



TECHNISCHE UNIVERSITÄT MÜNCHEN
DEPARTMENT OF INFORMATICS

BACHELOR'S THESIS IN INFORMATICS

Socially Interactive Learning Materials

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Sozial-Interaktive Lehrmaterialien

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I confirm that this thesis is my own work and I have documented all sources and material used.

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Abstract

Online learning systems are gaining popularity fast because of the multiple advantages they have over regular face-to-face education. One benefit for the students is that they have an easy access to the course materials and can review them multiple times. In this thesis we prove that when learners study individually on an eLearning platform they communicate less with their peers. We claim that three kinds of interaction are crucial for a productive learning process and a faster skill acquisition - learner-content, learner-learner and learner-instructor interaction.

In this thesis we introduce one possible approach for stimulating interaction between peers. Based on the specific design of the used eLearning system, called "Labsystem", we add annotation sections where learners can discuss the learning materials. These are available for instructors as well, however, the focus is on the students.

In order to design the courses according to the learners' needs we need more feedback about their general disposition towards the learning materials. We state that students should be able to give such feedback quickly, i.e. without getting distracted. For this purpose we implement emoji reactions for each component of the labsystem.

We keep record of the number of annotations and the kinds of selected emojis per component. We display these records in graphics so that they are easily readable. Based on them the instructors can recognize topics which require further discussions and adjust the course to the students' demands.

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Chapter 1

Introduction

Traditional face-to-face learning has mainly contributed for the human scientific development the way it is now. However, it involves diverse inconveniences for learners and teachers. The distribution of learning materials is one example. Either the instructors have to provide each individual student with physical copies of the materials, or the students have to find such themselves. It is easy to loose or damage some of the copies. Learners have to keep record of all exercises and example solutions presented in class. It is therefore challenging to catch up on learning matter after missing a class. Another inconvenience is that all course participants have to be at the same place simultaneously. Distant learning was not an option in the past.

For these reasons *online learning systems* were developed. They have rapidly gained popularity as means for supporting the regular teaching and learning practices. They find applications not only in schools and universities but also in business companies. There they are used for professional trainings of employees. They enable remote access to the provided learning materials, which can be reviewed repeatedly and at any time. Some eLearning systems have evolved into the so called *MOOCs* - Massive Open Online Courses. There the users can find online courses on diverse topics and join them, sometimes even for free.

The purpose of eLearning systems is to support learners by giving them more flexibility than regular face-to-face learning. However, online systems try to preserve practices used by the latter. For instance, they provide the users with interaction features, since they are not able to communicate face-to-face. The course organizers rely on user's feedback when structuring their courses. Receiving feedback personally is not an option. Therefore, the system has to provide features for collecting user opinions.

1.1 Goals of the thesis

In the scope of this bachelor's thesis we will focus on the improvement of a certain eLearning system, called *labsystem*. This is an online learning platform which supports two practical courses (*iLab* and *iLab2*) offered by the chair of Network Architectures and Services at the Technical University of Munich. The system already disposes of multiple different features which facilitate the learning process of the students. However, it still lacks some functionalities, for instance interaction features, which are typical for very widely spread online learning systems such as Moodle, Coursera and edX.

Our first aim is to enable users to interact through the platform. The main focus is on the interaction between peers. For this reason we implement annotation sections beneath all texts and questions in each course assignment. There the users would be able to lead discussions. They shall be visible for the instructors. Thus, we prevent exchanging assignment solutions through the *labsystem*. We call this feature *interactive annotation feature*.

In order to improve the design of the courses, the instructors need feedback from the learners. Users already have the option to give general feedback about each assignment in text form. However, the lecturers are interested in more exact feedback. They would like to know how each individual explanation, question or exercise was perceived. Therefore, the users should be able to indicate their disposition towards each of these components. The process of sending feedback shall happen quickly. The students' focus should stay on the learning matter. Our second goal in the thesis is to enable students to send *short emotional feedback*. This feature will be represented through emoji reactions.

1.2 Outline

In Chapter 2 we introduce the *labsystem*, its structure and the features relevant for this thesis. We explain the conduction of the two practical courses and set our goals. We substantiate the benefits of interaction during learning by presenting the results of scientific researches and experiments. Then, we give a definition for short emotional feedback and analyze diverse techniques for achieving our objectives. Throughout the whole section we indicate requirements which a well-designed eLearning system should fulfill. They are only connected to the two main topics of the thesis - interactive learning and short emotional feedback.

In Chapter 3 four popular eLearning systems are presented in detail. We introduce the interaction and short emotional feedback features they dispose of. Each system is evaluated according to the requirements established in Chapter 2. Finally, we compare all studied systems and the *labsystem* based on these requirements.

