The MarkEd tool for Marking, Feedback and Moderation II

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Abstract

Marking is one of the most important processes involved in school teaching. A good marking system can make it easier for academic staff to manage the setting of each assignment, assign marking tasks to markers and moderate marking results. It should also help markers better understand the marking criteria and ensure that the way they are marking is consistent throughout the marking process. There is also a great need for students to have a better understanding of their own score and the feedback given by the markers.

Since staff and students at the School of Informatics of the University of Edinburgh[28] are not entirely happy with the current marking systems used by the school. Andrius Girdzius[45] used Figma[7] to propose a design of a better system called MarkEd. MarkEd is dedicated to helping students and teaching staff in marking, feedback, and moderation. Since MarkEd was only designed for basic functions of marking and giving feedback, other undergraduate students, Sun Wai Chung Chris[41] and Wan Mohd Hamdani bin Wan Mohd Azmi[38] improved on Andrius's design. Chris's improvements[41] on MarkEd are to allow staff of the School of Informatics[28] to do fairer and more efficient marking. Hamdani's improvements[38] are dedicated to increasing the quality of the feedback.

Based on the design of Andrius [45], this project will implement the first iteration of MarkEd which is a website for students and teachers to actually operate and interact with. After the first iteration, the second iteration is then refined based on my project supervisor Dr. Cristina Alexandru's feedback and suggestions, Chris[41] and Hamdani[38]'s improvements on Andrius's design and their evaluation results. The system is then evaluated with academics, markers and students from the School of Informatics[28].

Acknowledgements

First of all, I'd like to thank Dr. Cristina-Adriana Alexandru, who is the supervisor of my project. Thanks for her consistent help and advice from IPP to the end of the project. Although we can only meet online due to the pandemic, Cristina had meeting with us every week to ensure the smooth progress of our project. I also want to thank her for her great help in helping us find volunteers.

Then I would like to thank my parents and my friends for their encouragement and help during my postgraduate study. Without their help, it is difficult to maintain such an efficient study in the face of the pandemic.

Finally, I would like to thank the volunteers who are willing to participate in this project. Their opinions and suggestions are very useful. I hope that the implementation we make in the future can help them in their future work and study.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Xisen Wang*)

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Chapter 1

Introduction

1.1 Motivation

Marking is an indispensable part of the teaching process. By conducting various forms of marking, teachers can gain a comprehensive understanding of their students' learning. Therefore, they can obtain more objective and comprehensive feedback on the effectiveness of their teaching. In order to improve the quality of teaching, teachers can also improve their teaching methods in a targeted manner based on the marking result. For the students, they can use the marking result and feedback to understand their mastery of the content, so that they can purposefully cooperate with the teacher in their learning. At the same time, marking is an important tool for evaluating people's abilities and is an important criterion in the selection of talent.

The academics of the School of Informatics[28] manage all courses through a platform called Learn[16]. Learn integrates with third-party marking tools (such as Turnitin[30]) or redirects to third-party marking websites (such as GradeScope[10]) to get submissions from students and then records marks and gives feedback on the submissions. However, those different tools have different interfaces and different marking processes. This prevents the markers from forming long-term memories. As a result, the way to submit each assignment, check scores and feedback becomes inconsistent. This has caused a lot of trouble to students in the learning process.

With different marking systems, scores and feedback cannot be input and displayed in a unified standard and format. This undoubtedly adds to the students' and markers' troubles. This also cause that scores and feedback are distributed in different ways. For example, some courses send grades and feedback via email, others through Learn[16], Turnitin[30], etc. Students need to check each platform regularly to check their scores.

Sometimes some of these platforms do not notify any new scores.
Therefore, students need a better marking system on showing the result to help them understand their learning achievement and the teacher's feedback to them. This will help them make progress in the future. With a good marking system, student satisfaction will be higher and more students will be attracted. Course organizers can set and manage their course assignments more conveniently through this system. Markers can also use the system to make their marking fairer and more efficient.

1.1.1 MarkEd

MarkEd is an online marking website designed by Andrius Girdzius[45] to help with marking, feedback, and moderation in the School of Informatics[28]. Andrius only designed the user interface using Figma[7]. In the Figma, academics can set up all the course assignments. Students can submit their work and the academics can assign the students' submissions to markers. Once the submissions are assigned to markers, markers can mark and give feedback on submissions through this website. The prototype designed by Andrius can also be extended with a number of other third-party tools. Users can also create jobs to perform a series of automated actions.
However, in the marking tool designed by Andrius[45], he only designed some basic marking processes, without too much emphasis on the consistency of scoring and the work efficiency of the markers or the quality of their feedback. Therefore, two other students, Chris[41] and Hamdani[38] extended the Figma[7] design to include functionality for helping markers to become fairer and more efficient (Chris), and for encouraging them to produce higher quality feedback (Hamdani).

1.2 Aims and Research Questions

1.2.1 Aims

This project has been split into two parts. I and one other person on the project, Xiaofei Sun, will each be responsible for developing a different part of MarkEd. My goal is to implement browse submission interface and mark interface for academics and markers, and pages related to students to check their scores and feedback based on the design of Andrius[45]. Then improve the implementation by using some of the new features designed by Chris and Hamdani which were evaluated positively by previous evaluation participants (academics, markers, students in the School of Informatics[28]).

1.2.2 Research Questions

The main objectives of this paper were broken down into following research questions:
RQ1: What is the most appropriate and convenient technology to use to develop this prototype? (a) Programming language(b) Framework(c) Front-end design tool(d) Database management system
RQ2: How can we properly express the information obtained from the database to satisfy the previous design by Andrius[45], Chris[41] and Hamdani[38]?
RQ3: How can we improve the front-end design?
RQ4: How can we guarantee the security of the system, such that: (a) The user's personal data cannot be easily obtained? (b) The user can only access the pages under his user permissions? (c) The user can only use the functionalities under his user permissions?
RQ5: What is the perception about the usability of the implementation of: (a) Academic staff from the School of Informatics? (b) Markers from the School of Informatics? (d) Students from the School of Informatics?
RQ6: What is the potential impact of the tool for: (a) Academic staff from the School of Informatics? (b) Markers from the School of Informatics? (d) Students from the School of Informatics?

1.3 Structure of the Dissertation

Chapter 2 begins with an introduction to the previous undergraduate students' designs for MarkEd. This will be followed by an introduction to the marking tools currently used by the School of Informatics of the University of Edinburgh[28]. Finally some of the methods used for data collection in the evaluation will be presented.
Chapter 3 describes the methodology used in each stage of this project.
Chapter 4 begins by describing the development tools I have chosen for this project and why. Then each feature and page developed will be described in detail. Finally it describes how I deployed the results of the development to the server.
Chapter 5 introduces the process and results of the final evaluation in detail.
Chapter 6 begins with a conclusion of the entire project. It then discusses the challenges, limitations and skills that I have acquired during the project. Finally, it includes an outlook on future work.

Chapter 2

Background

2.1 MarkEd

MarkEd is an online marking tool designed by an undergraduate student, Andrius Girdzius[45] and improved by two other undergraduate students, Sun Wai Chung Chris[41] and HamdaniWan Mohd Hamdani bin Wan Mohd Azmi[38], using Figma[7]. These designs were made due to the lack of satification with marking tools of the students, academics and markers in the School of Informatics[28] of the University of Edinburgh.

2.1.1 Andrius's Design[45]

In Andrius's design[45](see figure 2.1), he designed the interfaces for the academics and markers' side. The home page of the design[45] listed all the related courses and courseworks that are related to the user. When a user clicks on an assignment, they will first see the dashboard page with basic information of the assignment. In the submissions page, the academics can manage the assignment information. On the jobs page, users can set up some customised scripts to be executed automatically. When some submissions are tagged as moderation, the user can choose to whom the site sends emails automatically. In the setup page, academics can manage the details of this assignment such as the number of questions and marks, the marking team and the permissions of each person and identity. On the modules page, users can customise and add small, independent components such as third-party plugins. Finally, on the marking data page, users can clearly see all the submissions and brief information about them such as the score, feedback and tags. User can access the marking page

by clicking on the selected submission. This displays the student submissions and the marking box for each question. After entering the score and feedback the user can choose to complete the marking or save it as a draft.

Andrius's final evaluation involved 6 academics and 5 markers. He used the SUS[40] to evaluate usability and got an 'OK' result. In terms of future impact, most people found it to be helpful. Some aspects, such as knowing the progress of the marking in the dashboard page and asking for help were very helpful. One marker suggested that markers should not see the administration page of assignments. One academic thought it would be really helpful to support keyboard shortcuts. However, more evaluation is needed in the future as the number of participants was not very large and the results varied greatly.

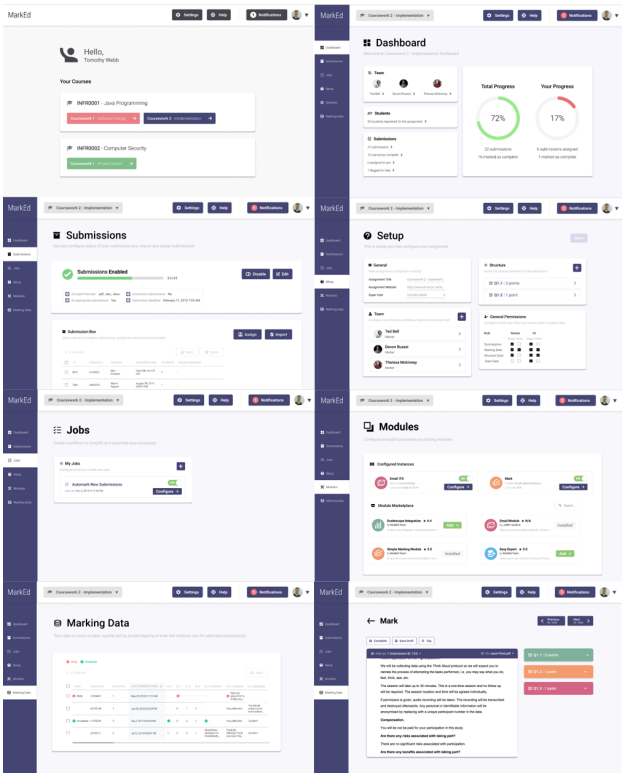

Figure 2.1: Screenshots of Andrius's Design[45]. Detailed screenshots are shown in Appendix A.

2.1.2 Chris's Improvement [41]

Chris[41] modified Andrius's marking page to help marking fairer and more efficient by adding 7 features(see figure 2.2). Firstly, Chris's new features allow user to shuffle and mark by questions[41]. The marker can choose to mark by questions or by students

when marking. Chris also added the feature of double marking to make marking fairer, which can be activated by academics. Chris also allowed users to have more functionalities in reviewing marking results. Users can filter the table in the marking data page or highlight submissions with empty or zero mark. Staff can communicate via the chat function. Unlike other communication systems, this chat function is only focusing on contact with colleagues in the marking team. Therefore, markers and academics can also find the person they need to chat with more quickly. Markers can also anchor certain submissions. When questionable submissions are encountered, the previously anchored submissions can be quickly found and compared. Chris's design also allows the marking process to be timed for markers. This allows the marker to be reminded when he is tired and to keep track of the marker's marking process. The reason for this is to make marker marking more efficient and to give academics a better view of the markers' working status.

Chris' final evaluation involved 6 academics and 8 markers. He also used the SUS[40] to evaluate the usability. The result was "OK". In the survey on future impact, the majority of participants gave a positive result. One of the features that participants liked the most was the anchor and compare assignments. One Learning Technology Specialist suggested that the anchor should user the term of "flag" instead of "tag". For the Shuffling and Mark By Question, 2 markers thought it is not useful and 2 academics thought it is great[41]. There were some markers who did not like the timer since they thought it is not ethical to have it.

2.1.3 Hamdani's Improvement[38]

Andrius's design[45] didn't attempt to encourage markers to improve the quality of their feedback. Hamdani hopes to improve the design to encourage markers to give better quality feedback. Therefore, he proposed 5 new features(see figure 2.3). Hamdani firstly applied the feedback sandwich concept[43] to his improvements to MarkEd[38]. This sandwich structure has three text areas which are positive feedback, then areas that need to be improved, and at the end some words of encouragement. Markers can also use Hamdani's feedback bank to view feedback given on previous submissions. The feedback bank also allows users to filter previous feedback. This allows markers to see what feedback has been given and reuse it. Hamdani has also added peer-review tags to the tag system to allow other markers to help with their marking when having difficulties. Hamdani has designed a chat system between students and markers. Students

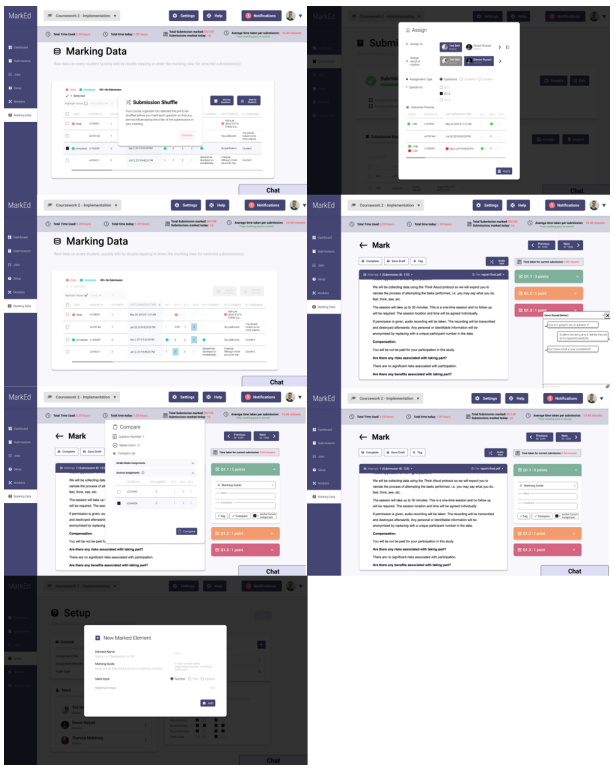

Figure 2.2: Screenshots of Chris's Design[41]. Detailed screenshots are shown in Appendix B.

can communicate with markers if they have questions with their results and feedback. This saves the academics from having to deal with questions from students every time they ask them. Hamdani has also designed a notification system so that markers and students can be reminded of the chat entries they receive[38]. Markers can also receive other reminders, such as when a question is tagged as needing their help, when marking is approaching a deadline, etc.

In the final evaluation, Hamdani recruited 6 academics, 8 markers and 1 learning techology specialist[38]. In the SUS[40] results, Hamdani's design received a "GOOD" result. For the feedback sandwich structure, all participants felt that it was a good idea but sometimes not useful. For the feedback bank, 3 academics felt that users should be able to sort the feedback in the bank to cope with the different situations encountered.

2.2 Current Marking Tools Review

Learn[16] is widely used in many schools around the world. Learn is also used as the most important tool for managing students and courses at the University of Edin-

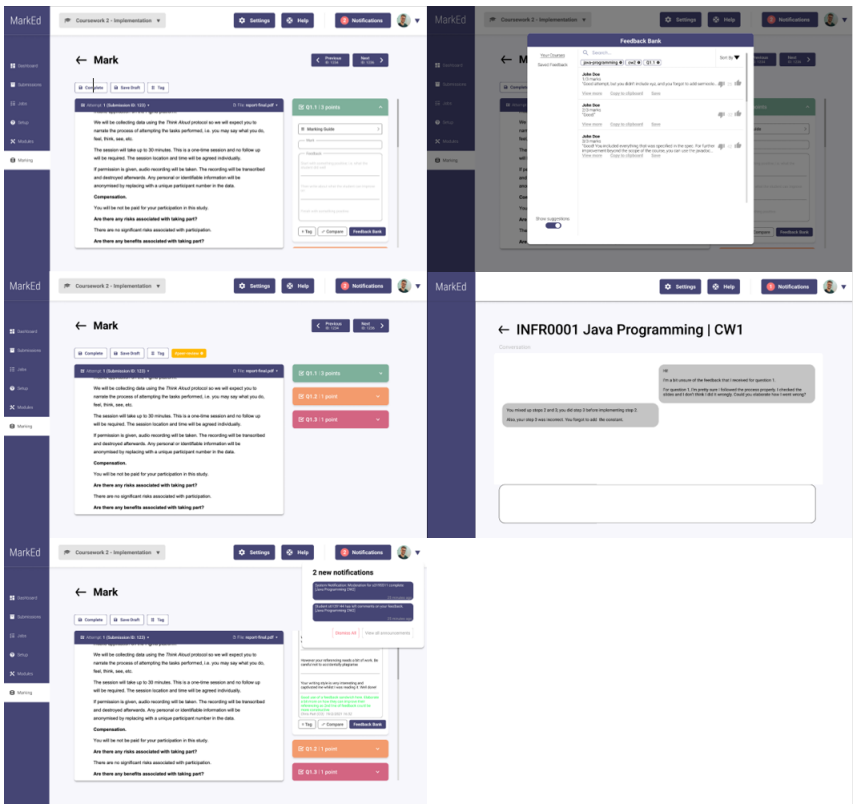

Figure 2.3: Screenshots of Hamdani's Design[38]. Detailed screenshots are shown in Appendix C.

burgh. It is highly regarded for its well-customised framework and easy integration with third-party applications. Academics can edit the pages of their courses such as course information, course materials, team information, etc. Students can submit only reports through the assignments set by academics. Academics can assign submissions to markers. Markers can see the marking criteria for each question when marking. Markers can also mark outside the system and import the results into Learn. The results can be posted and students can see their marks and feedback in the system. At the University of Edinburgh, there are many types of assignments such as reports, codes etc. Learn[16] can only handle report and has been abandoned by many schools around the world since it is not secure in certain aspects such as the live sessions are easy to be hacked[6], and not optimised for large numbers of students and teachers[5]. Therefore, Learn is not a perfect solution for Edinburgh University.

Turnitin[30] is a widely used plagiarism detection and marking tool used in 126 countries. In the University of Edinburgh, Turnitin is one of the most important tools in postgraduate study[51]. It has the largest database with 24 billion web pages and 250 million papers and millions of articles. Turnitin is also so flexible that it can be used

with many other third party tools to assist schools with marking and administration. Turnitin also has almost the same features as Learn in terms of marking, but Turnitin shows the repetition rate of the report to markers when marking. The interface design is clearer than Learn[16]. Although it has a powerful plagiarism detection function and a clear interface, Turnitin[30] only supports report type submissions and Turnitin is not user-friendly in terms of connectivity for student who are located in China. Therefore, Turnitin cannot be the perfect choice for the University of Edinburgh.

Gradescope[10] is also a marking tool widely used at Edinburgh University. During my MSc program, most of the question-based examinations were submitted and marked through Gradescope. It is also widely used internationally by over 600 schools. However, unlike other grading software, Gradescope has a number of features that make it very popular. Gradescope allows you to upload scanned copies of papers or digital submissions. It also has a built-in artificial intelligence assistant to reduce the markers' workload. For some programming assignment, it can also help markers with automatic marking. However, GradeScope[10] is very inflexible in some areas, such as the strict formatting requirements when submitting a commit. The system only supports two user roles(marker and student). It cannot be applied to all occasions in the Edinburgh teaching process either since we have academics to administrate courses.

2.3 Data Collection Methods Used for Evaluation

Interview : Interview is a simple and effective way of obtaining comments and subjective feelings about the product directly from participants[47]. The interviews can be conducted in three formats. These are the structured interview, the semi-structured interview and the unstructured interview. For structured interview, conducting an interview with a carefully structured set of questions can be very useful for the quantitative analysis of the data obtained. For semi-structured interview, once it has been found that participants hold a strong opinion, we can add necessary questions for the interview. Generally unstructured interviews are used when the researcher does not prepare the questions for the interview, and this is where we need to ask questions based on the topic of the interview and the user's responses.

Think Aloud : Think Aloud can be very useful in the evaluation[47]. This method will ask the participants to voice their thoughts on how they use the product, explain why they do so, and ask questions about their use. This method helps developers to identify problems that participants tend to make when using the product. It also helps

to identify user expectations and biases when using the product.

Co-operative Evaluation : Co-operative evaluation is a method of evaluating interfaces based on Think Aloud[47][42]. This design method is used to identify problems and helps the design optimisation process. Co-operative evaluation can involve more than one people at one meeting. During the evaluation, the participants completes a set of tasks in silence. In between each task, participants can describe how they did the task or ask any questions they encountered. Cooperative Evaluation helps the researcher to identify problems more efficiently.

Focus Group : Focus Group allows many participants to evaluate the product at the same time[47]. The researcher needs to prepare a series of questions in advance for the participants to discuss. The advantage of Focus Group is that the researcher can quickly obtain the views of a number of participants. For the participants, the discussion can also facilitate a more active expression of the participants' ideas and suggestions. With very little training, researchers can carry out a 'Focus Groups' approach. The experience of the researchers in organising a group discussion is very useful, as otherwise it is easy for the role of the participants in such activities to be under-utilised.

Questionnaire : Questionnaires are a very effective method of obtaining information[42], usually by asking participants a set of questions on paper or using an online form. It is useful to have sufficient background knowledge before the questionnaire design, as otherwise the questions will be biased. Conducting a good questionnaire is time and effort consuming. Full consideration should be given to how the questionnaire will be analysed before you start designing it.

System Usability Scale[40] : The System Usability Scale (SUS)[40] is a subjective measure of experimental results and is one of the most important subjective scales for evaluating the usability of a system. SUS includes a total of ten questions. The odd-numbered questions are positive questions. Even-numbered questions are negative questions. Each question has 5 options and represents different scores, namely strongly disagree (1 point), disagree (2 points), average (3 points), agree (4 points) and strongly agree (5 points). As it is a 5-point scale and the SUS ranges from 0-100, the conversion scores for all items need to be added together and eventually multiplied by 2.5 to obtain the SUS score. Systems with scores above 70 are generally considered to be at the "GOOD" level and scores above 50 are considered to be at the "OK" level.

Audio and Video Recording : Audio and video recording are the easiest and most effective way to record data.They allow you to record discussions when taking notes is difficult, as well as information that is not easy to record in writing.

Chapter 3

Methodology

This chapter provides an overview of the methodology used in this project. Each of these sections explains each stage of the project in detail.

3.1 Stage 1: First Iteration of Implementation

In this stage, I focused on solving {RQ1}, {RQ2}, {RQ3} and {RQ4}. Firstly, this project has many complex functionalities and modern interfaces. It is therefore particularly important to choose the right development tools before starting the project, such as the choice of language, the choice of framework, the choice of front-end and the choice of database. Choosing the right development tool will also make development less difficult and reduce the number of problems we encounter during development.
At this stage, I developed the basic functionality of MarkEd based on Andrius's design[45]. But as the project was split into two parts for two students to develop, in order to ensure that the design language of the two developers is the same and to facilitate future integration, I designed all the templates for the pages, such as the side bar and the top navigation bar. Then, I defined the front-end tools, so that the other student can simply embed her own developed pages into the templates I have developed. At the same time, I had to develop the login and registration pages for users so that we could have some accounts to develop for different roles of users when we are developing.
After the above development, we could work individually. I was responsible for developing Andrius's[45] homepage for academics and markers, a mark data page to display all the submitted assignments and marking results and a mark page for marking. In the student's interfaces, I also developed a student homepage for the submitting of assignments and a page for viewing marking results and feedback.

3.2 Stage 2: Second Iteration of Implementation

In this stage, I focused on solving {RQ2}, {RQ3} and {RQ4}. I selected one new feature(View All attempts) based on the feedback given by my supervisor Cristina in an informal evaluation after the first iteration and 3 new features(Mark By Question, Compare and Feedback Sandwich) based on Chris[41] and Hamdani's[38] design to add to my implementation.
To ensure that the final evaluation is carried out, I merged my code with that of the other student in the project and tested it. Once the testing was completed, I deployed the merged code to a cloud-based server. This allowed participants to access our project during the final evaluation.

