

#### RIEPILOGO

Gruppi	Conteggio	Somma	Media	Varianza
Colonna 1	5	72	14,4	0,3
Colonna 2	5	103	20,6	29,8

#### ANALISI VARIANZA

Origine della varia:	SQ	gdl	MQ	F	? di signific	F crit
Tra gruppi	96,1	1	96,1	6,385382	0,035424	5,317655
In gruppi	120,4	8	15,05			
Totale	216,5	9				

We can assess from the test that  $F > F$  - Critic, then we can reject the null hypothesis meaning that we can discard the hypothesis for which there are no differences between the two interfaces.

We observed that without labels a user can totally lose his mind an error by another one.

Conclusions: We applied the labels in the navigation bar.

## 2. Home page menu VS navigation bar

The test concerned: navigate as fast as possible, at first glance, among all the main pages, one group with the navigation bar with labeled names and second with the main page.

navigation bar vs home page

Group 1   Group 2

6	15
5	16
4	15
4	14
5	15
6	14
6	15

Analisi varianza: ad un fattore

#### RIEPILOGO

Gruppi	Conteggio	Somma	Media	Varianza
Colonna 1	10	50	5	0,666667
Colonna 2	10	148	14,8	0,4

#### ANALISI VARIANZA

Origine della varia:	SQ	gdl	MQ	F	? di signific	F crit
Tra gruppi	480,2	1	480,2	900,375	7,99E-17	4,413873
In gruppi	9,6	18	0,533333			
Totale	489,8	19				

Also in this case  $F > F$ -critic, but we can observe that for the speed test involved the result can be different from the victory of the navigation bar.

Conclusions: We have confirmed the intuition of the users and we implemented the navigation bar discarding the home page alternative.

### 3. first impact usability VS slide show information

We have assigned a complex job to the user: "Compare 3 courses belonging to the software application and development study plan and then save the comparison deleting one of them"

In the case of the help interface we obliged the user to read the info slides and then perform the action.

We have measured both the time and the accuracy.

Time

first impact vs help

Group 1    Group 2

68	90
80	92
87	98
67	102
70	89

Analisi varianza: ad un fattore

RIEPILOGO				
	Gruppi	Conteggio	Somma	Media
Colonna 1		5	372	74,4
Colonna 2		5	471	94,2

ANALISI VARIANZA

Origine della variabile	SQ	gdl	MQ	F	? di significatività	F crit
Tra gruppi	980,1	1	980,1	18,23442	0,002724	5,317655
In gruppi	430	8	53,75			
Totali	1410,1	9				

Errors		Analisi varianza: ad un fattore				
first impact vs help						
Group 1	Group 2	RIEPILOGO				
2	0	<i>Gruppi</i>	<i>Conteggio</i>	<i>Somma</i>	<i>Media</i>	<i>Varianza</i>
5	0	Colonna 1	5	16	3,2	2,7
5	0	Colonna 2	5	3	0,6	1,8
2	0					

ANALISI VARIANZA						
Origine della variabile	SQ	gdl	MQ	F	? di significatività	F crit
Tra gruppi	16,9	1	16,9	7,511111	0,025424	5,317655
In gruppi	18	8	2,25			
Totali	34,9	9				

For the time test, we can see that  $F > F\text{-crit}$ , and so we can state that the null hypothesis saying the two methods of interactions are equal is rejected. We can see how reading the help took a long time for the user.

However, looking at the second result in terms of accuracy and so how many errors the user committed, we can say that  $F > F\text{-crit}$  and so we have confirmed the negletting of the null hypothesis, and also we can state that the help slides in major part of the user was a good helper.

Conclusion: We have implemented the help in an info button, but we did not require the user to see it at his first look on the application.

## Conclusion

This project cost a lot of time in terms of implementation. This was the first time that we have to think about an application, design it, learn the final user habits, implement it and above all test it with the real final users that each time has discovered new critical issues and bring us re-design a specific part not only graphically but also conceptually.

Prospective for futures improvement:

There are features we haven't implemented as they would have given the application more purposes and uses, but certainly more longevity:

1. Chat room and real-time feedback section;
2. Courses notes, exercises and exams executed and commented with feedback.

**References:**

- Course's material;
- <https://www.excel-easy.com/examples/anova.html> to build the ANOVA OneWay Analysis;
- Adobe XD for the mockups;
- Axure RP 10 for the implementation of the system.