The focus of Chapter 4 is on the design of the two new extensions of the labsystem. There we describe what their layout should be. We explain the reasons for choosing this particular layout. In order to select appropriate emojis for the second new feature we asked the opinion of 29 people. The results of the study are presented in Chapter 4.

In Chapters 5 and 6 we present specific aspects of the implementation of the new features and evaluate the results of the project. We analyze to what extent the labsystem fulfills the established requirements.

In Chapter 7 we make conclusions about the accomplished goals. We discuss their effect on the labsystem users. Finally, we propose further extensions for improving the users' learning experiences with the labsystem.

Chapter 2

Analysis

2.1 Methodology

The two main topics of this chapter are interactive learning and short emotional feedback. The first two sections present the iLab course and the eLearning platform which supports it. There we describe the elements as well as some of the already existing features of this system in order to clarify how the iLab is conducted. We define three particular roles which a person can have in the course. Then we introduce our main goals in this thesis. Thereafter we substantiate the benefits of interactive learning and short emotional feedback and thus explain the reasons for our goals. In the end, we examine common techniques for achieving these objectives. Throughout the whole chapter we indicate requirements for a good eLearning system and present a summary of them in the last section. These requirements are going to be the base for our further approach.

The purpose of this analysis is to present our exact goals, provide scientific proof for their advantages and discuss the already existing ways of achieving them. In the end, we want to be able to choose an appropriate technique based on the facts presented in the analysis.

2.2 The iLab course

The Technical University of Munich offers a practical course called *iLab*. It aims at bachelor and master students who have a major interest in computer networks and all the necessary processes and technologies building up today's Internet. There are two different iLab courses - iLab and iLab2. The first one gives students the opportunity to create "their own Internet" and get familiar with the protocols and systems behind it. Each exercise consists of three parts. Firstly, every week there is a lecture where

the theoretical contents of the topic are explained. Afterwards, the students have to complete a "*prelab*" where they get confronted with theoretical tasks related to the practical exercise they would have to deal with later on. Finally, the students execute the practical exercise called "*lab*" in groups of two. The term *lab* is also used as a short name for an assignment consisting of a prelab and a lab. The iLab2 focuses on more specific network topics, which are partially chosen by the participants themselves.

The Chair of Network Architectures and Services uses an eLearning system (*labsystem*) which supports the students during both these courses. The main purpose of the eLearning platform is to facilitate the learning process for the students, to give them the opportunity to find answers to their questions fast, and share their personal opinion with their tutors and the other participants. Students can find all learning and examination materials online. A more detailed description of the system as well as the conduction of the course is presented in the next sections.

2.3 Roles

There are three different roles in the iLab course. Firstly, there are the *organizers* or *instructors*. These are employees of the Chair of Network Architectures and Services who prepare the plan of the course, all prelabs and labs, and hold the lectures about each new topic. Secondly, there are *tutors* who are usually students at the TUM and are responsible for correcting all assignments. Each assignment is corrected and graded by two tutors who also have to give the students feedback about the received grades. Furthermore, they are the first people to contact in case of vagueness in the material or difficulties in the execution of the given tasks. Lastly, there are the *participants* or simply *students* who execute each assignment in groups of two. They are responsible for acquiring new knowledge and showing their progress in each assignment. They receive grades according to the stage of this progress.

2.4 Labsystem elements

The labsystem provides six composition elements. Designing and arranging new elements appropriately results in the creation of a new lab (assignment). The following elements exist:

- *Page* or *text element* (*p*) - creates new text;
- *Multiple choice* element (*m*) - creates a new multiple choice question;
- *Input* element (*i*) - creates a question which learners have to answer with a free text input;

- *Schedule (s)* - creates a time-plan for the iLab course;
- *Collection (c)* - through this element one can join *p*, *m*, *i* and *s* elements and thus define the content of a page;
- *Lab (l)* - creates an assignment by joining multiple *c* elements.

The process of designing a lab begins with the creation of its content in separate elements. These could be a multiple choice, an input, a schedule or a text element. Thereafter, one can join all these components into a collection. This action simply creates a page with the desired content. Noticeably, a lab consists of multiple pages, i.e. collections. Thus, after having created all necessary collections, the editor can join them into the element *lab*.

During the creation of each element, one can set the visibility options and the rights which a user must have in order to be able to view it. Furthermore, one can set the desired layout, for instance, the arrangement of the possible answers of a multiple choice question. In order to be able to create an element, a user needs appropriate editing rights. During its creation, each element of the labsystem receives a unique address. It consists of the letter representing the type of element, for instance *p* or *i*, and a number. This address is later visible for the course administrators in the top right corner of the element.