3.3 Stage 3: Summative Evaluation

In this stage, I focused on solving {RQ5} and {RQ6}. With the help of our supervisor, I had 4 academics and 6 markers involved in my evaluation. I also invited 6 students to participate. At first we planned to use Think Aloud(see section 2.3) method with all the participants. However, due to time constraints, we were only be able to use co-operative evaluation(see section 2.3) and then conduct focus groups(see section 2.3) method with groups of participants to save time. A questionnaire(see section 2.3) was be used at the end to obtain SUS scores[40] and the participants' perceived impact on the future. I also conducted a one-to-one study with one of the academics who was very interested in our project. I asked the participant to use the think aloud(see section 2.3) method during the completion of the task to describe the process of using the implementation and then answer to a semi-structured interview(see section 2.3). The evaluation was split into two parts, with myself and my colleague doing separate evaluations of the parts we were responsible for. While I was working on the study, my colleague helped me to take notes. When the evaluation was completed, my supervisor and my colleague anonymised the transcript generated automatically by Zoom[37] and forwarded it to me. I used this transcript and the notes taken during the research to carry out thematic analysis[39] of the findings. The final results included the results of the data analysis, SUS scores and the participants' ratings of the potential impact of the implementation.

Chapter 4

Implementation

In this chapter, I focused on solving {RQ2}, {RQ3} and {RQ4}.

4.1 Choice of Implementation Tools

In this section, I will discuss the development techniques we have chosen for the implementation of MarkEd and the reasons for their selection. In summary, we used Django[33] as the development framework and Python[36] as the back-end language. For the interface design we used Boostrap[2] to create a clear and modern interface. Finally MySQL[22] was used to manage our database.

Django[33] : Before developing, I had two choices in choosing a development framework: Node.js[24] and Django[33]. Both are very well known frameworks in the field of web development. Chris[41] and Hamdani[38] used the Node.js framework for their final development. But since they didn't do much implementation, I decided to look for other better frameworks. Django has an extremely large API and the maintenance cost is relatively low[44]. Node.js uses JavaScript as the backend resulting in high coupling between the front and back end[48]. Django is more mature and stable than Node.js. Therefore, in the end, I chose Django as our developing framework.

Django[33] uses the MTV (Model, Template, View) design pattern[44]. This means that the web application is divided into three layers: a Model layer, a Template layer and a View layer. The Model layer is responsible for mapping the application business objects to the database (ORM) and providing URL routing to the MySQL[22] database API. The view layer is responsible for the processing of the functional business logic, and is called between the model and template layers when appropriate. The main role of the template layer is to provide the front-end HTMLtht pages to the user for display.

Python[36] : Python[36] is a scripting language for backend development. It is known for its elegance, simplicity, speed, versatility and power. It inherits the functionality and versatility of traditional compiled languages, but also draws on simple scripting and interpreted languages for ease of use[36]. Python has advanced modular components and a rich set of standard and third-party libraries[50]. This allows for consistency and flexibility of code when we need to increase the scale of a project, and significantly reduces debugging time and is more friendly to debugging source code.
For web development, Python[36] has the following advantages. Because web applications have frequent database interactions and display mostly dynamic pages, Python can be more efficient in the development process. The underlying implementation of the language, its associated standard libraries, and the wealth of third-party libraries in Python are all written in C[49], which is an important reason why the Python language is so fast. Python is not only a purely object-oriented language like Java[13], but it is also procedure oriented, as the underlying logic is written in C[49]. In practice, Python incorporates the coding styles of many languages. Therefore, we can choose different suitable ways to help us in implementing different functions to develop MarkEd[45].
Bootstrap[2] : Bootstrap[2] is an open source front-end framework that is used by many front-end developers due to its ease of use. It has a lot of beautiful styles built in. Bootstrap provides a predefined style sheet standard, so that the overall effect of the site is more uniform, more user-friendly and more comfortable to read. Predefined style sheets are not set in stone, developers can change according to their needs at will to make web development faster. The Bootstrap framework has many packaged components, such as drop-down menus, button groups, navigation bars, pagination, warning dialogs, progress bars, etc., to design a fully functional website.
Compared to other front-end development tools on the market, such as Foundation[8], LayUI[15], Angular[1], Pure[26], etc., Bootstrap[2] is much more aesthetically pleasing. Development under Bootstrap is easy and fast thanks to the source code for the various components provided in the official documentation. Bootstrap has been developed up to version 5.x, so it is more mature than other tools.
MySQL[22] : I also had two options when choosing a data management system, MySQL[22] and MongoDB[20]. Hamdani[38] chose to use MongoDB for his development, but since we decided to use the Django[33] framework for our development, Django has native support for SQL, so it was easier for us to use a data management system in SQL format. MongoDB stores data in memory, it may have memory requirements for the server (for financial reasons I could only deploy the project on a

relatively cheap server). If we use MongoDB Cloud[21] as our data management system, although we can ignore the memory requirements, the database is on the cloud rather than local. I was concerned that connection instability would occur when accessing the data. Therefore, I decided to use MySQL[22] for data management.
MySQL is a relational, highly portable, open source and web-enabled SQL database that is often found in small to medium sized web development[22]. Not only does it support Windows, Linux, Mac OS and other operating systems, but it also supports multi-user, multi-threaded relational databases. Also, because of its free and open source nature, and faster operation than other large databases, it is widely used in the development process of enterprises.

4.2 First Iteration of Implementation

4.2.1 Sign Up, Login and Log out

Although there are no login and registration pages in Andrius' design[45], they are important for this system because we have three different roles of user to access the site. This also allows us to test the different functions for three roles of users.
Sign Up : This registration page will not be used in the future because in reality the school will register the student for a school account when they enter the school and send them their account details. MarkEd is also intended to be integrated with the school system. However, I have given complete security functionalities to this registration page here, such as checking if there is empty information has been uploaded, check for the format of the email input by the user, not display the entered password and double verification of the password(see figure 4.1). The language of the prompts switch automatically according to the user's system language. For registration information, I have to check on the back end, for example for an already existing student or staff number, the system will return the registration page with an error message.
Of course, a good registration and login system needs to be very secure, and Django[33] offers an API(make_password)[25] for encrypting passwords. This API encrypts the passwords by hash encryption. I then store the encrypted result in the database so that no one can see the user's password. The API also provides multiple encryption methods, so that if one encryption method is broken, I can change it to a different encryption method to keep the system secure. I also used the POST[46] transfer method to transfer the user's registration information between the front-end and back-end, so

that the user's information is secure compared to the GET method[46]. Allowing users to verify the account they just registered is essential for a secure website. Once a user has registered, an email is automatically sent to the user. Django has also provided the API(send_mail)[25]. I just needed to set up a set of information for the mail server in the settings file to send the email. I also have HTML embedded in the emails I send to users. This not only makes the emails more aesthetically pleasing to send.

I have encountered a problem when storing user's profile images. In my previous development experience, the uploaded images were usually converted to binary format (Blob) and then saved to the database. The binary data is then converted into images when read. But when I looked at how to do the above with Django, I didn't find a similar operation. But I found that Django supports an ImageField by default[18], and that Django saves the image in a specific folder on the server, and then saves the relative location of the image on the server in the database. When reading, the image is read from the database after the relative location is read from the corresponding location.

Login : Once registration is complete, we can access the login page(see figure 4.1). Although the login page is relatively small, I need to perform more verification. For example, whether the student or staff number exists, whether the password is correct and whether the user is validated by the email(see section 4.2.1). And after a successful login, the user's role needs to be checked in order to redirect the user to a different page. For example, students will go to the student page and academics and markers will go to the teacher page. As with the registration, I used another API provided by Django (check_password). This API allows me to compare the entered password with the encrypted password stored in the database without knowing the password in the database, thus generating a comparison result.

For a fully functional website, the ability to record a user's last login information and automatically log them in the next time they visit the site is also a key part of the user experience. The student system at Edinburgh University is very poor in this respect. I have to manually enter my login details myself every time. Therefore, here I use the browser session to save the user's information, and the next time the user visits the site I will first check the user's login information saved in the session. If it is there, I will redirect the user to the page he should be looking at. If not, I let the user log in. In all future pages, I have added the ability to check the session so that even if some users try to access a page to which the user is not entitled by typing the URL directly, the user will be redirected to his own home page. When a user tries to access a specific page by entering a URL when they are not logged in, they will be redirected to the login page.

Log Out : Logging out(see figure 4.1) will simply delete the session saved when logging in. Then the user is redirected to the login page.

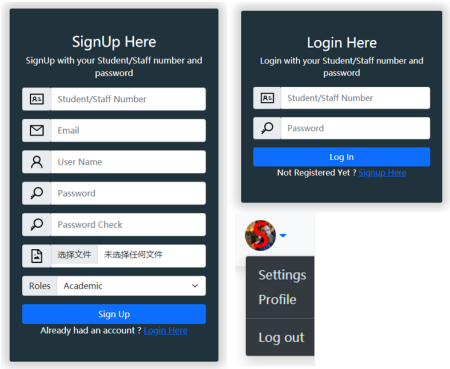

Figure 4.1: Sign Up Page, Login Page and Log Out Button

4.2.2 Router Design

A good router design is very important for a good website. A good router design reduces coupling during development and also makes it more clear to the user which page they are on. I also had a lot of difficulty here in designing this router.
Every website should have a homepage. When I finished developing the login and registration pages, I made the home page of MarkEd as the home page for teacher. Later I found out that this is not good. Because this does not separate the teacher side from the student side. Therefore, the MarkEd home page should be a router. After the user enters the MarkEd URL, the first level router(Home in figure 4.2) should determine the user's login information like a judge and redirect the user to the second level router(Student and Teacher in figure 4.2). This way, when developing, the code on the student and teacher's interfaces is stored in separate folders and on separate routers. This reduces the coupling between the student's and the teacher's interfaces. Figure 4.2 shows the full router design in graphic.

4.2.3 Teacher's Interfaces

Teacher's Homepage : This page(see figure 4.3) is relatively simple. I use the same design as Andrius's Figma[45] since it just showing the basic information of the courses. I check if the user is logged in as marker or academic and display links to courses and assignments relevant to the user. However, the structure of the data stored in the database is not the same as the structure that needs to be presented. This is because in

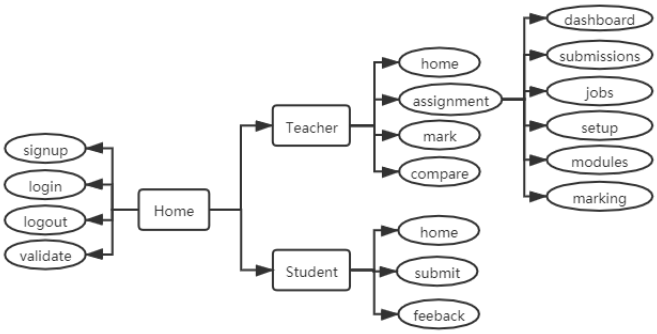

Figure 4.2: Router Design

the database, courses are a table and assignments are a table. Assignments are stored with a course foreign key to correspond to the course. The data is then retrieved from the database and saved in a specific format for the front-end to retrieve and display. In addition I have a saved teacher and course relationship sheet. So first I get the teacher's id, then I get the courses associated with that teacher in the teacher and course relationship table, and then I find all the assignments associated with that course based on those courses. Each course and the assignments related to it are then saved in the form of classes. In this way each course is an object. Once passed to the front-end in this way, the front-end will easily read this information. The front end side first reads the session information to display the welcome message, and then loops through the information received for a set of objects. Each loop displays the courses and assignments associated with this user.

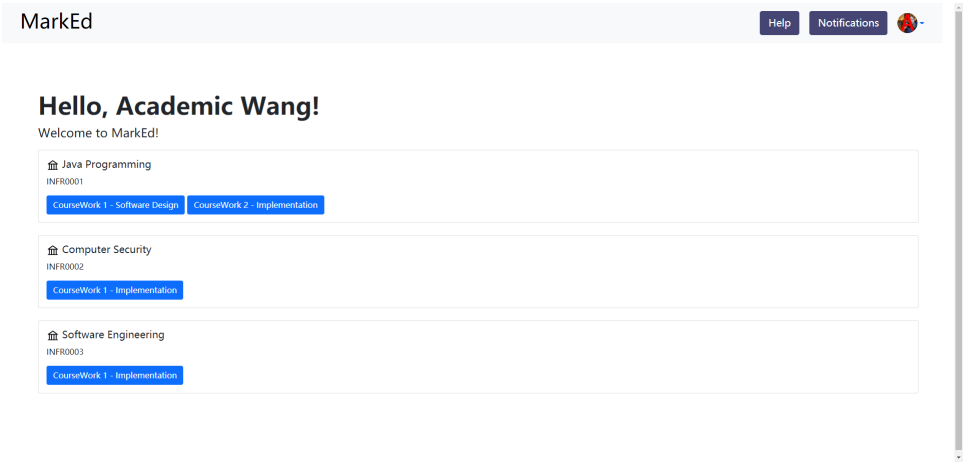

Figure 4.3: Teacher's Home Page

Templates : Once the teacher's home page has been made, the teacher can then choose

to access any of the assignments in the course that are relevant to him. For each assignment, it has 6 sub-pages. These are Dashboard, Submissions, Jobs, Setup, Modules and Marking. Here we will divide the project into two parts, and I will only be responsible for the marking part. The other pages will be the responsibility of another student related to this project, Xiaofei Sun. However, to ensure that the design language and templates for the pages we develop are the same and to make it easier to merge them, I have first created a template for the assignment page(the sidebar and the top navigation bar). I use the same design as Andrius's Figma[45] since the colorway matches the color of the University of Edinburgh. As there are 6 sub-pages here(see the left bar in figure 4.4), the work would be very repetitive and useless if I develop a router for each of them. Therefore I put these six sub-pages under the router of the assignments page in one place(see figure 4.2). I use different parameter in the URL to tell the back-end which page the user are in now. But putting all 6 sub-pages all under the same router could run into coupling problems(writing all 6 pages' code in one function), which would cause our code to interfere with each other during development and make it harder to merge. Therefore, I created different functions in the assignment router for each page to allow developers to develop the data passed to the front end. I only had to copy the functions from Xiaofei when merging with her. The advantage of this is that I don't need to make a template for each page on the front end, but simply make a judgement on the current page in the template file to highlight the current page in the left sidebar. There is also a drop down menu on the left of the top navigation bar for quick switching between assignments under this course. In terms of security, I also have to perform multiple checks on the data received on the back end. First I check the page name passed in via the URL is among the six pages. Then I check whether the id of the assignment exists and whether it is related to the current user. If any problems are found during these checks, the user is redirected to the home page that the user should be looking at.

Marking Data Page : As said before, each sub-page is a function under the assignment page. This is also true for the marking data page. In the marking data function, I use the method that is similar to the home page of teacher's interfaces to present the information on this marking data page. On this page, Andrius'[45] original design had the user ticking the submissions and then clicking the mark button at the top. I have modified it here so that for each submission there is a mark button so that user can get to the marking page in one step rather than the two steps in Andrius.

However this page is much more complex than what is shown on the home page on the

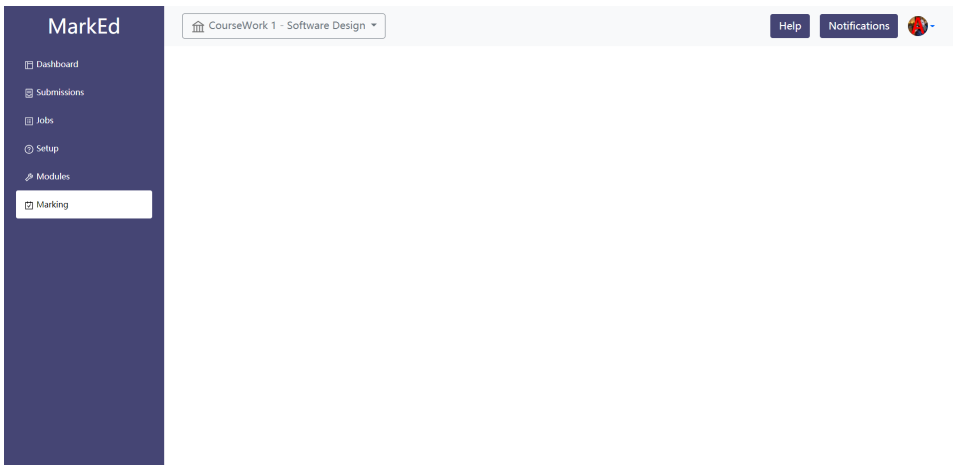

Figure 4.4: Template

teacher's side(see figure 4.5). Firstly for each assignment the number of questions is different for each assignment. So the number of columns in the table for each assignment is different. This also leads to the fact that I can't keep information (scores and feedback) for each question in the table of submission. This is because the number of columns for each table in the database is specified in advance but different assignments have different number of questions. Here it is only possible to add another "submission element" table to the database to hold each question. The foreign key of the corresponding submission is then stored in each submission element. In this way there is a one-to-many relationship between the submission and the submission element. The same applies to assignments, where each "assignment element" holds their maximum input, the marking guide and the foreign key of the assignment it corresponds to.

According to the structure described above, the first thing to do is to loop through all the questions to get the names of all the questions for the table header. In the table, each row corresponds to an object. The back-end stores in each object the last submission information corresponding to each row for the front-end to read easily. For some submissions that do not yet have marks and no feedback, a "-" is used to indicate this. The front end will make a determination in the last "Operator" column. If the submission has not been marked or in the marking status, a "Mark" button will be displayed here. If it is in finished status, a "View Feedback"(for Marker) or "Moderate" (for Academic) button will be displayed.

Mark Page : I had many difficulties with this page, as many of the operations on the form are not typical in my previous developing experience. For example, for each question, they have the same attribute, such as score, feedback, tags, etc.(see figure

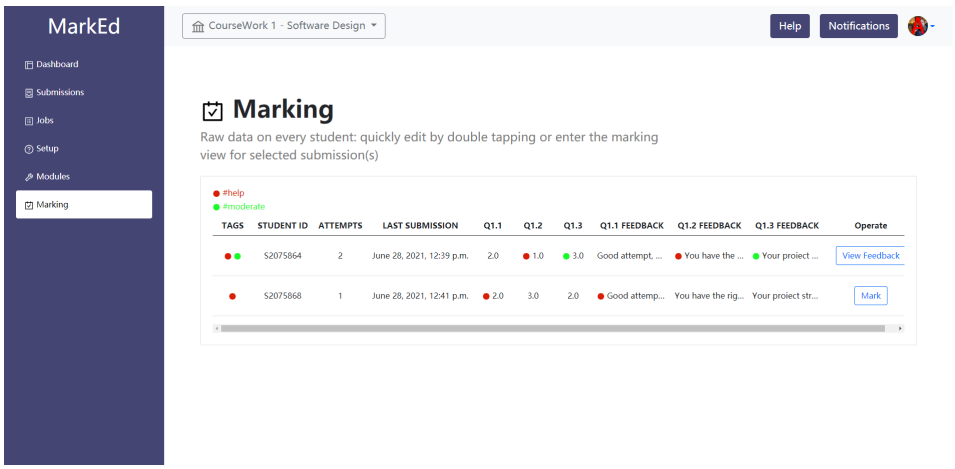

Figure 4.5: Marking Data Page

4.6) Therefore, it can be difficult to distinguish between them when using the form to send data to the back end(see section 4.2.3). At first, I made each question a form and then each question had a submit button. My supervisor later told me that this was very user-unfriendly. Then I decided to solve this problem in a different way. In the form, the back-end uses the ”name” attribute in the HTML to determine the name of the data received. Therefore, I had to give each question a different ”name” for the same attribute of questions, where I used the id of the question plus the name of the attribute to differentiate the ”name” attribute in the HTML. This way the back-end will know which attribute of which question it is. Once this has been solved, another problem arises. It is that a normal form will only have one submit button, and we want to implement two submit buttons for complete marking and save as draft. Here I learnt that the submit button can also have a name assigned to it. In the back-end, we can determine whether the name of a button exists in the information passed through POST[46] and then we can implement different functions. On this page, I have placed the complete and save as draft buttons on the right of the page because I think that the user’s mouse is always near the question during the marking process so that it will allow the user to click on the buttons more quickly. With the above two issues resolved, the rest of the mark page is relatively easy. The slightly more difficult part is how to make the input box for each question and its marking guide collapsible. Here I used the collapse[3] component provided by Bootstrap[2]. But the official document only mentions how to control it with button. I tried to give the title bar of each question the collapse function and it worked.

Of course, the mark interface requires additional checks to ensure the security of the

system. The first step is still to determine the role of the user. If the user is a student, they are redirected directly to the home page on the student side. The next step is to check the correctness of the data obtained from the front-end via the GET method[46]. If the user enters incorrect information in the URL it will also be returned to the corresponding home page. In the case of markers, users can see all questions but can only edit the questions they have been assigned. To reduce confusion, questions that are not assigned are presented as disabled(user cannot edit it and the input box turn to gray), i.e. the user cannot enter and check any input box for the question. For some submissions that have finished marking, marks also cannot be modified in any way. After the user clicks on any of the submit buttons, all the data on the page is first checked to see if there is empty information and the data is protected and sent to the back-end via the POST method[46]. Academics can modify all questions of all submissions. When the back-end receives the POST information, The back-end also checks that the incoming data is complete, whether the score field is entered as a number and whether the score is less than or equal to the set maximum input.

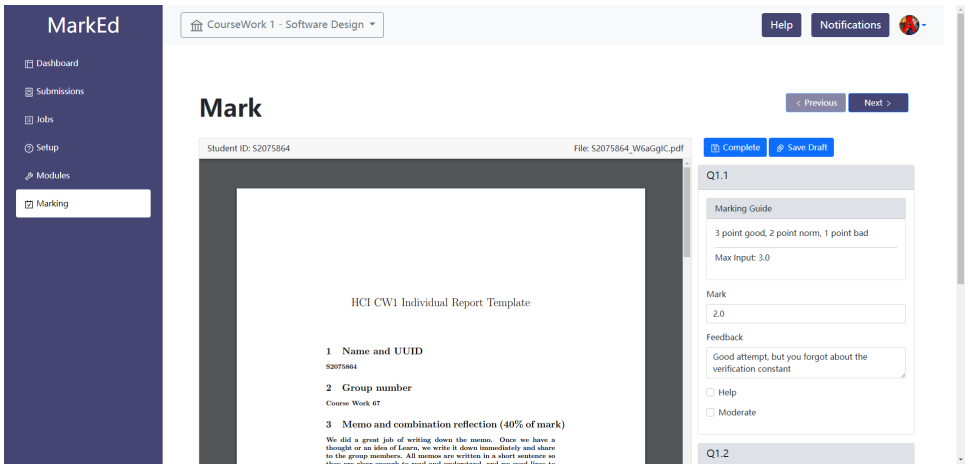

Figure 4.6: Mark Page

4.2.4 Student's Interfaces

Student's Homepage : As MarkEd is more focused on helping academics and markers' marking, feedback and moderation. There are relatively few features on the student's interfaces(see figure 4.7). The design here is almost identical to the previous Figma design[38], except that the buttons on the right have been placed in the table to simplify development. This side of the student homepage also uses the same method of displaying data as the teacher-side. Each row in the table is an object on the back-

end to facilitate reading on the front-end. Back-end has to calculate the total score and check the status of the different submissions. For example, when the user has not submitted, it will show ”Requested Submission” and there will be a submit button at the end of the row. If the user has submitted an assignment but markers have not yet started marking it, a button will be displayed for the student to resubmit the assignment. If the teacher starts marking, the student cannot resubmit. If marking is complete, the last column of the row will become a View Feedback button to view marks and feedback.