2.5 Some features of the labsystem

The labsystem offers multiple different kinds of support for the students in all three phases of each exercise. It provides the students with the option to watch all lectures online in case they missed some of them or need to revise them. Furthermore, the slides of each lecture are available to all participants.

It is important to note, that the main purpose of the prelab is to help students acquire the theoretical knowledge they need for the practical exercise. However, it does not have any effect on the final grade. Each team member has to complete the prelab on their own. It consists of different texts, explaining the material and usually a few multiple choice questions at the end of each article. The user selects the answers which they consider correct for each question. After that, they can immediately receive feedback from the system, telling them if they have got the right answers, by simply clicking on the "check" button. Each student has three attempts. In the end, they can also see the correct answers to the questions which they could not get right. Sometimes below the question there is a short explanation on why exactly these answers are correct. It is required that both teammates complete the prelab in order to continue with the lab. The purpose of this feature is to induce both team members to prepare for the practical exercise. They should have very similar theoretical background in order to be

able to work as a team and support each other. Therefore, each team member can see whether their partner has finished with the prelab or not. This should stimulate them to communicate more, since they cannot continue if one of them is not done. To avoid the one teammate blindly copying from the screen of the other one, in case they are working on the prelab next to each other, the system always shuffles the answers and displays them in a different order. One can of course still copy from the partner, but they would at least have to read the correct answers.

In the practical exercise the students have to answer open questions on the configurations they have carried out. Since this is a task they work on together, if one of the team members gives an answer to a particular question, the system automatically displays it for the other team member. If the participant has difficulties with a certain question or needs to note something about it, they have the option to send their supervisors an e-mail with their concerns. For this purpose the labsystem has the so called "Email-Where-You-Are" button, which is to be found at the bottom of each question of both the lab and prelab. By pressing this button the user can select the names of the supervisors they want to contact, write their question and the system automatically sends an e-mail to the selected people. This e-mail contains a link, which leads directly to the part of the lab addressed by the student.

In the case that the user needs to stop working on the lab and continue with it later on, they are provided with a field, where they can upload a file containing the texts and configurations which they have already done.

At the last page of every prelab and lab there is a box for feedback. There the participants can share their opinion on the whole lab and suggest improvements. However, these opinions are only shared with the supervisors and not with the other participants.

Provided the user does not have a proper Internet connection, but still wants to study for the iLab she or he can use the ePub export option. When using the ePub the participants can download all exercises they have access to at the time of downloading or just a part of them. They would be able to read the whole material and see all questions, but naturally they would not be able answer any of them, since this action requires an Internet connection. However, this is a very useful option which allows the users to utilize their time better.

Nonetheless, the labsystem was also created to support the tutors in their work. After logging into the system, the tutor can see which teams are done with their exercises and thus start the correction. The tutor can go through the answers of each team individually, however, this might be time-consuming. Therefore, the labsystem also supports cross-corrections. Below each question the tutor can see the answers of each team. In this way the corrector only has to read the question and the example solution once and then go through the teams' answers. The tutors can write comments where they find it necessary. After that they should grade each answer and can decide whether

to make their correction visible to the team or not. All corrections which are not made visible or not done at all are marked in red. In this way, a tutor can easily see what more is to be done. In order to avoid missing some answers, the tutor can check the status of the correction process in a different window. There it is shown if the correction for each team has been completed or not.

In the click of a button the tutors can hide the example solutions from their screen in case they are working with a student on some part of the exercise. In the same way, they can also hide all students' answers and leave only the example solutions visible, if they are for instance making a review of the whole exercise in front of the students.

2.6 Goals

To this point the lab system does not allow the participants to communicate with each other. They can only send e-mails to the supervisors. Therefore, we consider it useful to provide the students with the option to annotate the material in such a way, that all other participants and all supervisors can see their notes. The goal is to make all texts and questions annotatable. This raises a few questions about the annotation layout. It should be designed in such a way that it is both usable and not intrusive, so that they do not interrupt the work flow of the users.

Once disposing of an annotations feature, we would like to be able to analyze which sections provoked more discussions and which - less. By displaying the number of comments for each component of the lab on a graphic we will be able to see which materials or questions engaged the attention of the students more. This would be a clear sign for the lecturers to spend more time on these units and maybe provide better explanations.

Furthermore, the organizers of the course would like to receive more feedback from their students. They need to be able to analyze it better in order to adjust the course more accurately to the expectations and needs of the learners. For this reason, we would like to add *emojis* below each multiple choice or input element. The emojis have become popular in the last decade with the spread of mobile chat applications. They represent different feelings, moods or objects in the form pictures. In this way the course members would be able to give short feedback in a very casual way. On the other side, after analyzing the inputs of all users, the lecturers would have a clear overview of the general students' opinions of the exercises.