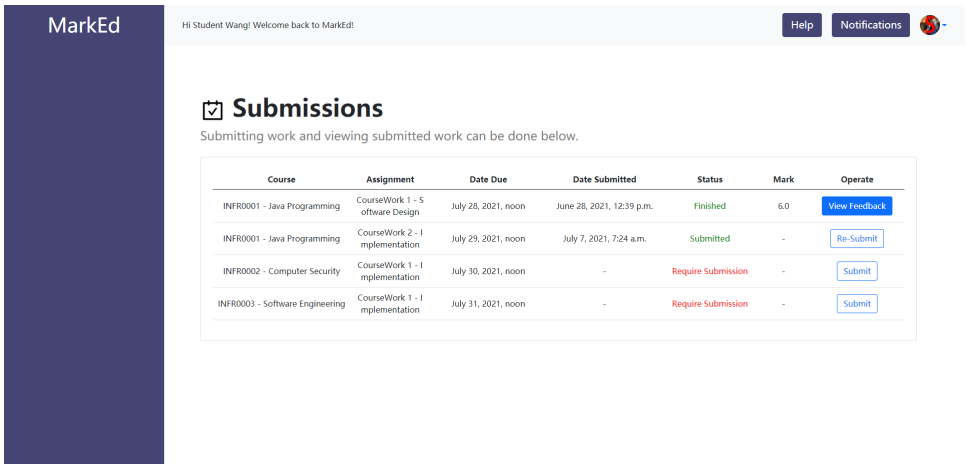

Figure 4.7: Student Home Page

Submit Page : Since I already had experience with uploading user profile image before, I now know how to do it for handling uploaded files. Django also provides a FileField format[18] to help me save files, and the procedure is the same as for ImageField. The security requirements are also very high. Therefore, I’ve added some validation here as well. First I make sure that the assignment id passed by the URL is exist in the database. I also check if this student is enrolled in the course corresponding to this assignment. I also check what the status of the student’s submission is for this assignment, if it is an assignment that the student hasn’t submitted or the markers hasn’t started marking, the student can submit. Otherwise the user is redirected to the student’s home page. Figure of the submit page is shown in 4.8.

View Feedback Page : This page is relatively simple to implement. It starts by displaying the name of the current job in the top left corner(see figure 4.9). The submission display box on the left is implemented in the same way as the mark page on the teacher’s side. In the top right hand corner, I simply add up the scores for each question and divide by the maximum number of each question to get the total score. The table on the right shows the scores and feedback for each question. There is no need for a

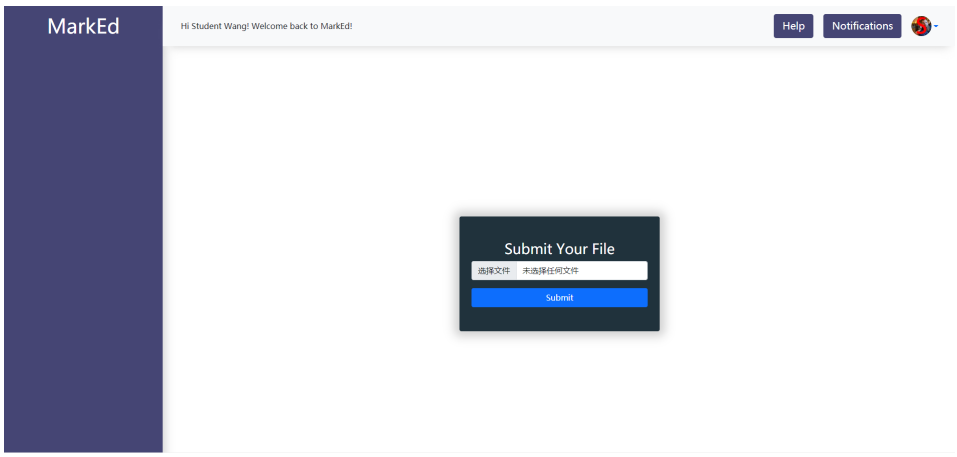

Figure 4.8: Submit Page

class to represent the table here, as this information is stored in only one table.

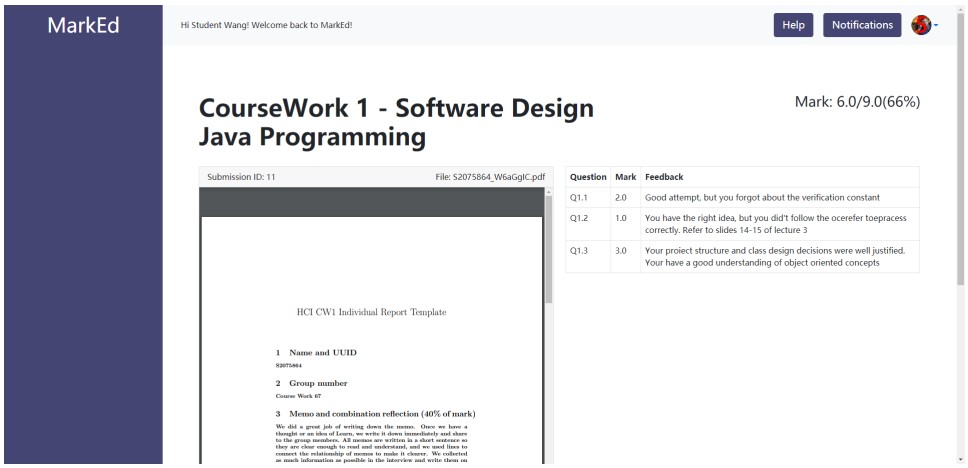

Figure 4.9: Feedback Page

4.3 Second Iteration of Implementation

4.3.1 View All Attempts

This improvement was suggested by my supervisor, Cristina. During the first round of development, I thought that the markers would only see the final results submitted by the students. However, in the actual marking process, the marker needs to be able to see all of the student's submissions for assignments where the student's revisions and evolution are sought. Therefore, on the marking page, I replaced the place where the file name was displayed with a select element(see figure 4.10). I then modified the

source of the file presentation box below by listening for changes to this select element. However, when I was done, I found that the file presentation box did not change as I thought it would. After looking up some information about switching the source of the embed element, I realised that I needed to refresh the embed element as a whole rather than just switching the file path of it. Although the final result is OK, it still does not support some operations that would be used in real life. For example, students are currently not supported to submit more than one file or one zip file at a time. This is because it would add a new table to hold these relationships. I was unable to complete this feature due to time constraints. This feature will need to be added in the future.

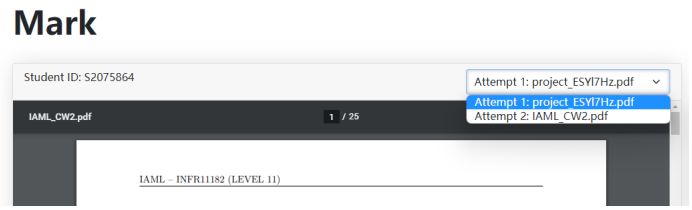

Figure 4.10: View All Attempts

4.3.2 Mark By Question

This feature was proposed by Chris in his paper[41]. He treat shuffling and mark by question as one strategy. Although it didn't turn out well in the final evaluation because many teachers felt that shuffling didn't help them to mark more fairly. However, marking by question is still very important to many teachers and is very helpful in their marking. Therefore, in the top right corner of table in the marking data page, I have added a mark by question button. This button is a drop down menu which includes the names of all the questions for this assignment. The data here is also read from the back-end to the front-end for all the questions for the assignment. As the mark by question interface is similar to the direct marking interface, except that the mark by question only displays the questions selected by the user, I have used the same front-end file as the mark page. In the case of mark by question, the back-end will only transmit information about the selected questions to the front-end, whereas a direct mark will transmit all the questions submitted for this assignment. By doing so, it reduces the redundancy of the code and also reduces my development time. Reusing code also makes it less difficult for me to maintain it.

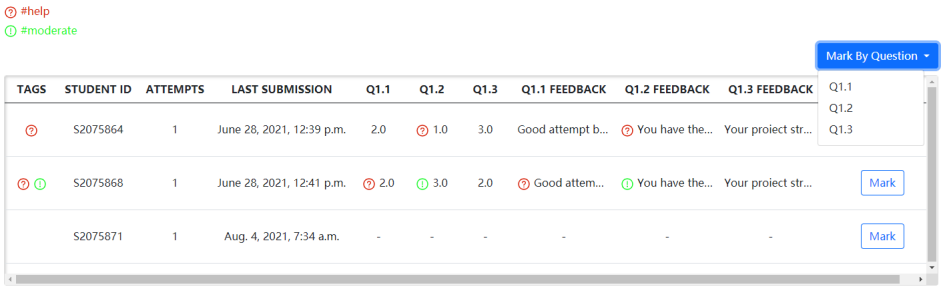

Figure 4.11: Mark By Question

4.3.3 Compare

This function was also proposed by Chris in his paper and the Anchor and Compare Submissions feature had good results in his evaluation[41]. With this feature, users can compare between two selected submissions. However, due to the time constraint, only the compare function is implemented here. I need to implement anchor submissions in the future. First I added a Compare button to the card of each question inside the mark page. By clicking on this button a small window will pop up. This window shows some details of all the other submissions for this assignment, including the student number and the mark for each question. The user selects one of the submissions for comparison and is taken to the compare page. The file presentation box on this page is a reuse of code of the file presentation box on the mark page. The card for the question is also reused from the mark page. This reduces development time and keeps the design style consistent. At the end of each submission there are the same complete and save draft buttons as on the mark page. Figures of the compare feature is shown in figure 4.12.

4.3.4 Feedback Sandwich

This feature was proposed by Hamdani[38]. At the beginning of the structure, the markers should fill some positive feedback, in the middle they should write about areas that need to be improved, and at the end they should include some words of encouragement. In his paper, some people felt that this feature was not good because it would force all markers to mark in this style. However, the final evaluation was positive.
During the implementation, I needed to consider how to preserve this structure. It was simple to create three text areas for each part of the sandwich structure, but it was important to save and recover the structure from the database. The structure of the database was already set in the first iteration of implementation and it would be very difficult to change it again. Therefore, I had to think of a way to preserve the

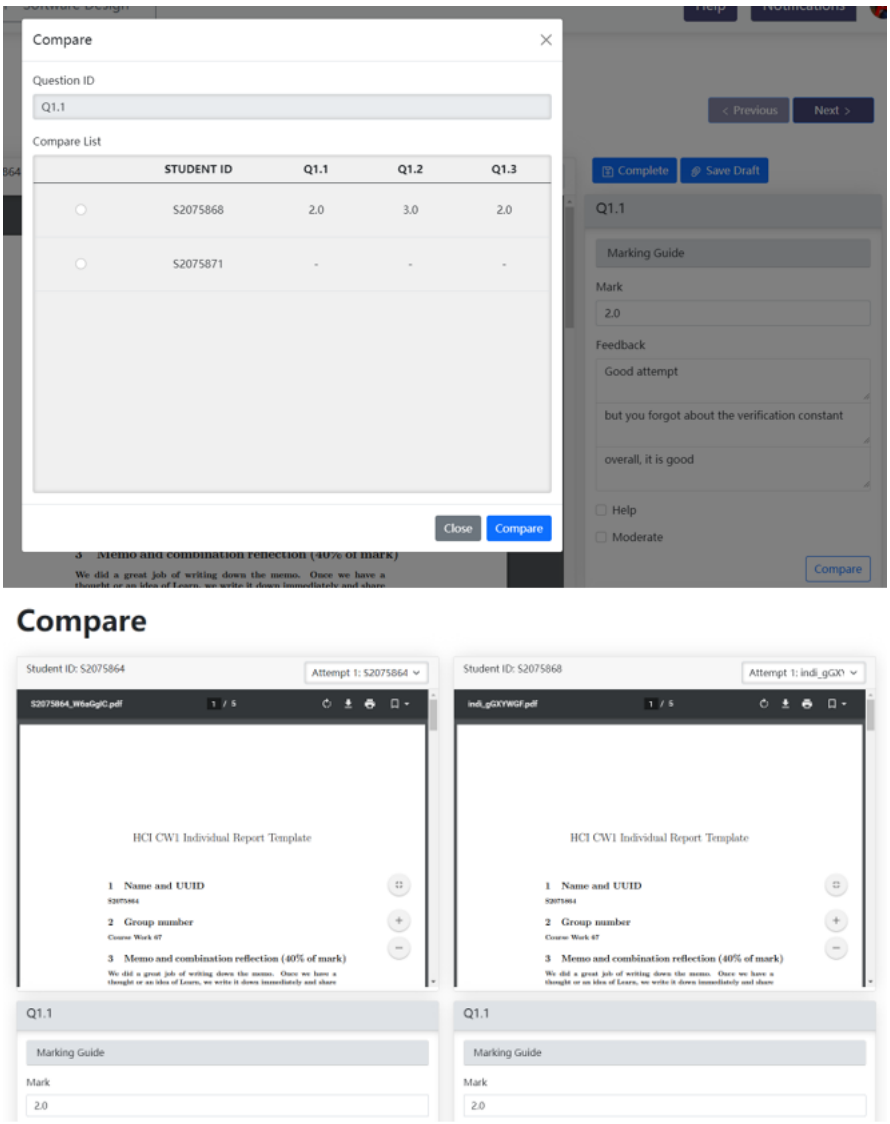

Figure 4.12: Compare

structure. I used the dictionary type[27] to separate the three parts of the structure and then converted to JSON[14] when saving to the database. When reading it, I just convert the JSON into a dictionary type[14] and then put each piece of feedback from the dictionary type into the corresponding position on the front end. At the same time such a structure can cause problems when reading some old feedback from the system because my old feedback is not saved as JSON. To take care of the old feedback, I use a ”try catch”[4] method here, and once the data cannot be converted into a dictionary(the data is not in JSON format), I will create one manually on the back end.

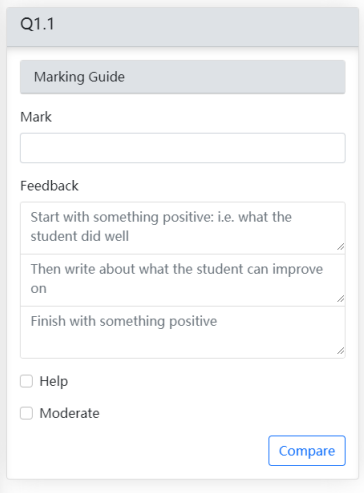

Figure 4.13: Feedback Sandwich

4.3.5 Improvement on Front-End

Although the web pages created using Bootstrap are very good looking, they give the impression that all the elements on the web page are on the same level and have no priority. ThereforeI have taken inspiration from window 11[32](windows 11 enhance the shadow effect) and ios[12](which was famous by their shadow design[29]). They separate of priorities by adding shadows to different elements. Therefore, I have added shadows to every card, every bar (sidebar, navbar) and every table on the site to give it a more three-dimensional look. But it is not enough to only add shadows, it is also important to make them look more advanced. With reference to windows 11 and ios, I have improved the look of the site by putting the shadow sources inside the elements, increasing the distance the shadows and making the shadows lighter.

4.4 Deployment on Server

Although the original plan for this project did not include this task, I had to deploy the website we developed to the server in order to make it easy for the participants of the evaluation study to access our project. But with no previous experience of deploying servers, this part took a long time to complete.

Firstly, as I am more familiar with Windows and I only need to open the server when evaluating, I planned to use my own computer as the server to deploy my project. There are many options for deploying server in Windows, such as IIS[11] and Apache[35]. I have chosen to use IIS because it is comes with the Windows system. All I need to

do is turn on the IIS service in the Windows settings. I was soon able to successfully deploy my own project to my own server. I was able to access the project on my own computer by typing in the IP address of my computer. But later I found that when I accessed my server from another network, I could not access it. That's when I realised that my server was using an IP address that was assigned by my router to the internal network. This meant that my IP address was not a public IP address and could not be accessed by devices on other networks. But if I need to publish my private IP, I need to spend money on some services. Google Cloud[9] will give new users $300 of usage. Therefore, I decided to use Google Cloud to deploy my project.

There are a number of options for creating a new instance in Google Cloud[9]. In terms of configuration, I chose the cheapest configuration for price reasons. For the system, Windows with an interface is very expensive, so I chose Ubuntu. In Ubuntu[31], there are also two options for server management software, Nginx[23] and Apache[35]. Since I chose the cheapest configuration when selecting my instances, nginx was a better choice. This is because nginx takes up less memory and resources compared to Apache. And because there are many people working on the same account at the same time when evaluating, Nginx handles requests asynchronously and non-blocking, so nginx has higher performance. After selecting a server, all that remained was to configure it according to the documentation on the Nginx website. Then install MySQL as the database on the server. Export the data I am using for development as a .sql file and then import it on the server. There were still many other problems to be solved during the implementation. For example, the server's default firewall is on and I need to turn it off or set the firewall rules to allow HTTP protocols in and out. The IP address of the server is dynamic by default. I didn't notice it at first, but then after restarting the instance I realised I couldn't access the project before I realised I needed to change the IP address to a static one. The project cannot use the default MySQL[22] root account to access the database on Ubuntu. I needed to create a dedicated account and then grant all permissions to the database you need to read and write to this new account. In Django[33], the MySQL table names are the Django project name plus the table name in the code. When I was developing, my Django project name had upper case letters, but the table names automatically generated in the database were all lower case. However, MySQL on Windows is case-insensitive, while Ubuntu is case-sensitive. Therefore, I exported the database information from Windows with the table names in all lower case, and I had to manually change them to upper case in Ubuntu.

Chapter 5

Evaluation

This chapter will focus on solving {RQ5} and {RQ6}. The evaluation will use a range of data collection methods to capture participants' perceptions on usability and future impact based on my implementation. The final results will be obtained through data analysis methods. Studies will be conducted with academics, markers and students. It is hoped that during the research process we will be able to obtain suggestions from the participants to help inspire future development.
This evaluation was approved by the Informatics Research Ethics Process. The RT number is 2019/70801.

5.1 Data Collection Methods

Due to the epidemic, all meetings were conducted through Zoom[37] and all questionnaire results were collected through Microsoft Forms[17]. In the research process, I used two methods to conduct the study. For most of the participants, I used the co-operative evaluation[42](see section 2.3) method to start the study. The participants were given a series of tasks before the evaluation. When all participants had successfully completed all the tasks, I send them a link to the questionnaire via Zoom's[37] chat for them to fill in. This questionnaire include a SUS[40] score and questions about the impact on the future. After completing the questionnaire[42](see section 2.3), the participants discuss freely through the Focus Group(see section 2.3) method. Some academics were very interested in our project and are very enthusiastic to be involved in it. Therefore, I chose to work with these academics on a one-to-one study. The first step was to use the think aloud method2.3. Then I conducted a one-to-one semi-structured interview with the participants. At the end, a questionnaire was given to

the participants to obtain SUS scores and their views on the impact of my developed functionality for the future.
However, due to the epidemic, I was only able to complete this study in China. According to the GDPR protocol, I cannot have all the audio and video recordings of the research process. So after the study, my supervisor and another researcher in this project they collated the transcripts generated by Zoom[37] after the study. They also anonymised the participants' information.

5.2 Participants

Due to the epidemic, I did not get to know many markers and academics during my MSc studies. My project supervisor Cristina, as an academic, helped me to find participants among her colleagues. My development also included a student's interfaces. However, as I am not very good with Facebook[19], I recruited some participants from the WeChat[34](which is used as the main social media platform for students from China) group of Chinese students. In the end, with the help of Cristina, we were able to invite a total of 4 academics, 6 markers and 6 students(see table 5.1). Among these participants, academic had more work experience than markers. In the following sections, I used A1-A4 to represent the 4 academics, M1-M6 to represent 6 markers, and S1-S6 to represent 6 students.

Participants	Role	Participated Meeting
A1-A3	Academic	Academics Group Study
A4	Academic	Academics Individual Study
M1-M4	Marker	Marker Group Study 1
M5-M6	Marker	Marker Group Study 2
S1-S6	Student	Student Group Study

Table 5.1: Participants Information

5.3 Materials

I have prepared three different Participants Information Sheets(see Appendix E.1) for three different roles of participants. In the PIS I introduced the participants to the reasons and process of this study as well as the potential risks and benefits they will encounter if they participate. At the end they were given an introduction to the data protection measures in the study. Then I send each of them a Participant Consent

Form(see Appendix E.2) to sign for their consent to participate. Once the evaluation has started, different roles of participants will be given different sets of tasks(see Appendix E.3) to complete in advance. These tasks are designed based on all the functions I have implemented. They are intended to give the participants a good understanding of the project so that they can perform better in the later stages of the study. I also assign tasks to academics on the student's interfaces to get ideas and suggestions from academics on the student's interfaces. In the one-to-one semi-structured interview or Focus Group discussion, three different sets of questions(see Appendix E.4) are prepared for three different roles of participants. These questions will first include some general questions based on the system and detailed questions based on each feature. Finally ask how they feel the project will affect them in the future. Finally, different roles of participant will also receive three different sets of questionnaires(see Appendix E.5). The questionnaire will include ten questions from SUS and future impact of each function I implemented.

5.4 Protocol

As the project has been split into two parts, I and another student in the project, Sun Xiaofei, evaluated our own development successively. But I am the only one responsible for the development of the student's interfaces, so I will conduct the study with students by myself. Each of our studies lasts about half an hour each, each meeting takes one hour in total for both myself and Xiaofei's study. I will ask the participants at the beginning of the meeting if they all agree to record the meeting. If they all agree, I will ask Xiaofei to turn on the recording. And before we start we need to check with all participants that they know about the consent form and have filled it out and sent it to me. If not, they will be asked to send it to me after the meeting. I would then introduce them to MarkEd and what they would need to do for the next hour. Xiaofei and I will take note for each other's study process. During each of our study, regardless of the method, the approximate process was to first complete the tasks I had prepared in advance, fill in the questionnaires and answer the questions prepared in advance.

5.5 Data Analysis

When all the studies were over, as I was in China, I could not hold any audio or video recordings of the research process. So Cristina and Xiaofei anonymised the transcript

automatically generated by Zoom[37] and forwarded it to me. I used this transcript and the notes taken during the research to conduct a thematic analysis. During the analysis, I use a mixture of top-down and bottom-up methods(result shown in figure 5.1). The features I have implemented is used as the top themes(top-down), then the transcript and notes are analysed to produce sub-themes(bottom-up), and finally the SUS questionnaire and impact questions are used to obtain a usability score.

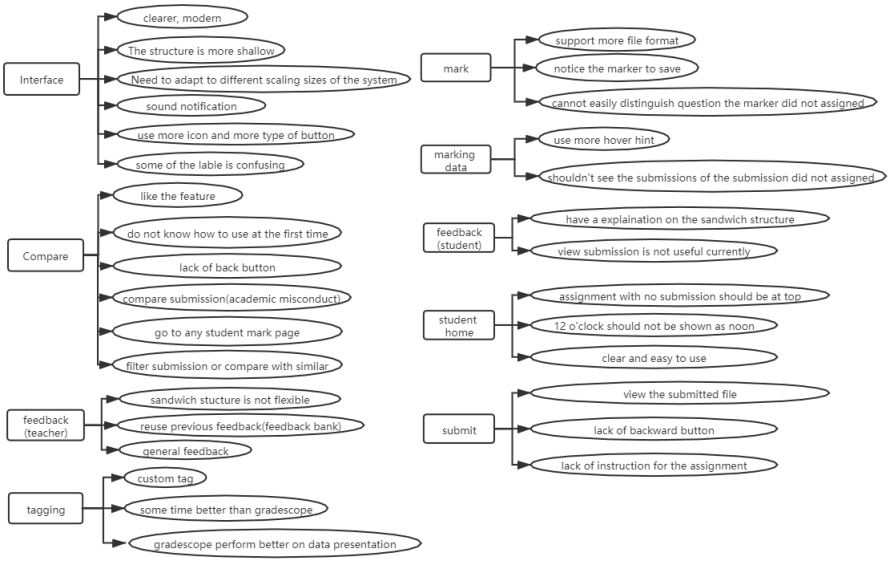

Figure 5.1: Data Analysis Themes and Subthemes

5.6 Results

Interface Design : I received very positive comments on this section of the GUI design. All participants said that the interface was very clear and modern, and M5 felt that the depth of the hierarchy was shallower than Learn[16], which allowed him to find what he was looking for more quickly.*"The hierarchy is lower than before. Because if I want to mark with Learn, then I guess, we have to first jump in the course and then jump in some specific major and then specific student and then specific question." –M5.* However, for some laptop users (S4 and M3), the default display scale ratio on their system is 125%. This causes some elements of the page to be larger than others see. This results in them having to scroll horizontally to see all the information when looking at some tables. A4 gave me a lot of suggestions. She suggested that to give the user an audible prompt when complete some tasks, add icons to some buttons to prompt the user and change the naming of some labels to reduce confusion.