2.7 Benefits of interactive eLearning

The main purpose of eLearning platforms is to organize learning and presenting materials and provide a massive content. Such systems usually aim at higher education and workplace training [1]. They do not focus as much on learner assistance, thus the users are expected to cope with the learning materials by themselves. However, it has been shown ([2], [3], [4], [5]) that interaction improves the learners' understanding of the material and to that effect also their achievements. Berge focuses on three types of interaction, which according to him are very valuable for the learning process - the learner-content, learner-learner and learner-instructor interactions. The first type of interaction happens in the learner's mind. Students have to think through the material, try to make sense out of it and thus answer their own questions while reading. Berge notes that according to social constructivists a very big part of learning happens in a social context. In other words, during an interaction with other students learners tend to not only comprehend and remember the material, but also analyze, synthesize and evaluate it. During an interactive learning students are also more personally engaged in the process [6]. Obviously, the interaction with the instructor or teacher is essential since he or she is the one who is supposed to help the learners with the material they could not deal with themselves. Therefore, these three types of interactions build up the first three requirements for the updated version of the labsystem (*R1.1, R1.2, R1.3*).

Adams and Granić [7] recognize three fundamental components of any learning environment:

- pedagogical and psychological functions
- appropriate technologies
- social organization of education

Again we observe that the social aspect of any learning process should not to be underestimated. Academic, social and emotional learning should be merged and developed together, in order to achieve the most effective possible tuition [8]. Previous research points out that skill acquisition happens through social-instructional interactions with people, who have more experience in the particular field [9]. It has also been noted that sequential instruction is very important [9].

The learner should have the opportunity to ask many questions and receive the corresponding answers and practical advices [9]. According to Pressley et al. obtaining instant feedback and correction are crucial for a good learning process. It is particularly difficult to relearn something once one has remembered it wrong. Therefore, it is so important that tutors correct the mistakes of their students fast. With respect to online learning systems, this means that the platforms should offer tools which enable students to ask questions and receive explanations and tips anytime (*R4.1*). Usually tutors cannot

correct the assignments of each learner immediately. In fact, they tend to wait until all students have submitted their assignments. This prolongs the communication between the two parties in time.

One way to construct an eLearning system which enables immediate feedback is to integrate tools which support synchronous and asynchronous discussions (*R2.1, R2.2*). These two modes of interaction are important for engaging students in the learning process [10]. As already mentioned, interaction is essential for every learning process and feedback is a part of the learner-learner and learner-instructor interactions. An annotation feature allows all users of the system to communicate at any time and place. Thus, it facilitates the interaction and makes it possible to receive constant feedback.

Berge emphasizes on the importance of formative and summative feedback. These are "processes for collecting information about the students' level of performance" which help to evaluate how fast and how well students comprehend the material. Formative feedback is used to make decisions regarding restructuring the course and make it more beneficial for students. Summative feedback is used by the organizers of the program in order to decide on the continuation of the course. [6]

Kunimune et al. note that asynchronous discussions help students build up their knowledge [2]. They implemented an annotation sharing system for eLearning materials. It allows users to annotate texts directly on the web page and share them with the other users if they want to. The users also have the option to comment on the shared annotations of the other users and in such a way start an asynchronous discussion. Kunimune et al. lead an experiment among students of the Shinshu University, Japan, in order to find out how they corresponded to the system. They found that students tend to use the annotation option to help themselves in their own learning process and not to discuss with others. Therefore, the researchers suggested discussions should be provoked in some way. [2]

Stimulating online discussions seems to be a common problem. Jakobs reviewed multiple researches on the utilization of the comment sections of different German newspapers. She found that the majority of users are not at all interested to give comments online. Furthermore, those readers who do write in the comment sections tend to express their opinion towards the article. However, they rarely get engaged in discussions with other readers [11].

After conducting two similar to one another experiments involving annotated by supervisors texts, Wolfe came to the conclusion that students tend to comment more on those parts of the texts, where supervisors' notes are to be found [12]. This can be considered as one way of provoking discussion.

However, after conducting a survey on the students' opinions about usefulness and helpfulness of the annotation system, Kunimune et al. found that most of the students evaluated the sharing and comment options as very helpful or rather helpful - more

than 75% of all participants [2]. Also the annotation feature was very well perceived by almost 75% of the students [2]. Gao also noted that according to researchers, most of the users have a positive impression of social annotating [13].