Teacher's Interfaces : For the Marking Data page, A4 feels that some users will not read the legend in the top left corner. The user should be prompted what the tag is when they place their mouse over it. M5 feels that markers should not see some submissions in the marking data that he has not been assigned. This is inconsistent with what I had in mind when I designed it and the previous design by Andrius[45]. Further research is needed on whether this can be seen or academic should be setting this feature up. For the mark page, M2 thinks I need to support more types of marking. *"This tool seems to assume that all of this is mark question by question and you give a certain number of points for each one. That is going to not work for any holistic or criteria based marking." –M2.* M2 also felt that the system did not give a hint of whether the marking had been saved successfully. M6 also felt that the user should be given a hint when the marking needed to be saved. M5 thought it would be difficult for him to distinguish the disabled questions. For feedback, almost all participants felt that the sandwich structure would help them to rate. However, M3 believes that not all marking require such a structure like simple feedback. Sometimes the feedback was so repetitive that he did not want to write the same feedback many times over. Similar suggestions have also been made by M5 and A4.*"Actually, do you have anything like where it can give a general feedback for specific question? It is really useful, especially if a student has done well, it will be much easier for the marker to just say great. It saves time instead of having to write something that exists in every question." –M4.* For the tag system, almost all participants agreed that it was a good idea, but there were still some features that needed to be added. A1 felt that academics need to be able to filter the table on the marking data page to quickly capture all submissions tagged as moderate. M6 thought we needed to add some customisation to allow the user to add their own tag, for example a submission that was not completed marking at the moment which he would like to see later. Everyone found the comparison function very useful. A4 did not understand the usefulness of this function at first, but after using it, they understood and liked it. *"It was very clear. It was good. It was easy to read, and it would be quite quick to go through the marking and to be able to compare." –A3.*. But this is only the most basic comparison function, more needs to be developed. A1 and M3 felt that the process of comparing the two submissions required a similarity check in order for them to determine whether academic misconduct existed between the two submission. M5 believes that the submission pool can be filtered when selecting submissions for comparison, for example by filtering out submissions with similar scores. *"With only three records is quite easy to find it, but I was wondering if*

there is hundreds of submissions." –M5. A2 thought the Compare page lacked a return key to return to the marking page before their comparison. Moreover, M5 thinks he needs a button for each of the two compare submissions to redirect to the corresponding marking page.

Student's Interfaces : For the student side of the homepage, all students agreed that the system would help them submit assignments and view marks and feedback more quickly. S1 thinks that assignments that have not been submitted should be placed at the top of the table. For the feedback page, S2 felt that the system should explain the sandwich structure, however, M5 felt that the feedback received by the students should not show the sandwich structure and just stitch it together into a whole feedback paragraph. S1 felt that the box to show all the submitted files was not necessary, because there is no information in it. When submitting assignments, S5 thinks I need to add a back button in the page. S4 thinks there should be a description of each assignment and a marking criteria*." I think we need a button to see which is submitted, or which is marking now, and I think we should have a button to see what I submitted before." ——S1.* S1 thinks they should be able to see their previous attempts after submitting the assignment.

System Usability Scale : In the figure 5.2. The average score given by the 4 academics was 72.5 (GOOD). Two questions' answers were lower than expected. The majority of academics were lacking confidence about the project, which may be due to the fact that our system is not yet fully developed. Academics also thought that the learning costs of the project would be high, which may also be due to the fact that we do not have a good help system and also there are usability issue. The average score given by the 6 markers was similar to that of the academics (72.92), also GOOD. M2 gave a total score of 40 to my implementation which is extremely low. I think it is because the system was not fully developed which did not match what his expectations. The score given by the 6 students was high, with an average score of 90. This may because there were no obvious problems due to the small number of features. To summary, the overall average score is at the GOOD level. Although the final results are very positive, the sample is not very large and there are some outliers in the sample. A large number of participants involved in future evaluation will still be needed to obtain more accurate results.

Future Impact : In order to be able to capture quantitative user perceptions of future impact, a series of different questions were prepared here for participants in different capacities. Each question is on a 5-point scale. From one to five correspond to five

Participant	A1	A2	A3	A4	M1	M2	M3	M4	M5	M6	S1	S2	S3	S4	S5	S6
SUS	52.5	80	62.5	95	62.5	40	87.5	82.5	87.5	77.5	97.5	100	87.5	70	87.5	97.5

Table 5.2: SUS Score For Each Participant

Roles	Samples	Avg	Mid	Std	Max	Min
All	16	72.75	85	17.39	100	40
Academics	4	72.5	71.25	18.82	95	52.5
Markers	6	72.92	80	18.60	87.5	40
Students	6	90	92.5	11.18	100	70

Table 5.3: SUS Score Summary

ratings from very unhelpful to very helpful. The result is shown in table 5.4. For academics, A4 felt that this system is very helpful in saving her time, while others felt it would be somewhat helpful. All academics felt that this would help slightly in ensuring fairness. A1 felt that this would not help him in reducing errors, while the others felt that it would help. All academics felt my development would help them to moderate their marking and three of them felt it would be very helpful. For the markers, all but M2 thought that my development would help them save time slightly. All felt that my development helped them to ensure that the marking was fair and two of them found it very helpful. All markers except M2 thought that they could reduce the number of errors by using my development, while M2 thought that it did not help at all. All felt that they were able to seek help more easily and two of them found it very easy. The student impact questions' results remain very high. All agreed that the project would help them save time, reduce errors and make it easier to submit assignments, check marks and give feedback.

Impact on	Role	Samples	Avg	Median
Time Saving	All	16	3.8	4
Marking Fairness	Academics&Markers	10	4	4
Prevent Error	All	16	3.3	3
Ask for assistance	Markers	6	4	4
Moderate Marking	Academics	4	4.5	5
Submitting Assignments	Student	6	4.8	5
Checking Score	Student	6	4.5	4.5
Viewing Feedback	Student	6	4.7	5

Table 5.4: Impact Question Results

Chapter 6

Conclusion, Discussion, Future Work

Conclusion : During this project, I developed all of MarkEd's pages about student side, teacher's homepage and marking related pages based on Andrius' design[45] and some modification proposed by Chris[41] and Hamdani[38]. In the process, I first researched their articles to get a thorough understanding of MarkEd. The first iteration was then developed based on Andrius' design. My project supervisor Cristina evaluated and suggested improvements based on this first iteration. I then further developed the pages based on my supervisor's suggestions and the features of Chris and Hamdani's design which had had good evaluation results. Finally, academics, markers and students were brought together to evaluate the project. In summary, this paper addressed the following research questions, which were mentioned in section 1.2.2:
$\{RQ1\}$: Addressed in 4.1. Firstly, I chose Django[33], a more mature web development framework with more APIs and lower maintenance costs. Django uses Python[36] to develop which is more flexible and easier to develop. Therefore, Django was a good choice for us to develop this project. Among most of the front-end tools on the market, I chose the better looking and more mature Bootstrap[2] as the front-end development tool for my project. For data management, MySQL[22] is the choice of most companies and developers due to its low requirements and high performance.
$\{RQ2\}$: Addressed in 4.2.3. Because of the great variety of data, we used a large number of tables in our databases to hold data. When I want to present information to the user on a page, for example all the submissions for an assignment, I need to extract the information I need from a number of tables and then algorithmically organise them into a table that the user can see clearly based on the relationship held in each table of the database. On the back end, I get the data and collate it into an object and I can process the data in the back end, for example I need to show "-" when a property value

is empty. Each object then corresponds to each row of the table in the front-end. This way the front-end only has to display the objects passed in from the back-end one by one when displaying the table. This reduces the difficulty of displaying on the front end and reduces the difficulty of processing the data on the back end.

{*RQ3*}*:* Addressed in 4.3.5. During the first iteration(see section 4.2), Firstly I implement the interfaces from Andrius's[45] Figma design and ensure system consistency by using Boostrap to unify the design language across the pages. By adding animations to each card, such as the collapse effect in the marking page, adds a modern feel to the interface. During the second iteration(see section **??**), I implemented the interface from Chris's[41] and Hamdani's[38] Figma design. I also studied current design trends to add the proper shadows to the interface to improve the sense of hierarchy which is not present in the original Bootstrap.

{*RQ4*}*:* Addressed in 4.2. Security is one of the most basic requirements for a good system. I have been very concerned with the design of the security of the system. First of all, from registration page, users are asked to verify their email address via email. All information entered by the user is checked for validity, e.g. whether the user already exists. As there are two sides to the system, students can only access the student side and teachers can only access the teacher side, and users can change the URL to access all pages. So on all pages I have added a login information check to ensure that the user cannot access the pages that his permissions disallow.

{*RQ5*}*:* Addressed in 5.6. With the help of Cristina, my project supervisor, I gathered a total of four academics, six markers and six students for the final evaluation. I used thematic analysis and SUS to obtain the results of the assessment. In general, almost all users found the front-end of my development to be clear and modern. During the evaluation the participants found some important features missing in terms of usability and gave many constructive suggestions. The final result in terms of SUS scores was GOOD, although the scores given by the students were extremely high, I still got a GOOD result in academics and markers. However, as the number of participants was not large and the variety of nationalities of the students was not large, more evaluation of my development will be needed in the future.

{*RQ6*}*:* Addressed in 5.6. Overall, with the exception of M2 almost all participants found the system to be somewhat helpful in all aspects to save them time. All markers and academics who participated felt that it helped them to ensure fair marking and four found it very helpful. Half of the participants felt that my development would help them to reduce errors in their future work and studies. Other features such as

revising marks, requesting help, submitting assignments, viewing feedback etc. were also found as helpful by all the participants.

Challenges : The most serious challenge we face today is the epidemic. All meetings with my supervisor became online. Because of the epidemic, I finished my MSc project in China. This prevented me from conducting face-to-face research with the participants in the evaluation and I was not allowed to have access to audio and video recordings of the research process after completion. Although this caused me a lot of frustration, the data analysis went smoothly with the help of Cristina and Xiaofei. Since the courses were all taught online this year. I didn't get to know many academics and markers during the MSc teaching. this resulted in me not having any contact details of teachers I knew to contact. As I am currently in China, accessing and using Facebook[19] became difficult. I ended up having to recruit participants from the WeChat[34] group of Chinese students.

Since I had a lot of experience developing websites before, development was relatively easy for me. But I had never deployed a server before, so the most challenging part for me was deploying my implementation to the server. Firstly I wasted a lot of time deploying the server on Windows. It was only after I had finished deploying that I realised that my IP address was not accessible to the external network. Then when I was using Google Cloud[9], I had a lot of difficulty connecting to the google server as I was in China. Luckily, I was able to choose the right server management tool for the deployment.

Limitations : Due to time constraints, some tasks were not completed as planned. My original plan was to have a formative evaluation in between iterations to help me develop the second iteration. I only had two months to complete the project. But it took two weeks as I waited for the school Ethics Committee to approve my study documents. I didn't have time to apply for another evaluation. Therefore, I conducted one evaluation in the end.

The final evaluation had a total of 16 participants, of which the results showed some outliers, so more evaluation will be needed in the future to obtain more accurate results. Although the total number of participants was small, it would have taken over 8 hours to conduct a one-to-one evaluation of all the participants. Therefore, due to time constraints, we were only able to conduct co-operative evaluation for most of the people. This resulted in us not collecting detailed enough information from users like if we had been using Think Aloud or observations from face-to-face studies.

Skills Acquired : Through this project, I learnt a lot about front-end design, such

as the use of animations, the use of shadows, etc, because in the previous learning process, we only cared about the implementation of the functionality and never considered the user's experience. During the development process, I learnt how to secure the system through password encryption(see section 4.2), the use of sessions, POST methods[46] and so on. During the deployment process, I learnt how to use Ubuntu[31] and Nginx[23] as I had never deployed a server before. For the final evaluation phase, I have always used the Think Aloud(see section 2.3) method in previous courses. During this project, I also learnt how to collect data during the evaluation using the co-operative evaluation(see section 2.3) and Focus Group(see section 2.3) methods.

Future Work : Firstly, for the front-end design, I have only considered the style, animation and shadows of the individual components here. However, the colour scheme is also very important for a good front-end. For example by using different colours in the same shade to give the user a more comfortable feeling. As far as the security of the system is concerned, although I have developed many features for security, this is not enough. In the future more security features could be added, such as SSL and HTTPS. This enables the encryption of data transmitted over the network. The user's data is also protected by checksumming. For development, the current development can only perform the most basic marking functions. More features are yet to be developed. During the evaluation, the participants gave a lot of very useful advice. Maybe I will start by implementing the anchor assignment function first in the future because I didn't finish the Anchor and Compare function(see section 2.1.2 and 4.3.3) designed by Chris[41] due to the time constraint and many participants involved in the evaluation suggested this idea. In the future someone could build on these suggestions and other good features in Chris and Hamdani's[38] paper to complete the functionalities. For the evaluation, 16 participants was not enough. In the future I hope more participants can be recruited to conduct more evaluations. I also hope that the epidemic will end sooner so that more face-to-face evaluations can be conducted to get more accurate and detailed results.

In the future, I also hope that our development will be able to access data from the University of Edinburgh for more practical application-based development. If things go well, I hope that our development will be adopted by the University of Edinburgh for practical use in the teaching process. If we receive good feedback from the use of the system at Edinburgh University, I hope to expand our system to more institutions.