When students at the University Clinic Hamburg-Eppendorf, Germany, were for the first time confronted with the eLearning platform Moodle, they were also rather reluctant to use the discussions forum and the chat. However, the researchers explain that with the possibility that multiple students do not consider reading the comments of other users in the chat and forum as using them. They also remark, that there was a very high deviation in the answers, concerning how much the students utilized the chat and the forum. Many of them noted, that they used them a lot, others - not at all. Nevertheless, multiple students found the eLearning platform Moodle as a whole helpful, because it organizes the learning materials very well. [3]

In her work Gao presents multiple advantages of interactive learning and social annotation systems. She remarks that interaction between students leads to a better reading comprehension and higher achievements. Another important point is that using social annotation tools positively affects students' motivation to learn. It was also suggested that interactive learning through social annotation increases the students' motivation to read. [13]

Wolfe describes two complementary studies on text annotation whose main purpose is to find out how beneficial annotations are to the readers as well as what effect they have on their reading practices. The participants in the first study were asked to think aloud while reading scientific texts which were previously annotated by college instructors. The aim was to evaluate the effect of those annotations on both novice and advanced students' reading and thinking. Wolfe remarks that annotations containing strong views have a greater influence on the students than annotations which are rather neutral. [12]

One deduction of the study is that novice readers tend to comment more than advanced students [12]. This might be an indication that beginners have a greater need for interaction. Critical annotations provoked more comments. Wolfe concluded that annotations lead to a more reflective reading [12].

In the second study a part of the participants received annotated texts and the other part - non-annotated. They were all asked to write a personal response to the text they read. The results of the study suggest that in general students who receive annotated texts do not summarize as much as students who read plain texts [12]. This conclusion also supports the statement above, that annotations prompt students to analyze and reflect more.

Current eLearning systems do not focus on the personal learning routines of each user. They are rather concentrated to meet the needs of e-educators, who prepare their courses in a way they find most appropriate. Adams and Granić state that it is important to adjust eLearning systems to the individual learning practices of the users and let

go of the "one-size-fits-all" model [7]. According to them the learning process and the user's interaction with the eLearning system have to be combined better, since they are dependent on each other. In other words, the interaction with the eLearning platform should be smooth and unobtrusive (*R3.1*).

There is a connection between cognitive and emotive processes in human learning. It has been shown that users execute their tasks significantly worse if they are experiencing cognitive difficulties. The learning effectiveness, motivation and performance of the users are influenced by the "compatibility of cognitive styles and technology". Therefore, researchers nowadays concentrate on finding the dependencies between human learning, cognition and technologies. The purpose is to design systems, which take into account the differences in the learning styles, previous knowledge, culture and self-regulation skills of the users. Online learning systems should not be boring. They should support and encourage the learning process. [7]

As mentioned above, the art of interaction with technology has an effect on human emotions. This can be both positive and negative. Yet, current technologies cannot recognize this influence when it takes place [14]. We also stated that these emotions affect the user's performance, hence if one wants to improve the usefulness of a given system they have to take these emotions into account and clarify what triggered them. Thus, if a system cannot automatically detect emotions it should at least allow the users to indicate these emotions by themselves (*R4.2*).

2.8 Techniques for material annotation

The first step before deciding on a design for the annotation system is to consider the different possible annotation techniques. The problem of positioning and screen real estate is very complex and requires careful consideration [12]. It is especially difficult to find a good way to annotate plain texts. Switching their attention from the text to the comments section requires a considerable cognitive effort by the users [12]. Therefore, putting the comment section in a different pane might not be a good idea, since it can cause that the readers do not use the comment section at all [12]. Nevertheless, when adding an annotation to a specific part of the text, the reader first has to indicate the part of the text they are commenting and sometimes summarize it shortly [12]. Otherwise it would not be clear to what they exactly want to draw other users' attention.

The following four annotation techniques seem to be used the most:

- **Footnote** or **split screen**, where the annotations are placed at the end of the screen or some part of the text. (medium.com, telegraph.co.uk)
- **Interlinear**, where the annotations are embedded into the original text. (Facebook)

- **Mark-up** or **sticky note**, which represent the annotations in layers over the original text. (Moodle, edX, PDF editors)
- **Aligned** or **marginal**, where the annotations are inserted in the margins next to the text. (ILIAS, Google Docs)

[12]

According to Wolfe, the footnotes and interlinear annotations are the least useful for the learners, for instance, because they very often miss the comments pane in the end of the page [12]. One reason why the interlinear annotation is not so well seen might be that the readers can confuse the comments with the actual text. Mark-up and sticky notes are not a better alternative, because they do not provide the option for discussion and also interrupt the flow of the original text, which multiple users heavily dislike [12].

Wolfe states that displaying annotations in the margins suits best the needs of online learning systems [12]. However, it brings with itself another set of problems to solve. The margins are usually very small, still the text notes could sometimes be very extensive [12].

As mentioned above, one of the purposes for including an annotation feature to an eLearning platform is to provoke discussions between users. It appears that the annotation layout has a strong influence on the amount of discussions started by the users. According to Jakobs in comment sections, which appear as footnotes, there are significantly less discussions to be found in comparison to websites which provide forums to their customers [11]. She concludes that users see forums as places to discuss with other users, whereas they consider the comment sections as places to give their personal opinion to the primary text. However, the research is conducted on newspapers, not eLearning systems.

There is not enough research which concentrates on the comparison of these four annotation techniques. Therefore, here we want to discuss them shortly, giving our personal opinion.

Footnote and split screen annotations are indeed commonly used. They find applications in different contexts such as social media, online newspapers, blogs etc. In these cases the annotations are usually used to express an opinion concerning the whole text and apparently such a layout is comfortable for the users. However, it is true that if one asks a question about a particular part of the text, she or he has to summarize that part shortly. Furthermore, in an eLearning system it is expected that many questions arise. Thus, footnotes might be usable for very short texts, however, they become rather disruptive when the texts get larger.

A marginal annotation layout can be commonly seen in annotation editors. These are systems whose main purpose is to provide diverse annotation tools. However, they are usually used for personal notes, i.e. highlighting texts and adding notes in order to

clarify the content. In the context of eLearning systems, where interaction is crucial, the annotation layout should foster discussions. Users should be able to share their annotations with other course participants and thus communicate with them. On the one side, discussions need space, therefore the margin has to be enlarged. On the other side, the bigger the margin is, the smaller the pane with the original content is. Thus, marginal annotation layout can also cause users cognitive efforts.

Sticky notes do not provide enough space for discussions either. In practice, sticky notes are usually used as a way of supporting the learner-content and learner-instructor interactions. In other words, they are useful for learners who like adding personal notes to a text, in order to highlight important parts of it for the next time they read it, or for teachers who review students' assignments and wish to give them short feedback. Sticky notes can be made collapsible and thereby they do not disrupt the original content so much. Furthermore, they can be placed anywhere on the screen. Thus, it is clear to which part of the text each one of them refers. This makes them a useful annotation tool, however, not for the purposes of this thesis.

Interlinear annotations can indeed cause confusion when used for plain texts. However, eLearning courses normally consist of other elements too, for instance questions, images or short tasks. In this case, having the annotations right below each element might be useful. Firstly, it is obvious to which element the user refers. Secondly, there is enough space for discussions, which is one of the requirements for an interactive eLearning environment (*R2*). The discussion blocks can be made collapsible, so that the window is better arranged and more clear. The described layout is already used by Facebook, which is the most popular social network nowadays. This can be considered an advantage, because the layout would be familiar for course participants, who are already Facebook users.

Multiple online learning systems such as Moodle, Coursera or EDX use forums or chats as a way to help learners communicate. They are displayed in a different window and are accessible through each content window by clicking on buttons, usually marked as "discussion" or "forum". Forums and chats are often used in order to ask questions and not so much to give personal opinions. Obviously, the users have to indicate the part of the course they are talking about in their comments.

2.9 Short emotional feedback

Different websites require feedback from their users in the form of rating scales. Depending on the kind of a website the users might be asked to evaluate a product they have bought, an article they have read, a movie they have seen etc. For this purpose the web pages provide a scale, represented in different ways, for instance stars, hearts, emojis. The customers simply have to choose the pattern which corresponds to the level

of their satisfaction. These scales are easy to analyze and give very basic and valuable feedback about the users' opinion to the given product.

We consider it useful to receive feedback about the emotions triggered during the interaction with the labsystem. The purpose of this kind of feedback would not be to analyze what exactly each user found good or bad, but rather to acquire a general overview on which sections caused more trouble and which - less. Therefore, we believe short feedback in the form of emojis would exactly meet our purposes. We will call it *short emotional feedback*. This formulation rises the question of what is short emotional feedback and what - not.

In our view, short feedback, which represents the emotions triggered within the user during her or his interaction with the system, is short emotional feedback. It has to be able to represent different emotions, for instance happiness, frustration, confusion etc. These should be chosen by the course administrators according to their purposes. Therefrom, rating scales represented by stars cannot be considered a technique for giving short emotional feedback. Such scales only represent the user's level of satisfaction, however not her or his emotions. The situation changes if the administrator has given a particular question, which the users can answer with the help of a rating scale. If this question concerns the users' feelings, for instance "*How happy are you with our services?*", we can consider the rating scale as an opportunity to submit short emotional feedback. However, it only partially fulfills the criteria for a short emotional feedback technique, because it only represents one feeling. Therefore, in this thesis we will focus on short emotional feedback represented by emojis.