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Appendix A

Andrius's Original Design

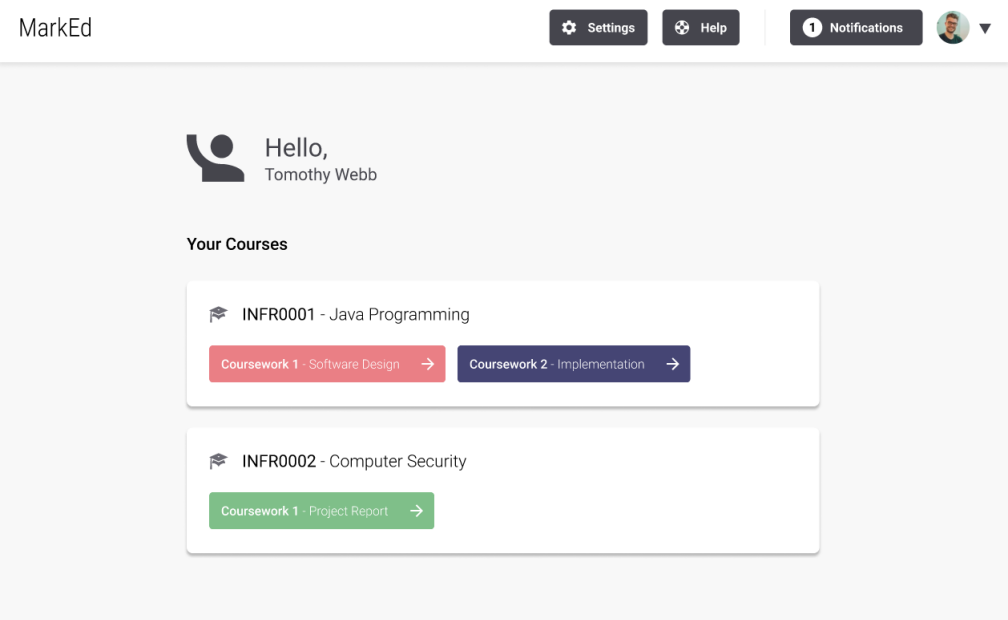

Figure A.1: Home page

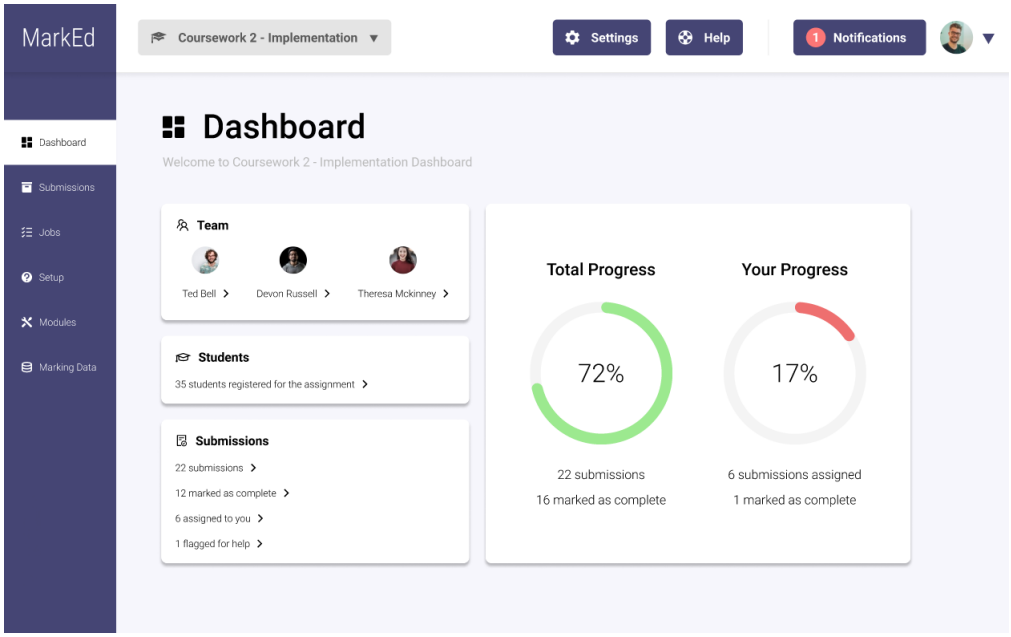

Figure A.2: Dashboard Page

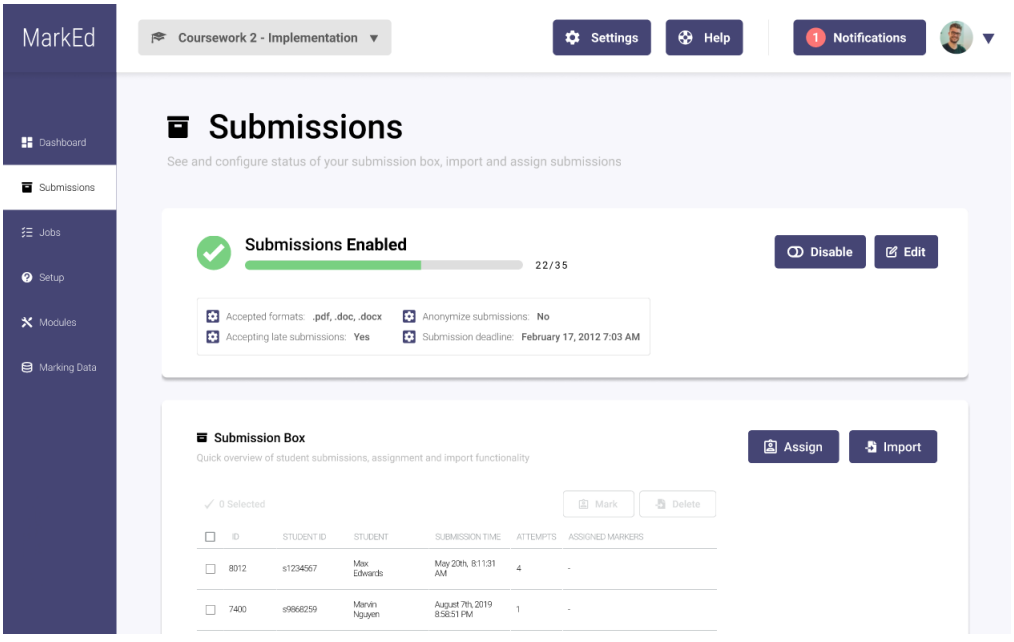

Figure A.3: Submissions Page

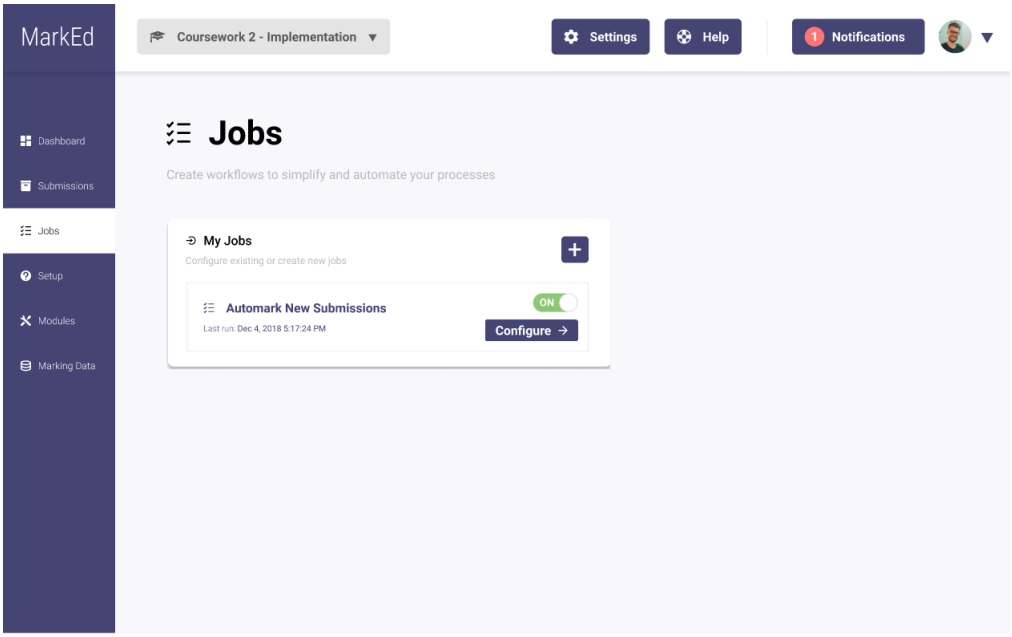

Figure A.4: Jobs Page

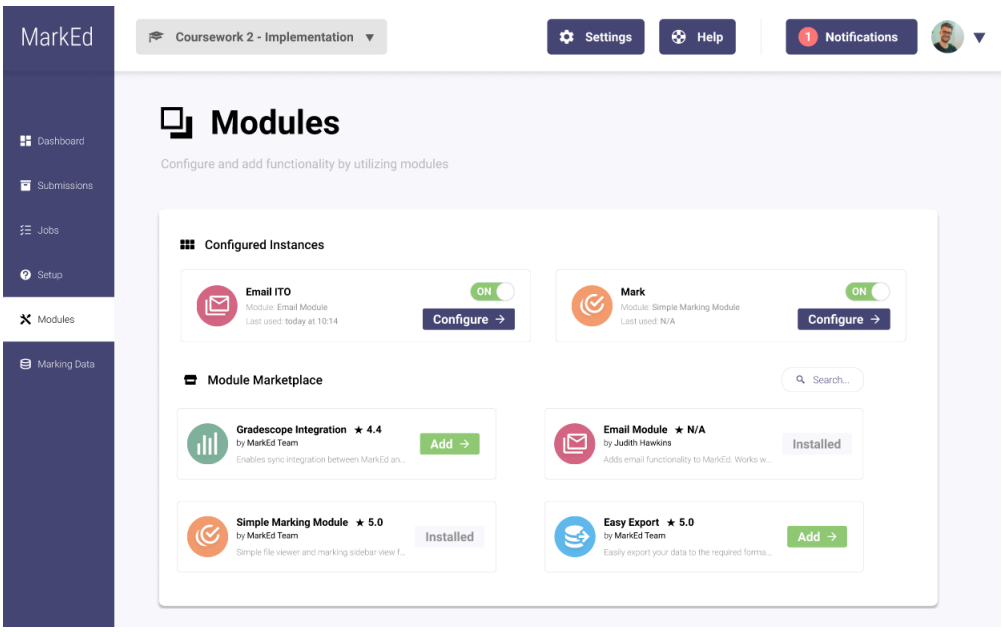

Figure A.5: Modules Page

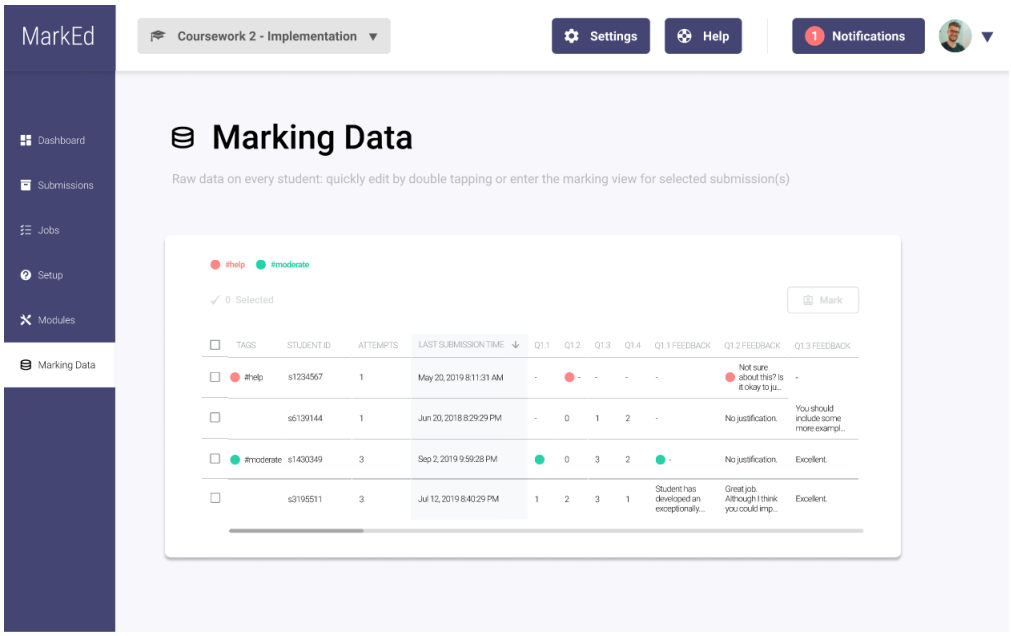

Figure A.6: Maring Data Page

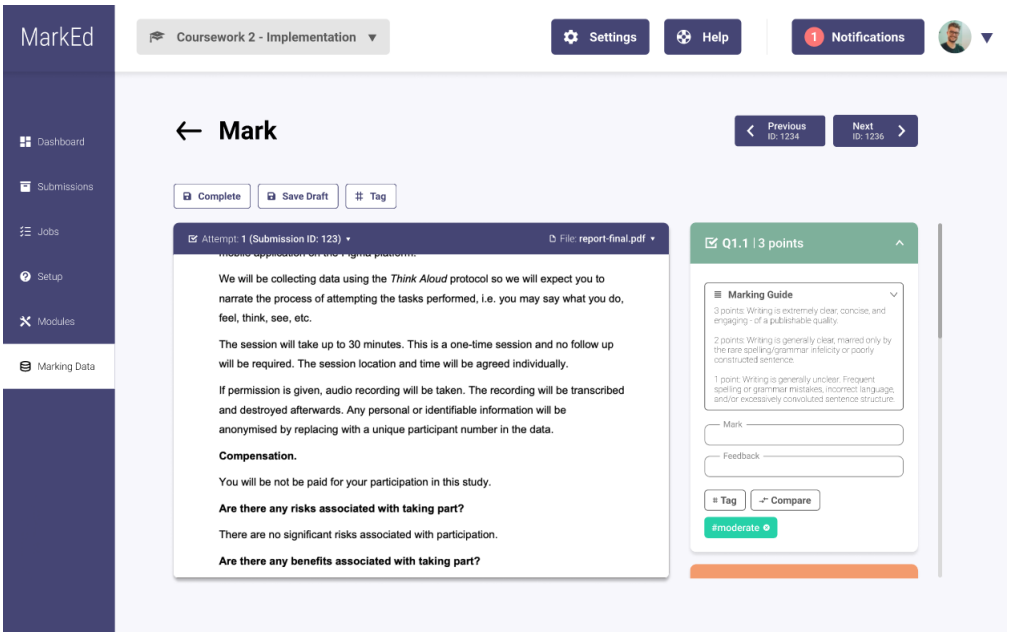

Figure A.7: Mark Page

Appendix B

Chris's Improvement

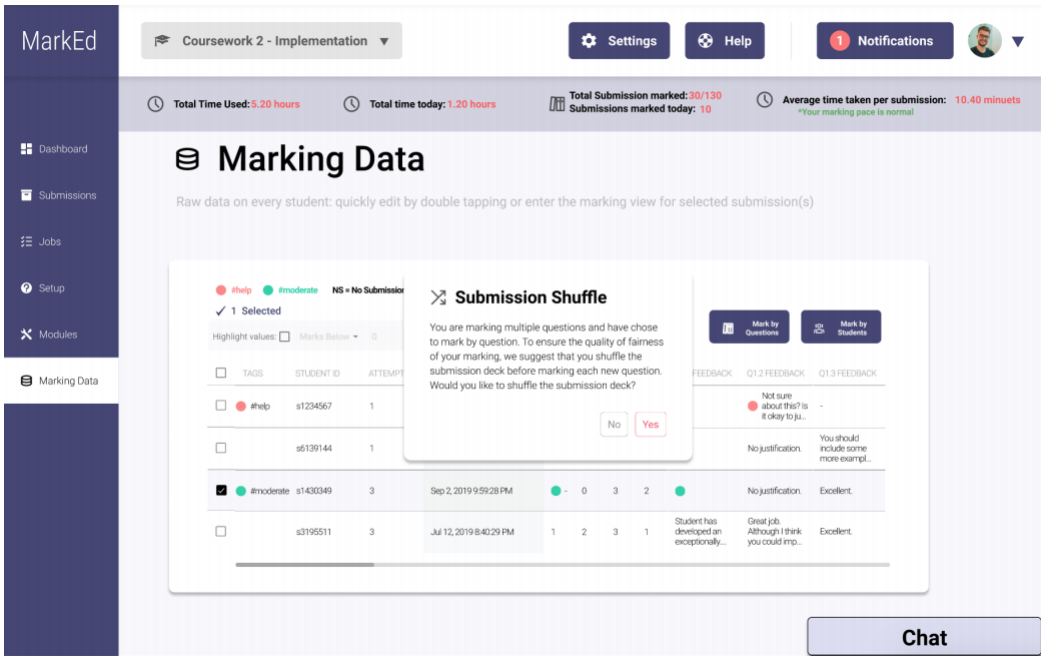

Figure B.1: Shuffle Submissions

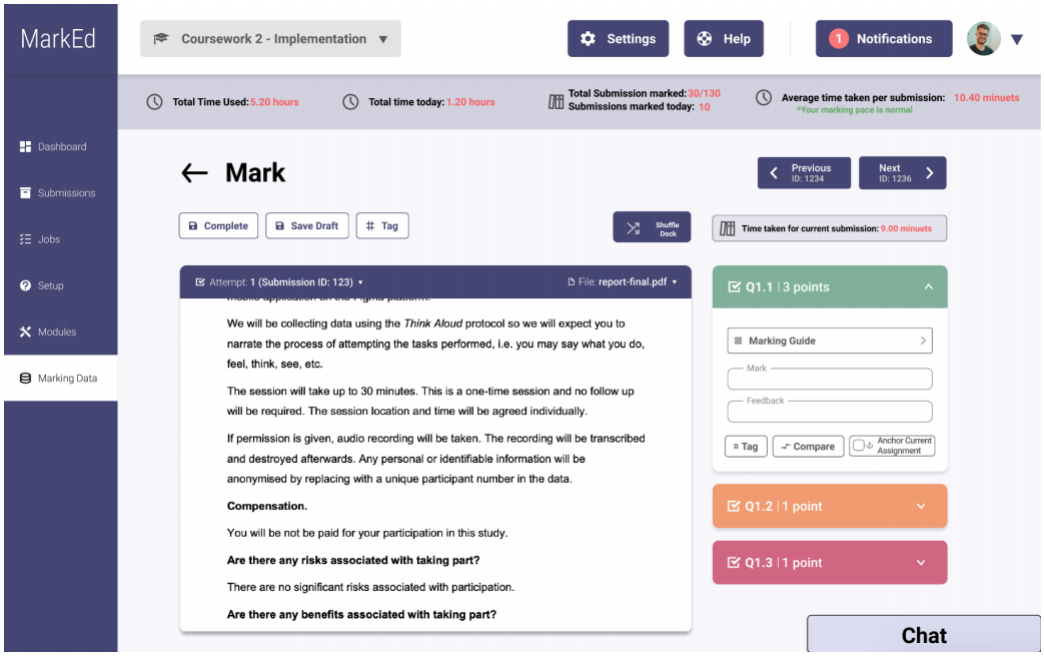

Figure B.2: Shuffle Submissions result

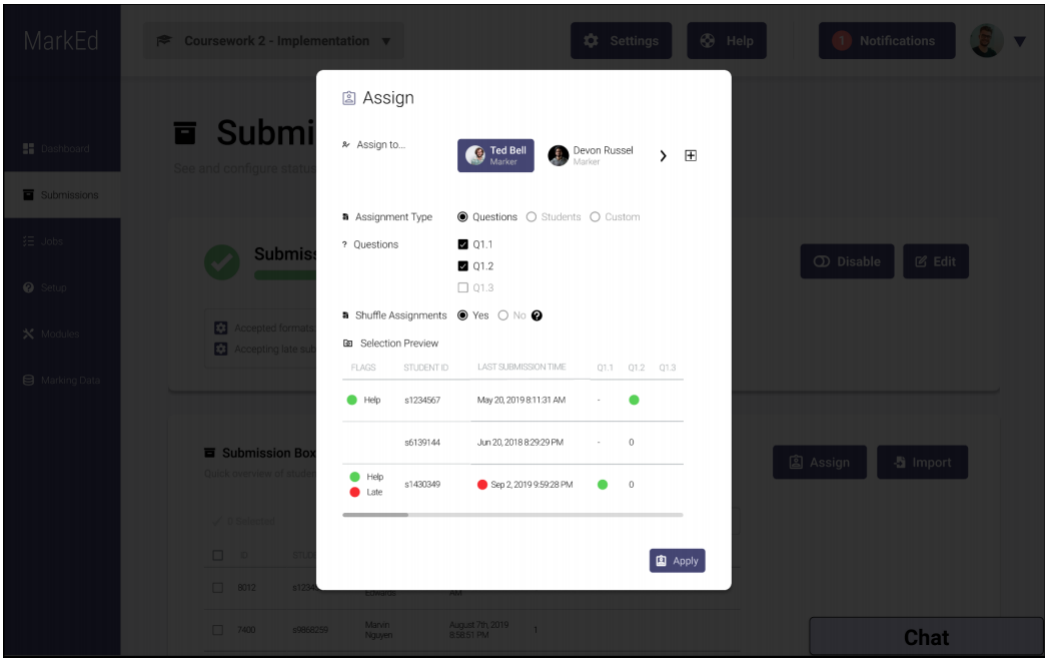

Figure B.3: Double Marking

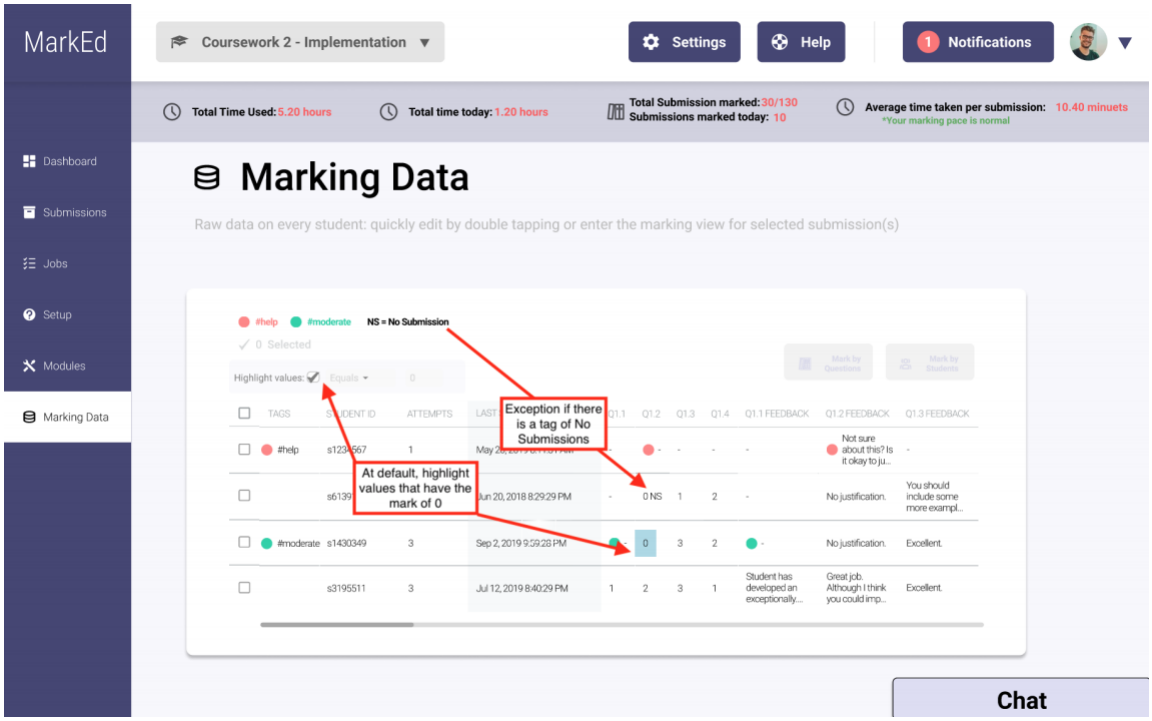

Figure B.4: Marking Review

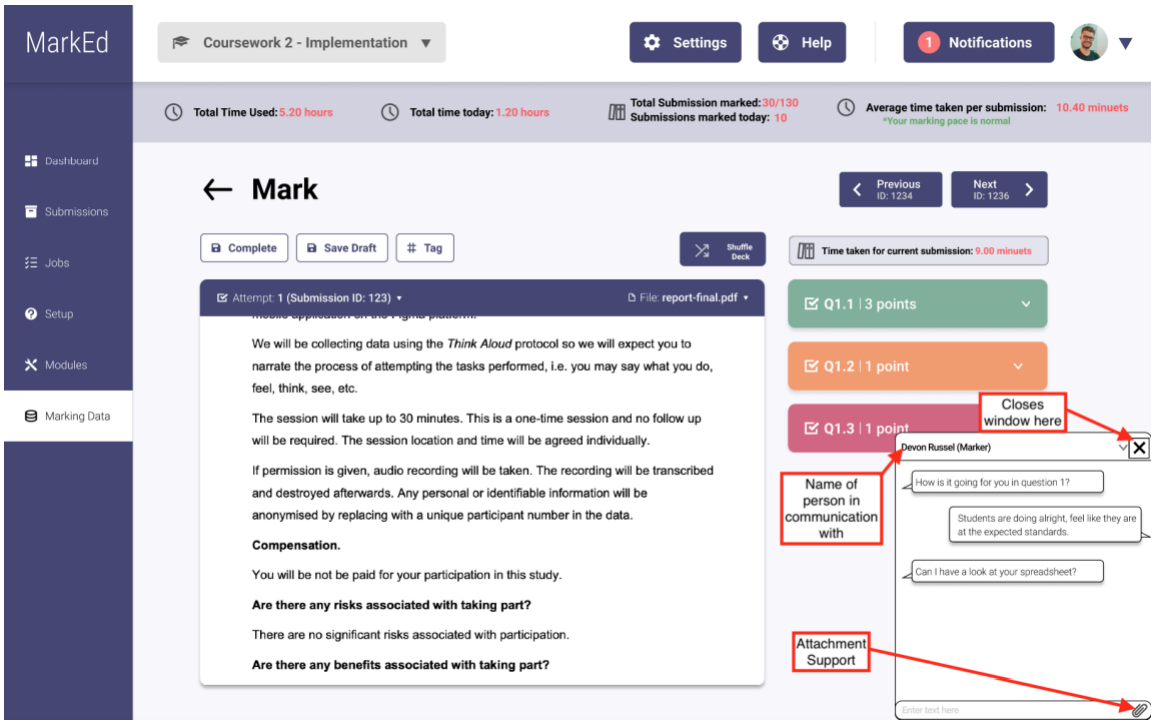

Figure B.5: Chat Box

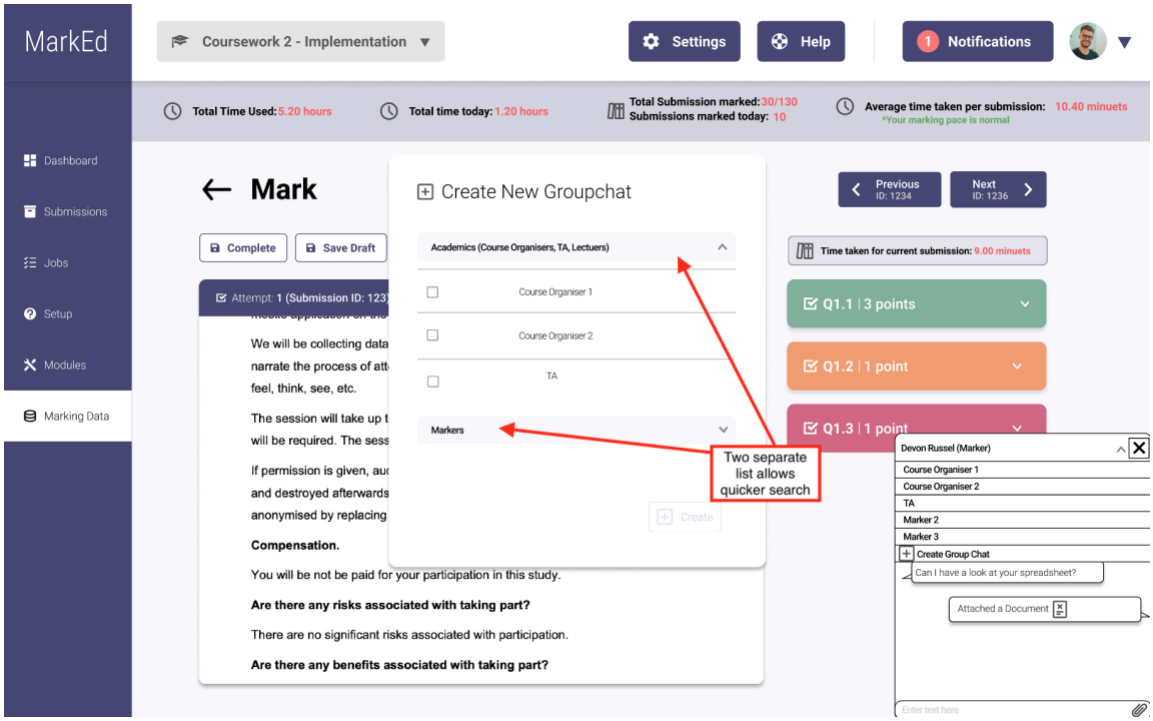

Figure B.6: Create Chat Group

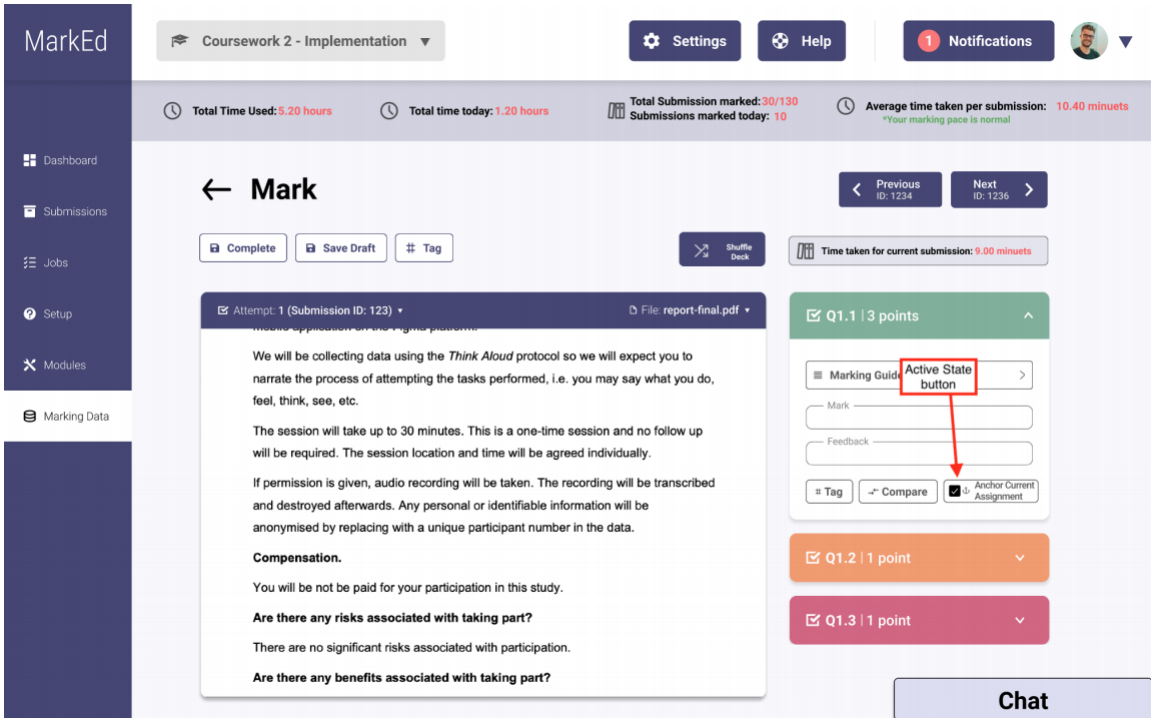

Figure B.7: Anchor Question

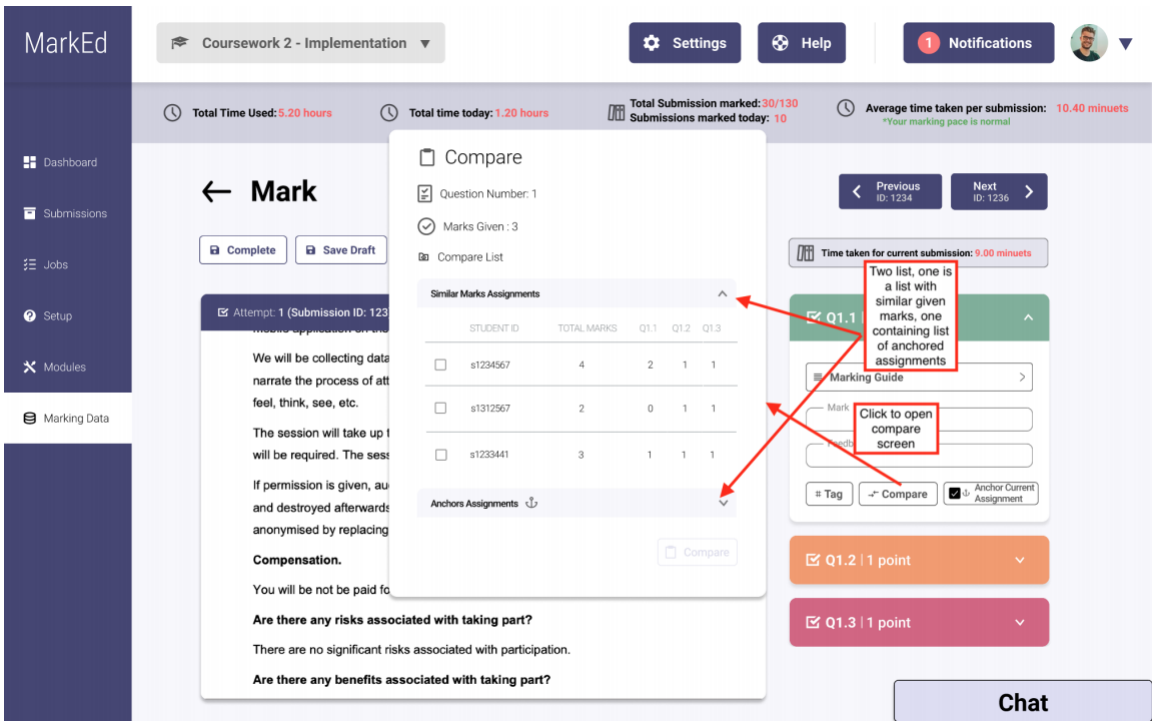

Figure B.8: Choose Compare Submission

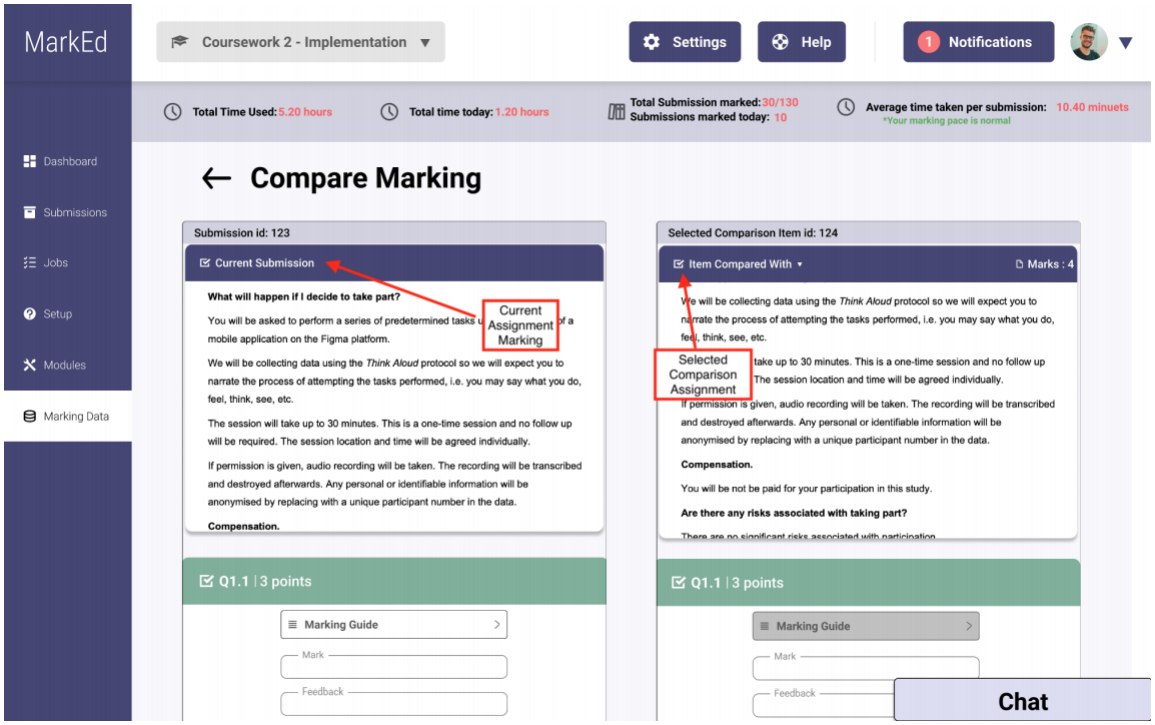

Figure B.9: Compare Page

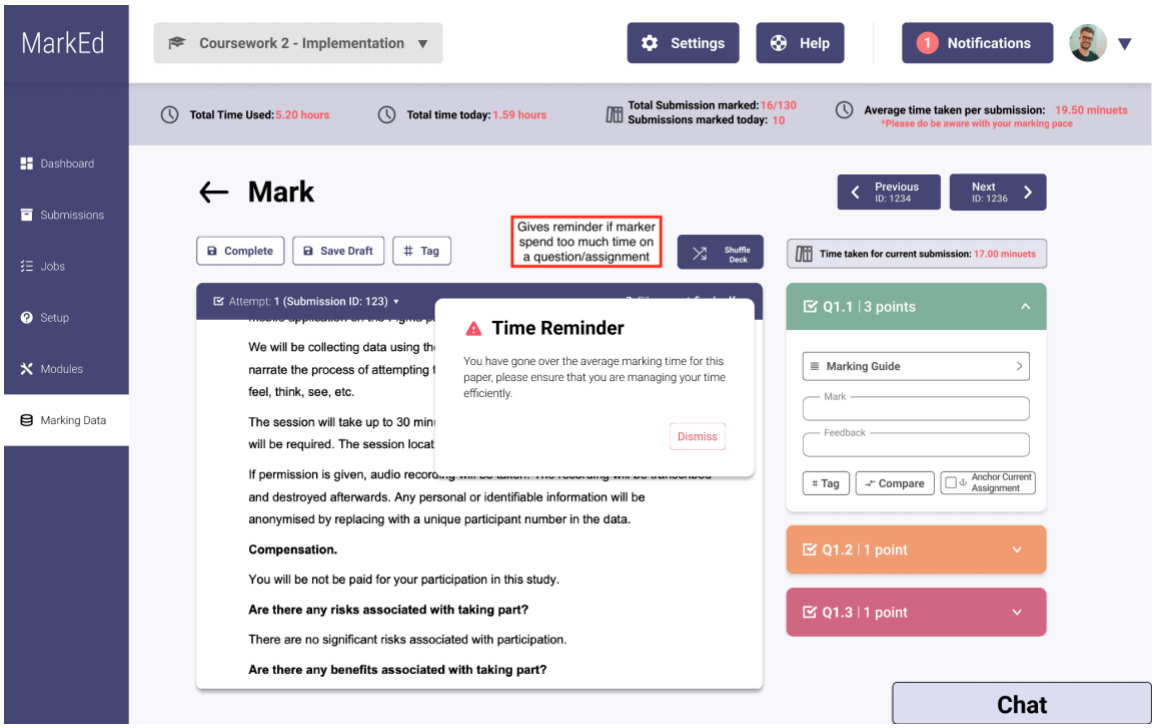

Figure B.10: Timer

Appendix C

Hamdani's Improvement

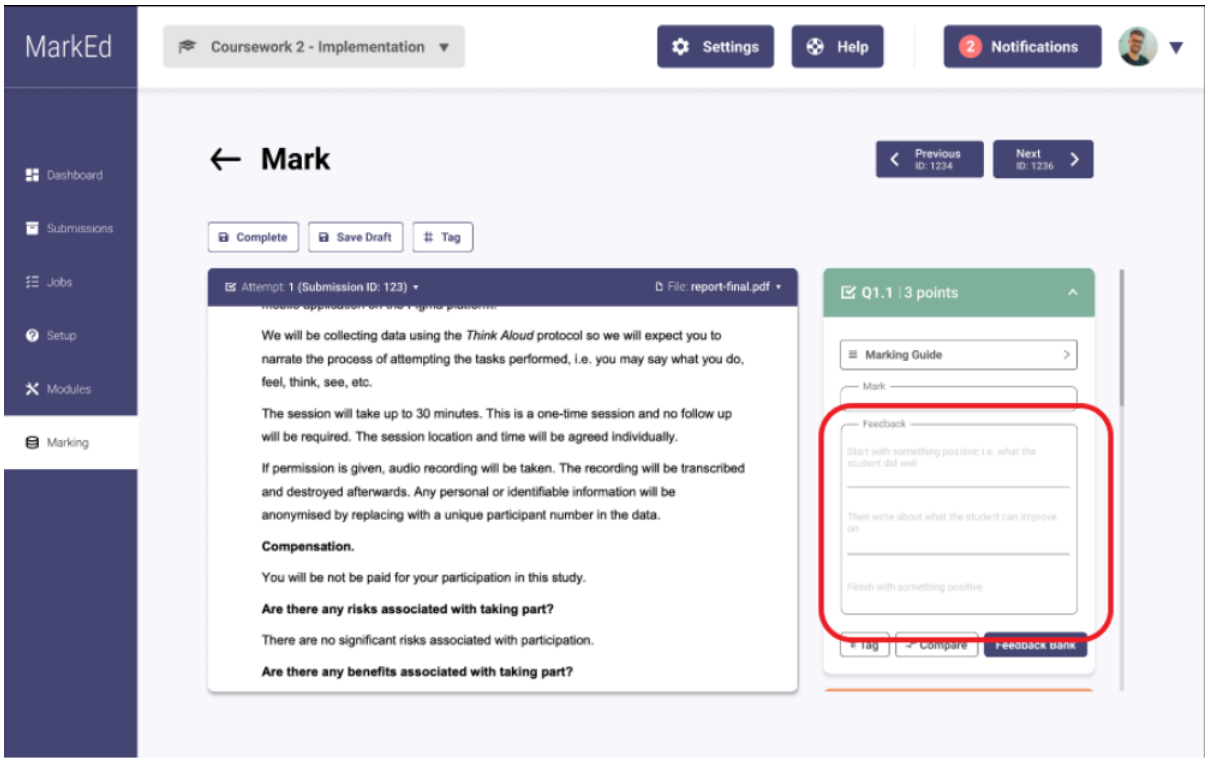

Figure C.1: Feedback Sandwich

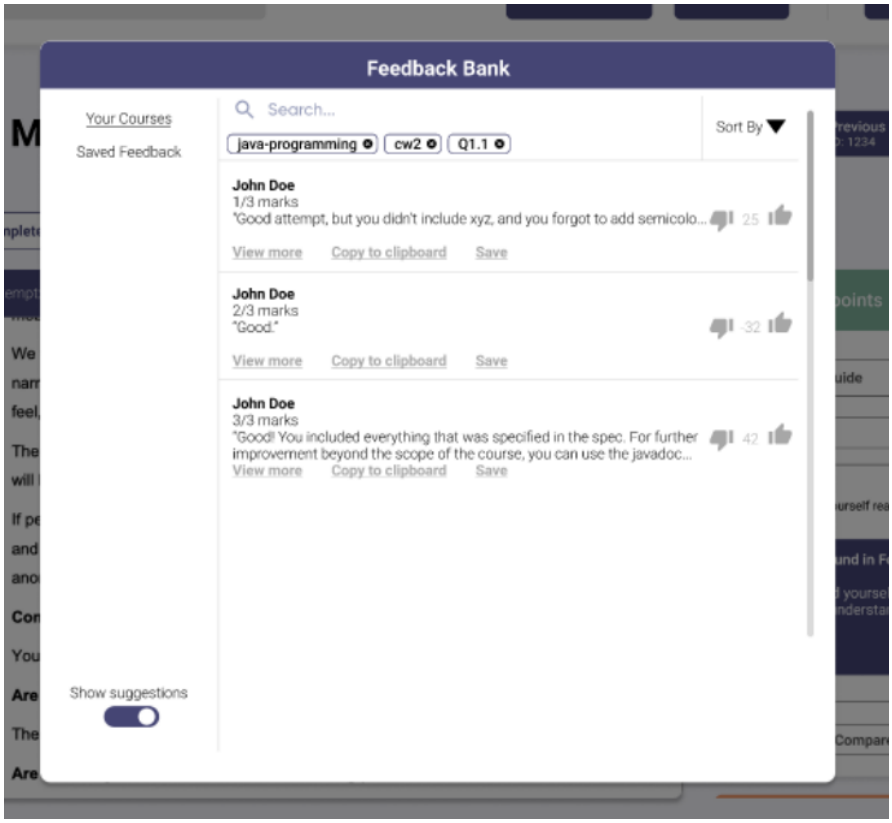

Figure C.2: Feedback Bank

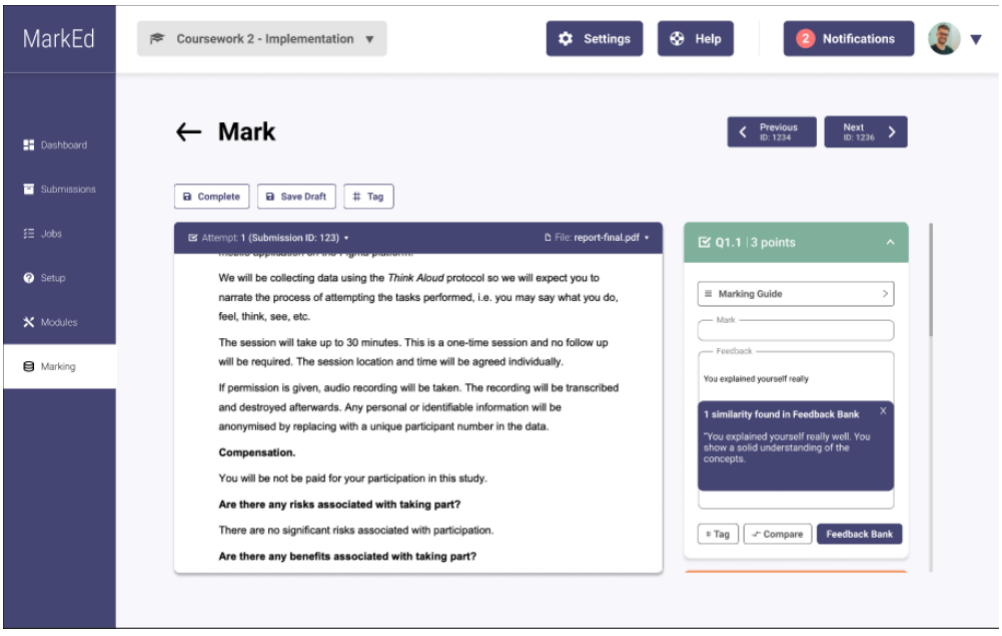

Figure C.3: Auto Feedback

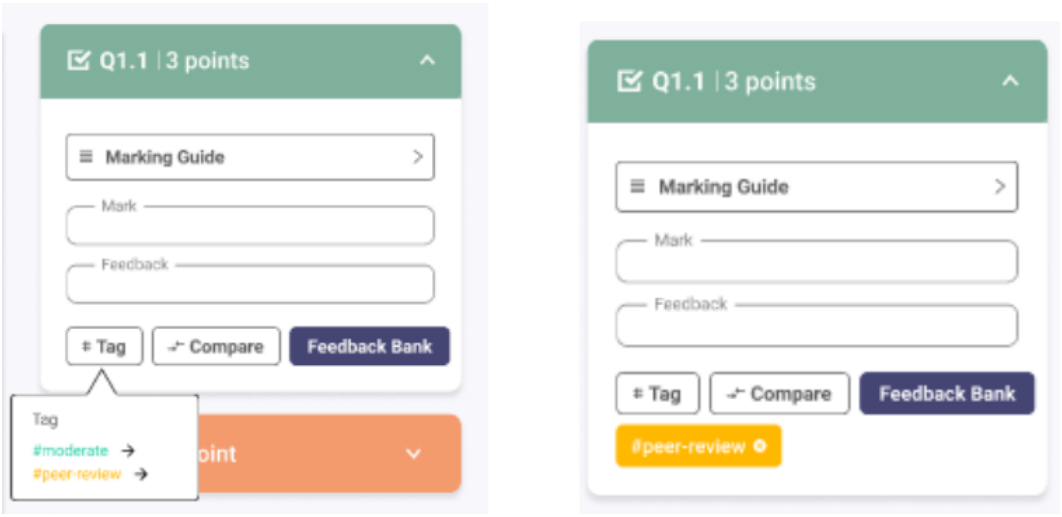

Figure C.4: Tagging System

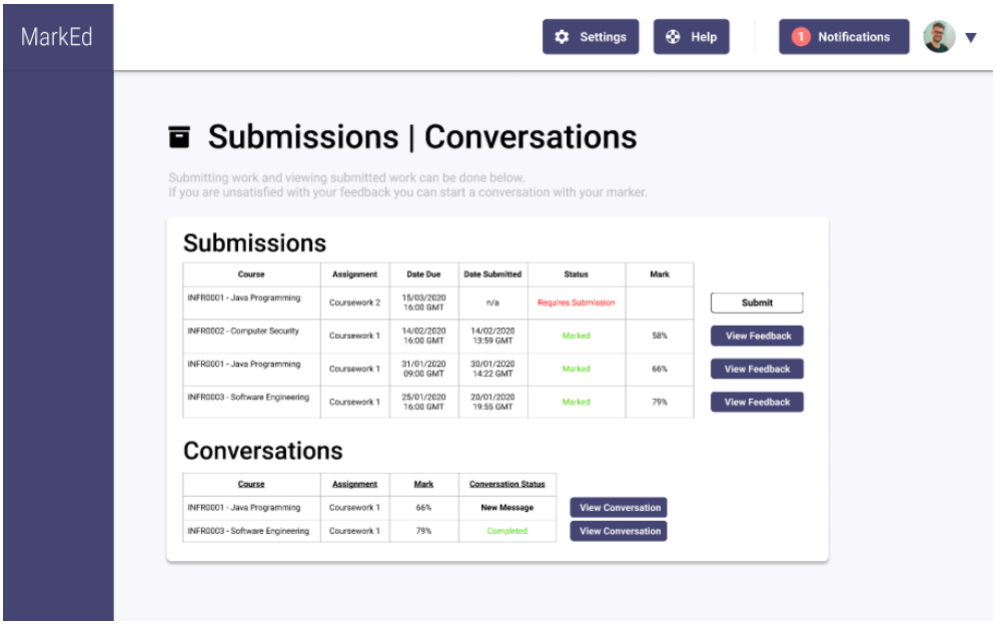

Figure C.5: Student Homepage

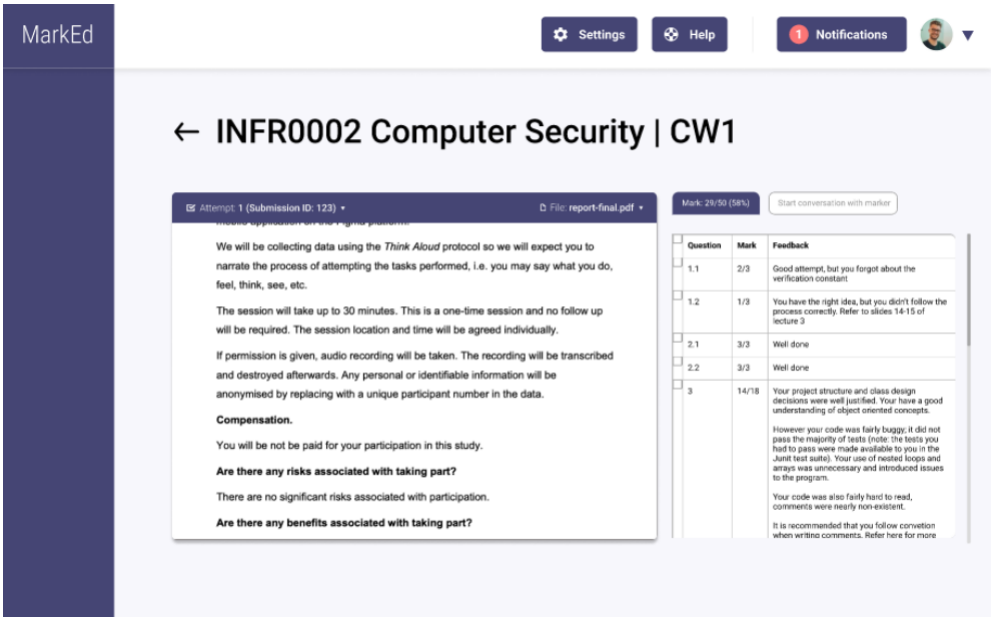

Figure C.6: Student View Feedback Page

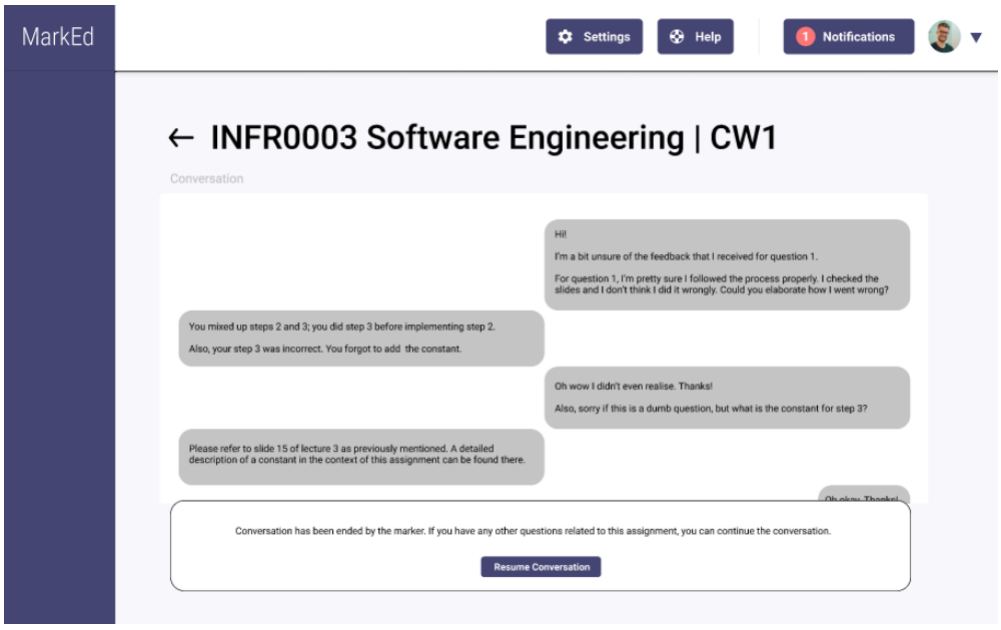

Figure C.7: Chat System

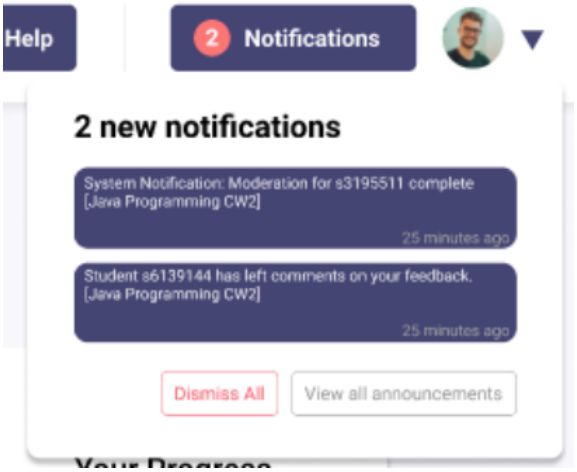

Figure C.8: Notification

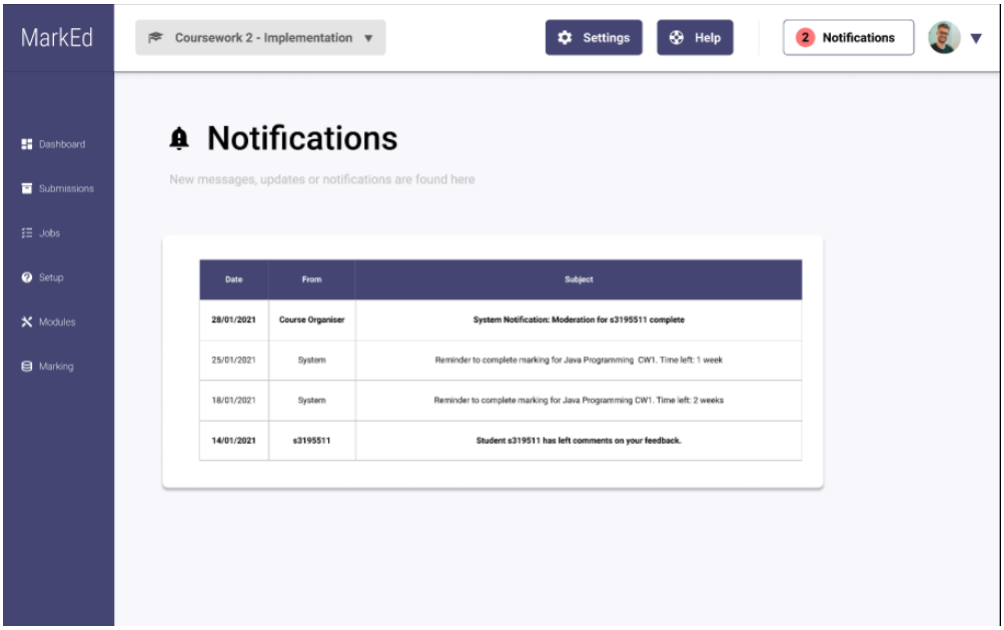

Figure C.9: View All Notifications

Appendix D

My design

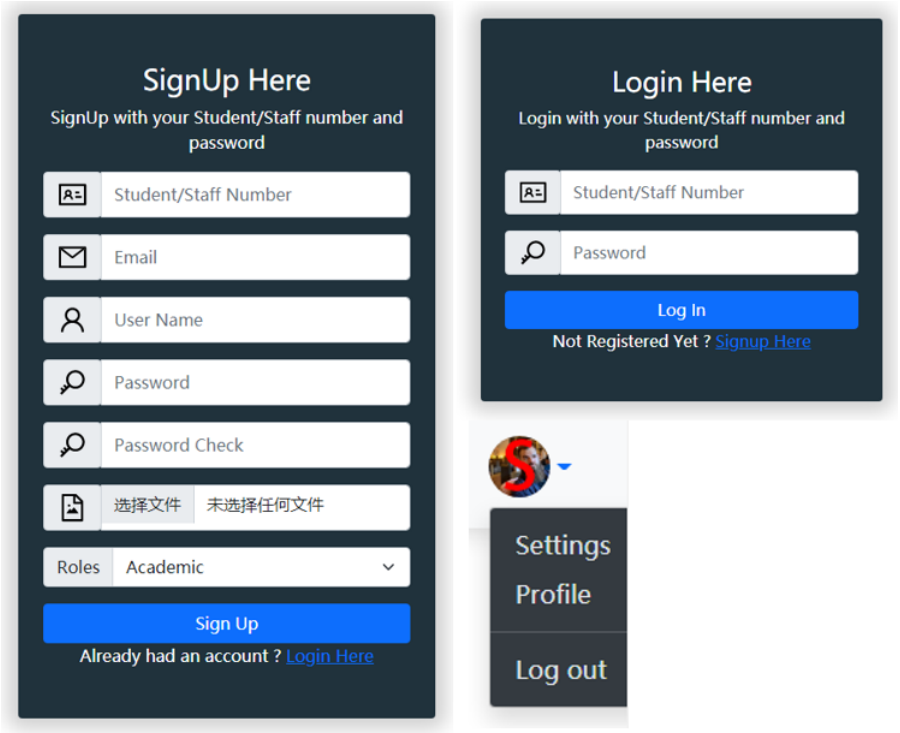

Figure D.1: SignUp, Login and Logout

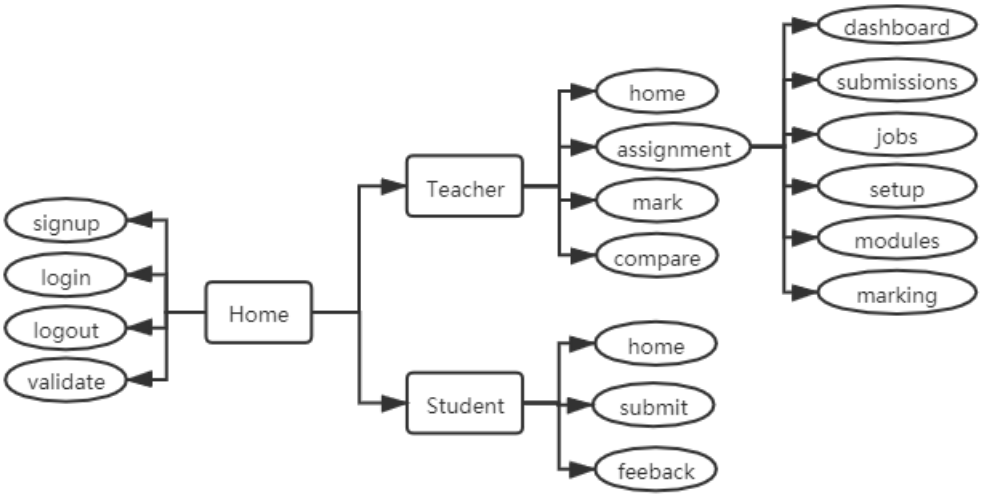

Figure D.2: Router Desgin

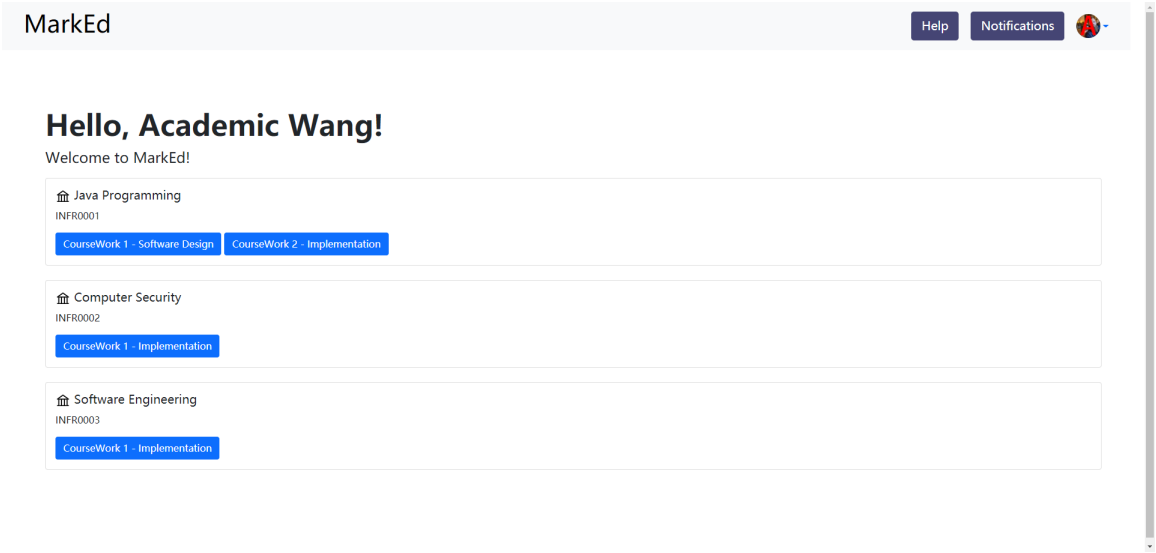

Figure D.3: Teacher's Home Page

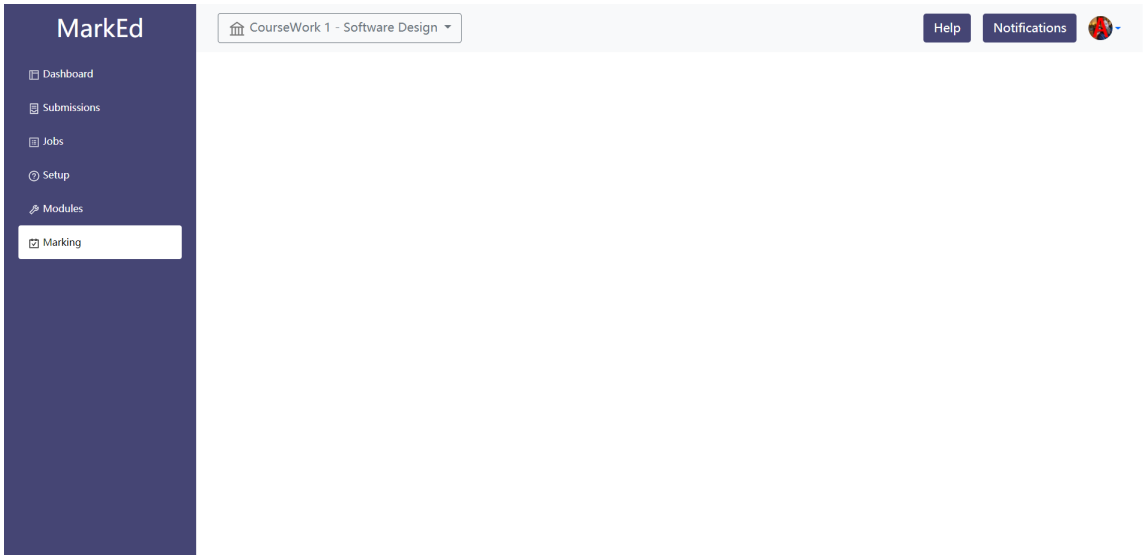

Figure D.4: Template

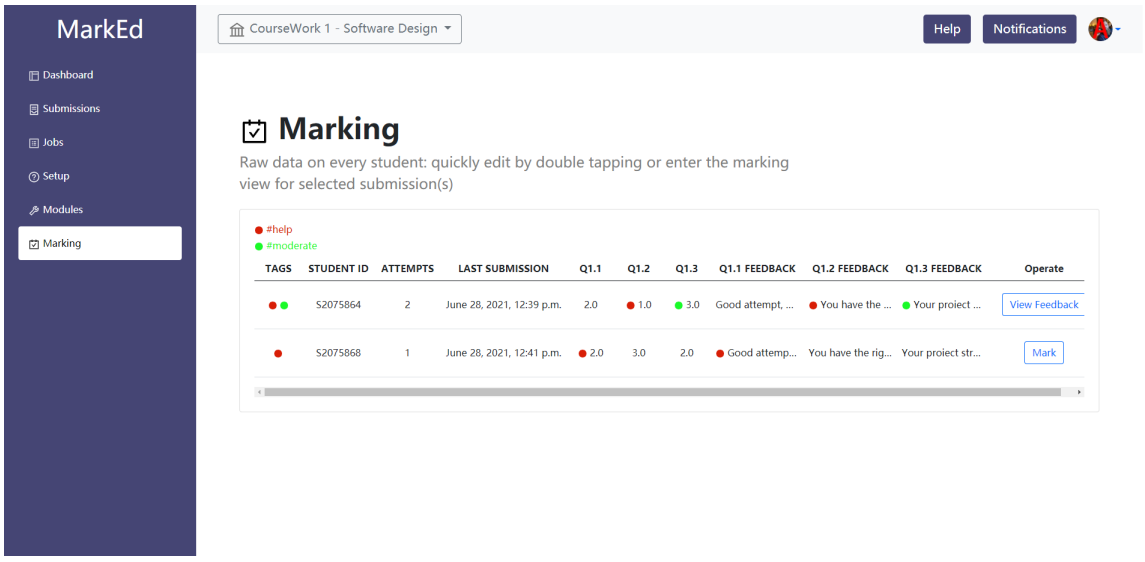

Figure D.5: Marking Data Page

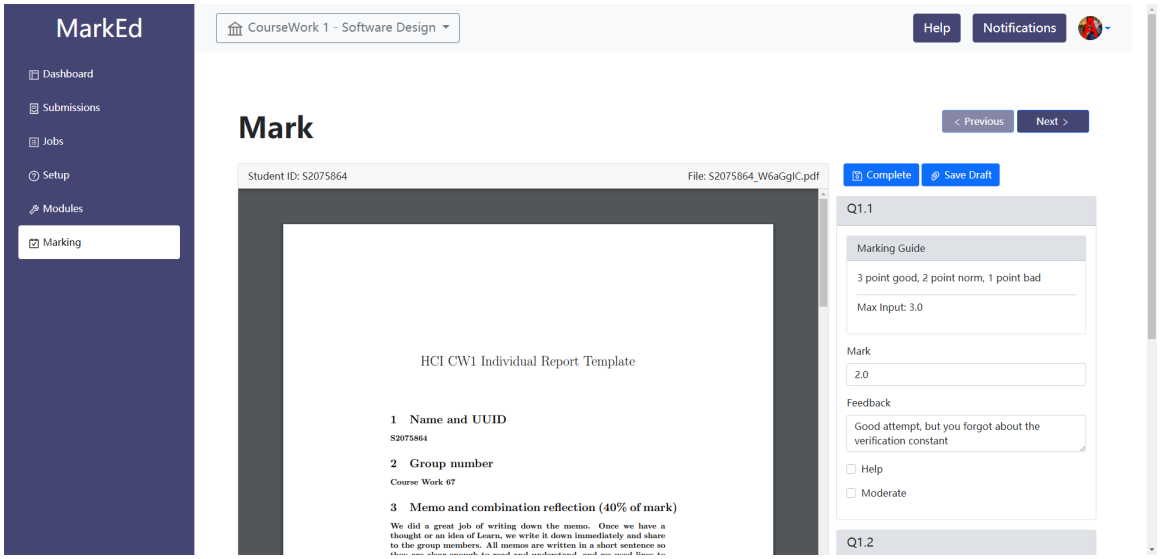

Figure D.6: Mark Page

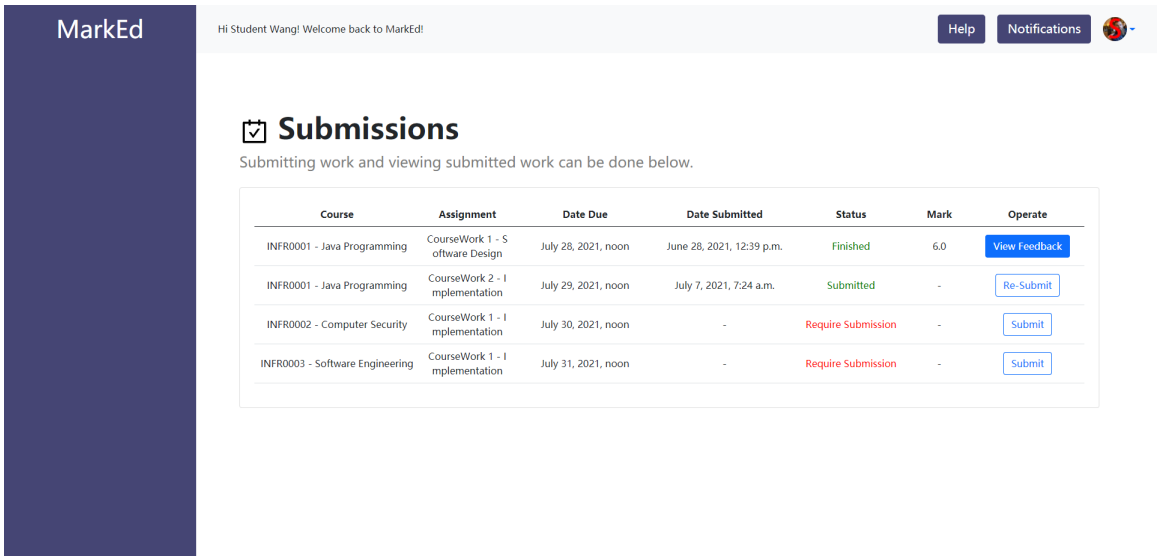

Figure D.7: Student Home Page

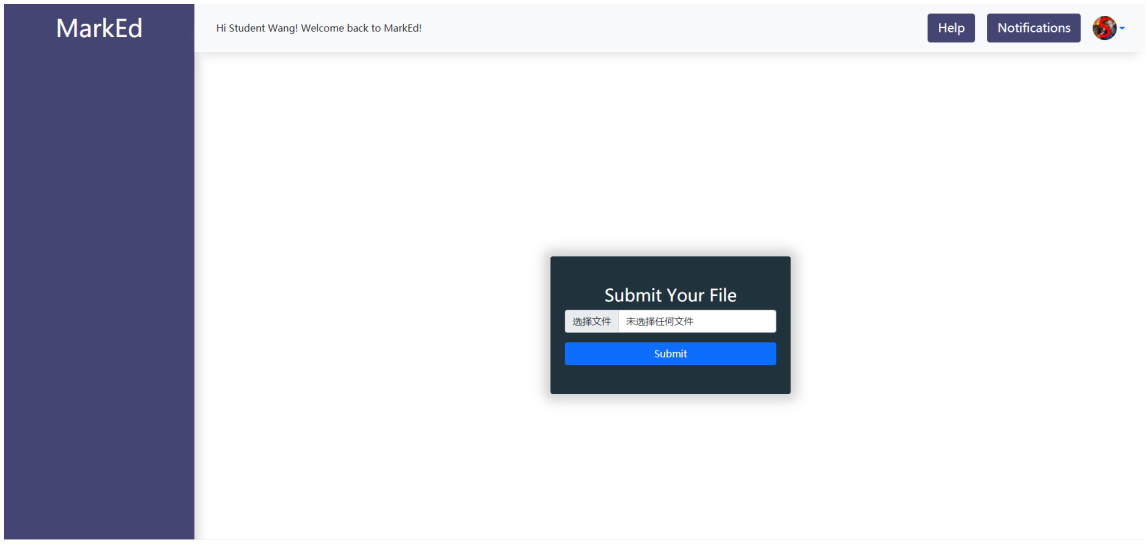

Figure D.8: Submit Page

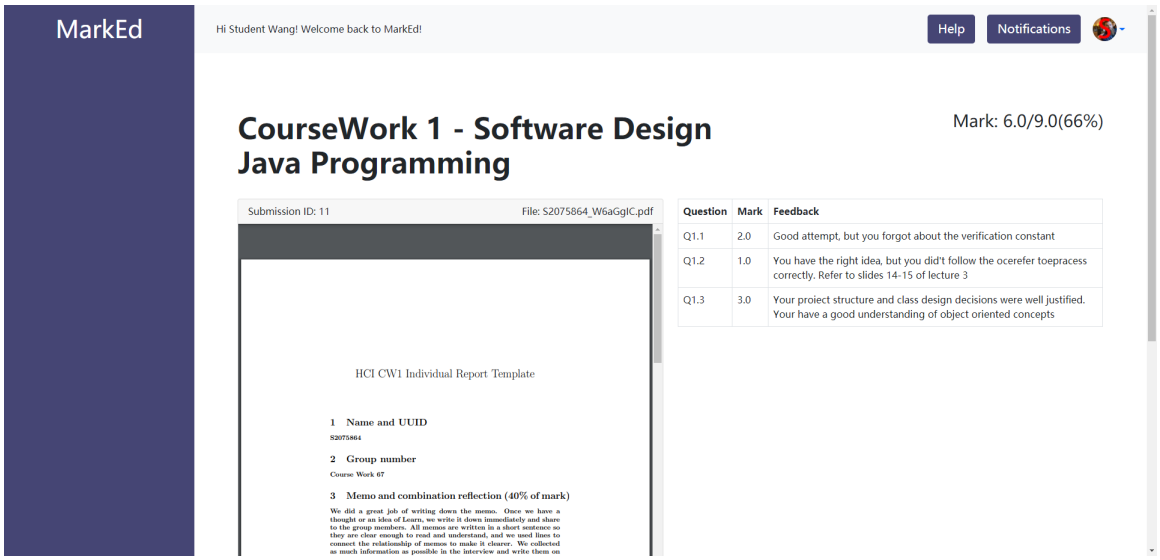

Figure D.9: View Feedback Page

Figure D.10: View All Attempts

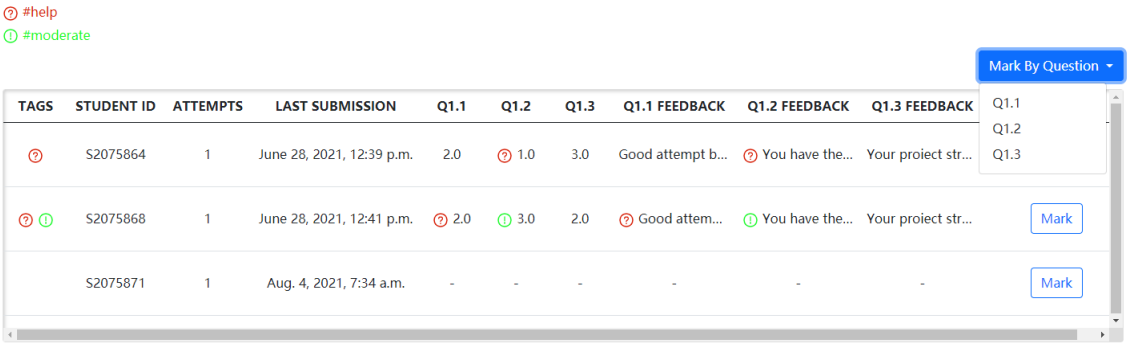

Figure D.11: Mark By Question

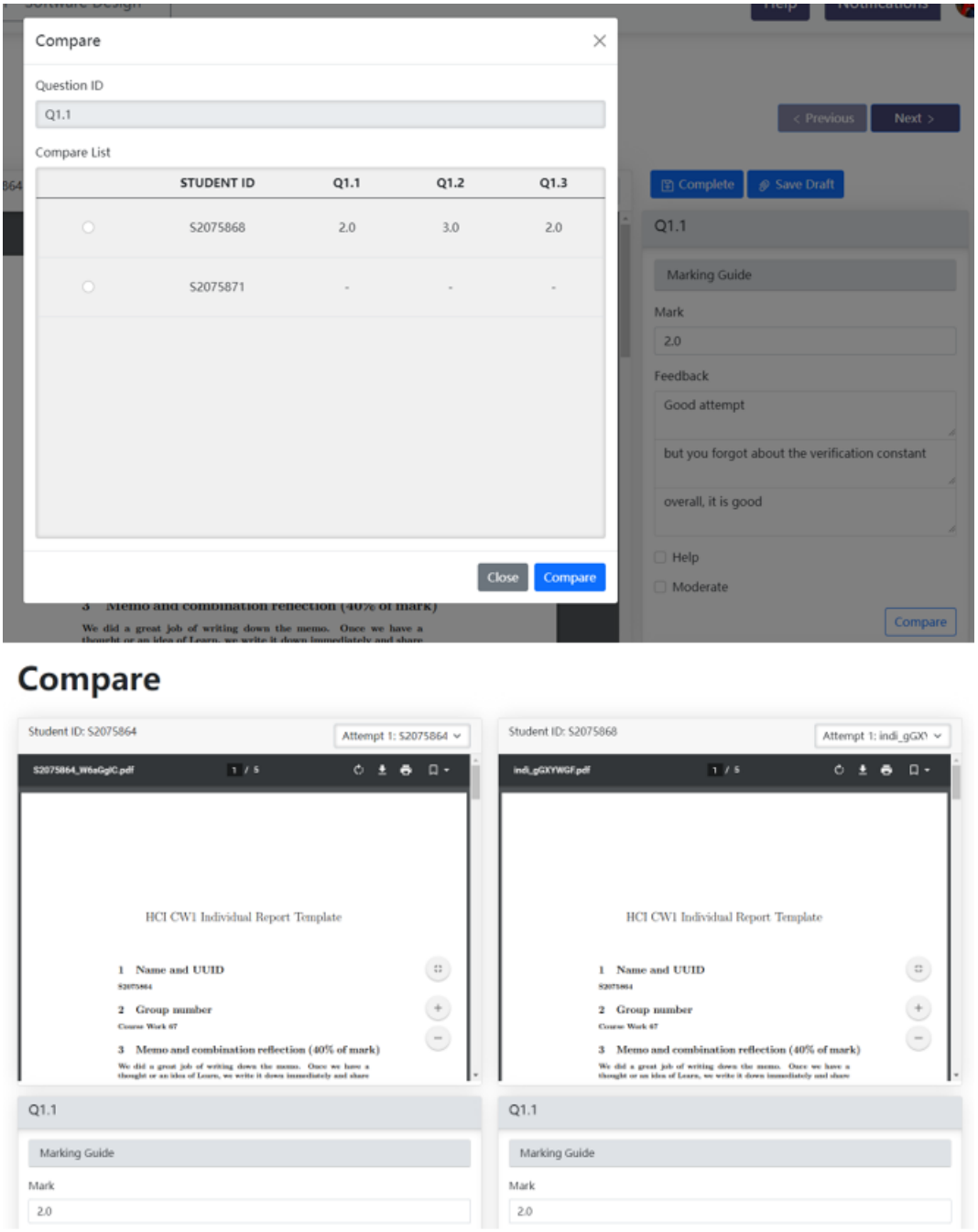

Figure D.12: Compare

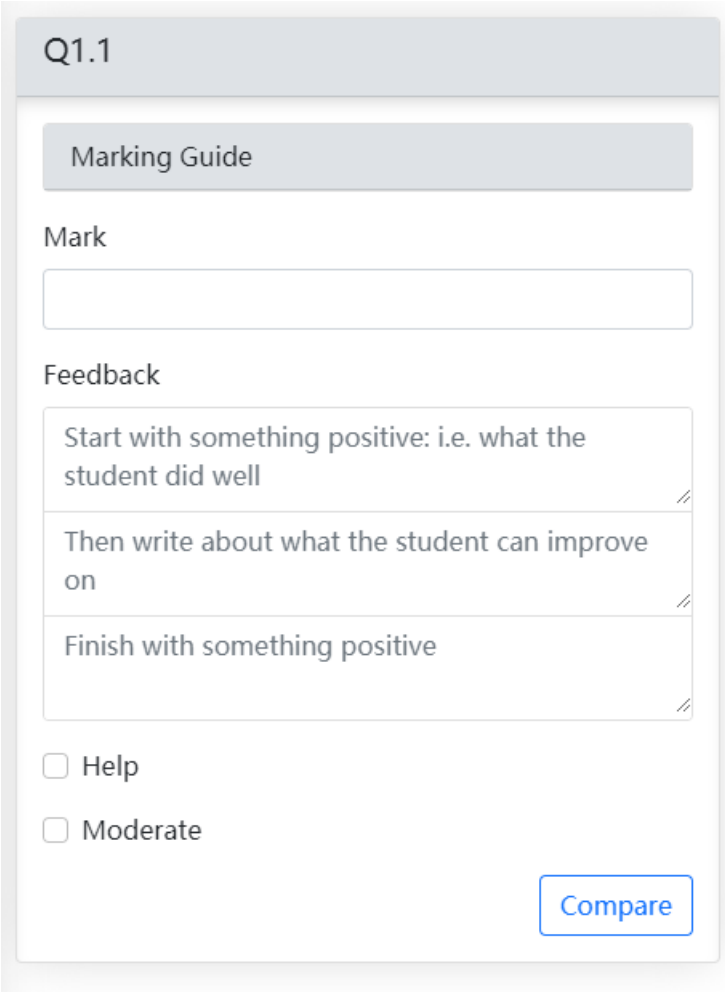

Figure D.13: Feedback Sandwich

Appendix E

Evaluation

E.1 Participants Information Sheet Used in Evaluation

E.1.1 Participants Information Sheet for Academics Group Meeting

Participant Information Sheet

Project title:	The MarkEd tool for Marking, Feedback and Moderation II
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Xisen Wang (Main Researcher), Xiaofei Sun
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/70801. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The researcher of the study is Xisen Wang and Xiaofei Sun, who are postgraduate students in the University of Edinburgh School of Informatics and Cristina Adriana Alexandru who is the supervisor. This study is conducted as part of the postgraduate project of Xisen Wang. Xiaofei will help with note taking.

What is the purpose of the study?

We are currently implementing an online tool (website) called MarkEd which will help with marking, feedback and moderation processes. The study is to evaluate our implementation formatively. The purpose of this study is to find out the usability and the potential impact of the tool for your marking and moderation. This will help us improve the implementation. Hopefully we can make this tool that you would like to use for your future work.

Why have I been asked to take part?

The reason why you are invited to participate in this study is because you are a course organiser or lecturer in the School of Informatics. You may have experience with other marking methods or tools. We hope that you can use your previous valuable experience to suggest improvements and shortcomings compared to other tools by using our implementation.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you decide to participate in the study, we will organise a cooperative evaluation. Xisen Wang will interview you by Zoom. Xiaofei will help with note taking. During this process you will be given a series of tasks to interact with and note down any details, actions, thoughts or questions. At the end, you will have a focus group discussion about how your feelings and suggestions on the prototype and the potential impact of this prototype on your future work. The whole process can take 30 to 40 minutes.

Are there any risks associated with taking part?

There are no significant risks associated with participation. Your comments and answers will remain strictly confidential. Nothing you say will have any negative effect on your employment, appraisal, pay, degree, or anything else related to your working/study conditions

Are there any benefits associated with taking part?

Although there are no physical benefits after this study, we do hope that the implementation of MarkEd will help you and your colleagues with marking and moderation.

What will happen to the results of this study?

The results of this study may be summarised in the Xisen Wang's MSc dissertation. Moreover, they may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a

maximum of 2 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. The researcher's supervisor Cristina Adriana Alexandru(Cristina.Alexandru@ed.ac.uk) will send the anonymised transcription to the researcher Xisen Wang(s2075864@ed.ac.uk) from Zoom of the interview recording via the university's secure encrypted cloud storage services (Sharepoint). Similarly, Xiaofei Sun will share with Xisen Wang anonymised notes. As Xisen Wang is currently in China, this will imply that no personal data will be recorded from there.

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact

inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Xisen Wang(s2075864@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Xisen Wang(s2075864@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

E.1.2 Participants Information Sheet for Academics Individual Meeting

Participant Information Sheet

Project title:	The MarkEd tool for Marking, Feedback and Moderation II
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Xisen Wang (Main Researcher), Xiaofei Sun
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/70801. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The researcher of the study is Xisen Wang and Xiaofei Sun, who are postgraduate students in the University of Edinburgh School of Informatics and Cristina Adriana Alexandru who is the supervisor. This study is conducted as part of the postgraduate project of Xisen Wang. Xiaofei will help with note taking.

What is the purpose of the study?

We are currently implementing an online tool (website) called MarkEd which will help with marking, feedback and moderation processes. The study is summative evaluation for our implementation. The purpose of this study is to find out the usability and the potential impact of the tool for your marking and moderation. This will help us improve the implementation. Hopefully we can make this tool that you would like to use for your future work.

Why have I been asked to take part?

The reason why you are invited to participate in this study is because you are a course organiser or lecturer in the School of Informatics. You may have experience with other marking methods or tools. We hope that you can use your previous valuable experience to suggest improvements and shortcomings compared to other tools by using our implementation.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you decide to participate in the study, we will organise an online one-on-one meeting. Xisen Wang will interview you by Zoom. Xiaofei will help with note taking. During this process you will be given a series of tasks to interact with the real web page as a marker while expressing your thoughts and feelings by thinking aloud. At the end, you will be given a questionnaire through Microsoft Teams to survey your feelings and suggestions on the prototype and the potential impact of this prototype on your future work. The questionnaire will also contain the questions of the System Usability Scale(SUS), which are about your general views on the system's usability. The whole process can take 30 to 40 minutes.

Are there any risks associated with taking part?

There are no significant risks associated with participation. Your comments and answers will remain strictly confidential. Nothing you say will have any negative effect on your employment, appraisal, pay, degree, or anything else related to your working/study conditions

Are there any benefits associated with taking part?

Although there are no physical benefits after this study, we do hope that the implementation of MarkEd will help you and your colleagues with marking and moderation.

What will happen to the results of this study?

The results of this study may be summarised in the Xisen Wang's MSc dissertation. Moreover, they may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that

could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 2 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. The researcher's supervisor Cristina Adriana Alexandru(Cristina.Alexandru@ed.ac.uk) will send the anonymised transcription to the researcher Xisen Wang(s2075864@ed.ac.uk) from Zoom of the interview recording via the university's secure encrypted cloud storage services (Sharepoint). Similarly, Xiaofei Sun will share with Xisen Wang anonymised notes. As Xisen Wang is currently in China, this will imply that no personal data will be recorded from there.

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What are my data protection rights?

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General information.

For general information about how we use your data, go to: edin.ac/privacy-research

E.1.3 Participants Information Sheet for Markers Group Meeting

Participant Information Sheet

Project title:	The MarkEd tool for Marking, Feedback and Moderation II
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Xisen Wang (Main Researcher), Xiaofei Sun
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/70801. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The researcher of the study is Xisen Wang and Xiaofei Sun, who are postgraduate students in the University of Edinburgh School of Informatics and Cristina Adriana Alexandru who is the supervisor. This study is conducted as part of the postgraduate project of Xisen Wang. Xiaofei will help with note taking.

What is the purpose of the study?

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Why have I been asked to take part?

The reason why you are invited to participate in this study is because you are a marker in the School of Informatics. You may have experience with other marking methods or tools. We hope that you can use your previous valuable experience to suggest improvements and shortcomings compared to other tools by using our implementation.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

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Are there any risks associated with taking part?

There are no significant risks associated with participation. Your comments and answers will remain strictly confidential. Nothing you say will have any negative effect on your employment, appraisal, pay, degree, or anything else related to your working/study conditions

Are there any benefits associated with taking part?

Although there are no physical benefits after this study, we do hope that the strategies or the implementation of MarkEd will help you and your colleagues with marking.

What will happen to the results of this study?

The results of this study may be summarised in the Xisen Wang's MSc dissertation. Moreover, they may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a

maximum of 2 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

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Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Xisen Wang(s2075864@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Xisen Wang(s2075864@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

E.1.4 Participants Information Sheet for Student Group Meeting

Participant Information Sheet

Project title:	The MarkEd tool for Marking, Feedback and Moderation II
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Xisen Wang (Main Researcher), Xiaofei Sun
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/70801. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The researcher of the study is Xisen Wang and Xiaofei Sun, who are postgraduate students in the University of Edinburgh School of Informatics and Cristina Adriana Alexandru who is the supervisor. This study is conducted as part of the postgraduate project of Xisen Wang. Xiaofei will help with note taking.

What is the purpose of the study?

We are currently implementing an online tool (website) called MarkEd which will help with marking, feedback and moderation processes. The study is to evaluate for our implementation. The purpose of this study is to find out the usability and the potential impact of the tool for your study. This will help us improve the implementation. Hopefully we can make this tool that you would like to use for your future study.

Why have I been asked to take part?

The reason why you are invited to participate in this study is because you are a student in the School of Informatics. You may have experience with other marking platform to view the marking result and feedback. We hope that you can use your previous valuable experience to suggest improvements and shortcomings compared to other tools by using our implementation.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted

and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you decide to participate in the study, we will organise a cooperative evaluation. Xisen Wang will interview you by Zoom. Xiaofei will help with note taking. During this process you will be given a series of tasks to interact with and note down any details, actions, thoughts or questions. At the end, you will have a focus group discussion about how your feelings and suggestions on the prototype and the potential impact of this prototype on your future study. The whole process can take 30 to 40 minutes.

Are there any risks associated with taking part?

There are no significant risks associated with participation. Your comments and answers will remain strictly confidential. Nothing you say will have any negative effect on your employment, appraisal, pay, degree, or anything else related to your working/study conditions

Are there any benefits associated with taking part?

Although there are no physical benefits after this study, we do hope that the implementation of MarkEd will help you have a better understanding on your marking result and feedback given by the markers.

What will happen to the results of this study?

The results of this study may be summarised in the Xisen Wang's MSc dissertation. Moreover, they may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 2 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher Xisen Wang(s2075864@ed.ac.uk) and his supervisor Cristina Adriana Alexandru(Cristina.Alexandru@ed.ac.uk).

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Xisen Wang(s2075864@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Xisen Wang(s2075864@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

E.2 Participants Consent Form Used in Evaluation

Participant number:_____

Participant Consent Form

Project title:	The MarkEd tool for Marking, Feedback and Moderation II
Principal investigator (PI):	Cristina Andriana Alexandru
Researcher:	Xisen Wang (Main Researcher), Xiaofei Sun
PI contact details:	Cristina.Alexandru@ed.ac.uk

By participating in the study you agree that:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1.	I agree to being audio recorded.	☐ **Yes**	☐ **No**
2.	I agree to being video recorded.	☐ **Yes**	☐ **No**
3.	I allow my data to be used in future ethically approved research.	☐ **Yes**	☐ **No**
4.	I agree to take part in this study.	☐ **Yes**	☐ **No**

Name of person giving consent	Date dd/mm/yy	Signature
_____	_____	_____
Name of person taking consent	Date dd/mm/yy	Signature
_____	_____	_____

THE UNIVERSITY of EDINBURGH informatics

E.3 Tasks Used in Evaluation

E.3.1 Tasks For Academics

1. Find the register page.
2. Find the login page and login by using a given account. (s2075865)
3. Find and open the Coursework 1 page for the Java Programming Course
4. Find the marking page.
5. Find and access the marked submission that has question Q1.1 tagged as moderation
6. In the marking page, find marking instructions for question Q1.1
7. Find the second attempt of the student.
8. Remove the moderation tag and change the score to 3 and complete the marking.
9. Compare Q1.1 with S2075868's Q1.1
10. Go back to marking page and mark by question Q1.1
11. Find and Logout
12. Login as a student (s2075864)
13. Submit a given file to Coursework1 of INFR0002 Computer Security
14. View the feedback for the CourseWork1 of INFR0001 Java Programming

E.3.2 Tasks For Markers

1. Find the register page.
2. Find the login page and login by using a given account. (s2075867)
3. Find and open the Coursework 1 page for the Java Programming Course
4. Find the marking page.
5. Find and access the marking page of the submission of S2075868
6. In the marking page, find marking instructions for question Q1.1
7. Give 2 points for each question and give feedback by using the given feedback for each question. Tag Q1.1 as moderate and save it as draft.
8. Compare Q1.1 with S2075864's Q1.1
9. Find the second attempt of the s2075864.
10. Go back to marking page and mark by question Q1.1
11. Find and Logout
12. Login as a student (s2075864)
13. Submit a given file to Coursework1 of INFR0003 Software Engineering
14. View the feedback for the CourseWork1 of INFR0001 Java Programming

E.3.3 Tasks For Students

1. Find the register page.
2. Find the login page and login by using a given account. (s2075864)
3. Submit a given file to Coursework1 of INFR0003 Software Engineering
4. Resubmit the file I have given to you to the Coursework 1 of Java Programming Course
5. View the feedback for the CourseWork1 of INFR0001 Java Programming
6. Find the second attempt of the student.

E.4 Questions Used in Evaluation

E.4.1 Questions For Academics

1. How long have you been teaching, including marking?
    (a) Less than 1 year
    (b) 2 to 5 years
    (c) More than 5 years