2.10 Summary of requirements

In the end of this chapter we want to summarize and shortly explain the recognized requirements. Most of them are based on the research presented above. However, we added a few more, which we personally consider important. All of the listed requirements are only connected to our two main topics - interaction and short emotional feedback. A well-designed online learning system should:

- **R1: Support interaction between diverse entities**
 - **R1.1: Learner-content** - the platform should help students handle the material, i.e. understand it and memorize it;
 - **R1.2: Learner-learner** - students should be able to communicate with peers through the eLearning system;
 - **R1.3: Learner-instructor** - students should be able to communicate with instructors and tutors through the eLearning system;

- **R1.4: Instructor-content** - after receiving the finished assignments from the students, instructors and tutors should be able to annotate the materials during the correction;
- **R1.5: Instructor-instructor** - the platform should support private communication between instructors;
- **R2: Support the diverse interaction modes**
 - **R2.1: Synchronous discussions** - all course participants should be able to lead synchronous discussions through the eLearning platform;
 - **R2.2: Asynchronous discussions** - all course participants should be able to lead asynchronous discussions through the eLearning platform;
- **R3: Be usable**
 - **R3.1: Smooth and unobtrusive interaction with the system** - the interaction with the eLearning platform should not interrupt or disturb the learning process;
- **R4: Provide feedback forms**
 - **R4.1: Immediate feedback and tips** - students should be able to post questions in the eLearning system so that tutors or instructors can answer them fast;
 - **R4.2: Short emotional feedback** - students should be able to indicate how they feel about the course and the learning materials.

To the requirements recognized in the scope of this chapter we added two more - *R1.4* and *R1.5*. We believe that a good eLearning system should support instructors in their interaction with the content and with each-other. Teachers should be able to annotate learning materials in the process of correction. Furthermore, they should be given the opportunity to communicate privately, through a chat for instance. Thus, they would be able to make decisions on the course structure and development or other topics, in which students do not necessarily have to participate.

Chapter 3

Related Work

In this chapter we present popular online learning systems in order to get an overview on the state of development of current technologies. We focus our attention on the kinds of interaction and short emotional feedback features each system offers. The first include for instance chats, discussion forums, messaging - as a representation of learner-learner and learner-instructor interaction, and text and video annotations or tagging as a type of learner-content and learner-instructor interaction. Types of short emotional feedback would be rating scales, depicted with symbols such as stars, emojis, hearts, thumbs etc. which serve to express the user satisfaction with a given material. Furthermore, for each presented eLearning system we indicate which of the defined requirements from Chapter 2 it fulfills.

3.1 Moodle

With its 105 million users Moodle is one of the most popular open-source eLearning systems nowadays. It is widely used for student assistance by schools and universities. It has over 81 thousand registered sites and offers more than 12 million courses. [15]

3.1.1 Interaction features

All possible questions and comments to the learning materials can be posted in a discussion forum provided for this purpose. Moodle offers three different types of forums depending on their purpose of use. The first one is the *Standard forum for general use*, where both students and teachers can start new threads (new discussions) or post their replies in old ones. A teacher can use the *Single, simple discussion* if they wish to keep the conversation focused on one concrete topic. In this type of forum students cannot start a thread themselves, but only comment on already existing ones. The *Question*

and Answer forum is appropriate when the instructor wants to receive an answer to a particular question by each participant. Generally, students can see the other answers only after they have posted one themselves. [15]

Teachers can annotate files (PDF, docx and odt) uploaded by learners, an option which the latter do not have. By clicking on it, the file is being displayed on the 'grading screen' where it can be annotated. One can use a variety of highlighting and underlining tools as well as sticky notes, if they have been uploaded by the administrator. Tutors can not only add annotations directly into the text but they can also post comments in a comment bank in the right margin of the screen as shown in Figure 3.1. On the one side, since the sticky notes can be positioned anywhere in the text, they might be a good choice for writing an annotation in the form of a few keywords, concerning a particular phrase or sentence. On the other side, if one wants to give a general feedback on the whole text or a big part of it, using the comment bank is the better alternative. It provides place for more extensive explanations. [15]