2. What do you like most about the MarkEd implementation?
3. What do you like least about the MarkEd implementation?
4. What do you think of the implementation in terms of marking? Do you have any suggestions for things that I could improve?
5. What do you think of the implementation in terms of tagging? Do you have any suggestions for things that I could improve?
6. What do you think of the implementation in terms of comparing? Do you have any suggestions for things that I could improve?
7. What do you think of the implementation in terms of the feedback sandwich structure? Do you have any suggestions for things that I could improve?
8. How do you think this implementation will influence your marking in the future?
9. How do you think this implementation will influence your moderation in the future?
10. Are there any features which you think we still need to add that are necessary for you? Please explain why.
11. Any other comments, questions or suggestions for this implementation?

E.4.2 Questions For Markers

1. How long have you been occupying marker roles?
    (a) Less than 1 year
    (b) 2 to 5 years
    (c) More than 5 years
2. How many marker roles have you occupied?
3. What do you like most about the MarkEd implementation?
4. What do you like least about the MarkEd implementation?
5. What do you think of the implementation in terms of marking? Do you have any suggestions for things that I could improve?
6. What do you think of the implementation in terms of tagging? Do you have any suggestions for things that I could improve?
7. What do you think of the implementation in terms of comparing? Do you have any suggestions for things that I could improve?
8. What do you think of the implementation in terms of feedback sandwich structure? Do you have any suggestions for things that I could improve?
9. How do you think this implementation will influence your marking in the future?
Work well assignment like,
10. Are there any features which you think we still need to add that are necessary for you? Please explain why.
11. Any other comments, questions or suggestions for this implementation?

E.4.3 Questions For Students

1. What do you like most about the MarkEd implementation?
2. What do you like least about the MarkEd implementation?
3. What do you think of the implementation in terms of submitting assignments? Do you have any suggestions for things that I could improve?
4. What do you think of the implementation in terms of viewing feedback? Do you have any suggestions for things that I could improve?
5. How do you think this implementation will influence your experience with marking and getting feedback in the future?
6. Are there any features which you think we still need to add that are necessary for you? Please explain why.
7. Any other comments, questions or suggestions for this implementation?

E.5 Questionnaire Used in Evaluation

E.5.1 Questionnaire For Academics

Formative Evaluation Questionnaire for Implementation on MarkEd - Academic

* 必答题

* 此表单将记录你的姓名，请填写该信息。

1. This form will record your name, please fill your name. *

2. SUS Questionnaire *

	1 - Strongly Disagree	2	3	4	5- Strongly Agree
I think that I would like to use this system frequently.	○	○	○	○	○
I found the system unnecessarily complex.	○	○	○	○	○
I thought the system was easy to use.	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system	○	○	○	○	○
I found the various functions in this system were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this system.	○	○	○	○	○
I would imagine that most people would learn to use this system very quickly.	○	○	○	○	○
I found the system very cumbersome to use.	○	○	○	○	○
I felt very confident using the system.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

3. Future Impact Rating - How helpful do you think the tool would be in the following areas? *

	1 - Very Unhelpful	2	3	4	5- Very helpful
Saving Time	○	○	○	○	○
Ensuring Fairness	○	○	○	○	○
Error-prevention (avoiding mis-clicks)	○	○	○	○	○
Moderate Marking Results	○	○	○	○	○

E.5.2 Questionnaire For Markers

Formative Evaluation Questionnaire for Implementation on MarkEd - Marker

* 必答题

* 此表单将记录你的姓名，请填写该信息。

1. This form will record your name, please fill your name. *

2. SUS Questionnaire *

	1 - Strongly Disagree	2	3	4	5- Strongly Agree
I think that I would like to use this system frequently.	○	○	○	○	○
I found the system unnecessarily complex.	○	○	○	○	○
I thought the system was easy to use.	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system	○	○	○	○	○
I found the various functions in this system were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this system.	○	○	○	○	○
I would imagine that most people would learn to use this system very quickly.	○	○	○	○	○
I found the system very cumbersome to use.	○	○	○	○	○
I felt very confident using the system.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

3. Future Impact Rating - How helpful do you think the tool would be in the following areas? *

	1 - Very Unhelpful	2	3	4	5- Very helpful
Saving Time	◯	◯	◯	◯	◯
Ensuring Fairness	◯	◯	◯	◯	◯
Error-prevention (avoiding mis-clicks)	◯	◯	◯	◯	◯
Asking for assistance	◯	◯	◯	◯	◯

E.5.3 Questionnaire For Students

Formative Evaluation Questionnaire for Implementation on MarkEd - Student

* 必答题

* 此表单将记录你的姓名，请填写该信息。

1. This form will record your name, please fill your name. *

2. SUS Questionnaire *

	1 - Strongly Disagree	2	3	4	5- Strongly Agree
I think that I would like to use this system frequently.	○	○	○	○	○
I found the system unnecessarily complex.	○	○	○	○	○
I thought the system was easy to use.	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system	○	○	○	○	○
I found the various functions in this system were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this system.	○	○	○	○	○
I would imagine that most people would learn to use this system very quickly.	○	○	○	○	○
I found the system very cumbersome to use.	○	○	○	○	○
I felt very confident using the system.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

3. Future Impact Rating - How helpful do you think the tool would be in the following areas? *

	1 - Very Unhelpful	2	3	4	5- Very helpful
Saving Time	○	○	○	○	○
Error-prevention (avoiding mis-clicks)	○	○	○	○	○
Submitting Assignments	○	○	○	○	○
Checking Score	○	○	○	○	○
Viewing Feedback	○	○	○	○	○

E.6 Thematic Analysis Themes and Subthemes

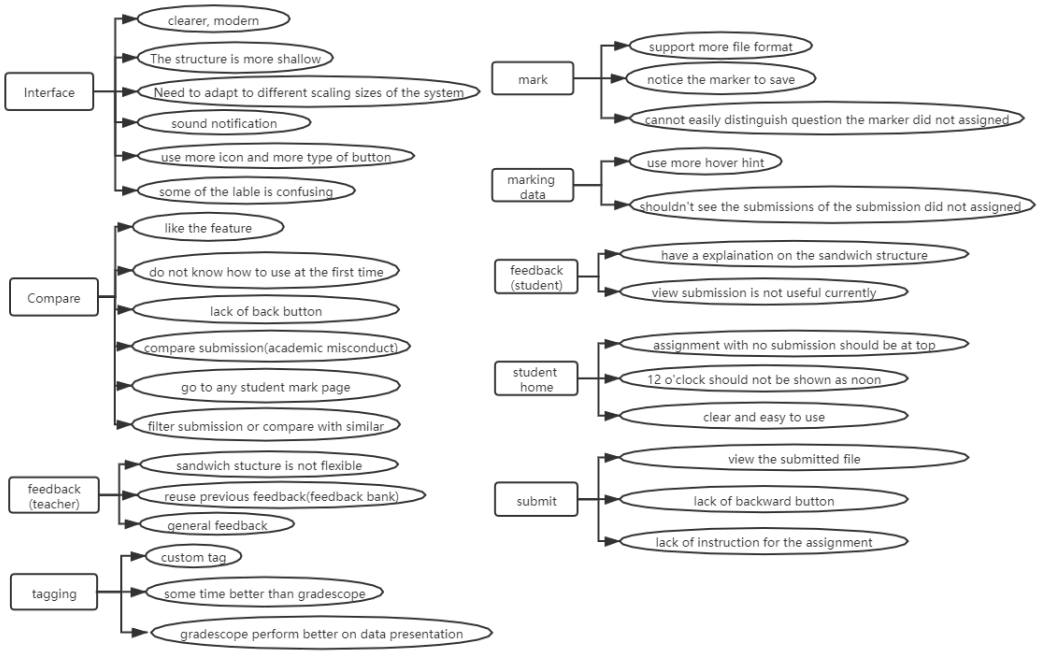

Figure E.1: Themes and subthemes