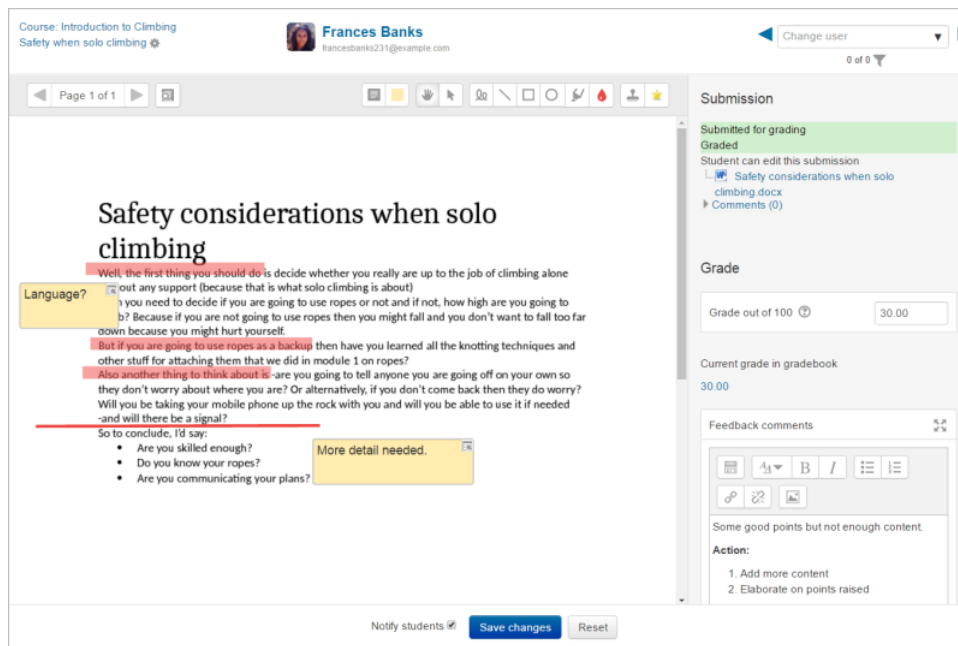


Figure 3.1: Moodle annotation feature for teachers ¹

Until recently, the whole content of each sticky note was fully displayed on the screen, without the possibility to be compressed. In some cases this can be very disruptive for the reader, because the notes interrupt the flow of the original text. Therefore, Moodle 3.3 offers a new feature - the notes can be collapsed into a small speech bubble, which indicates the presence of an annotation on a specific place [15]. Only after clicking on it the user can see its content. Furthermore, all annotations and comments are

¹Source: <https://docs.moodle.org/33/en/File:Annotatingsubmissions1.png>, July 2017

searchable [15]. An example of the layout of collapsed annotations is shown in Figure 3.2.

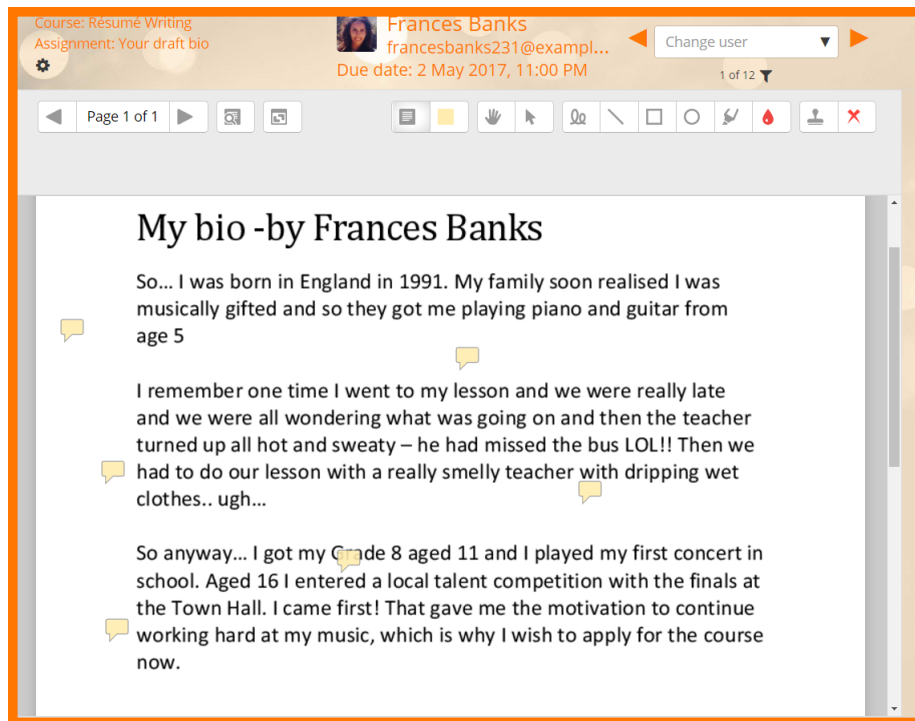


Figure 3.2: Collapsed sticky notes on Moodle ²

Another communication feature offered by Moodle is *messaging*. That is a chat where one can text other users privately. The chat has to be initially enabled by the administrator, otherwise it cannot be used. If a user has new unread messages a red icon with the number of people who wrote this person is displayed on top of the messaging icon. When composing a new message, one can either search by the name of the recipient or by the name of the course in which the recipient participates. For the first option, one has to have the one sought-after in the contacts list. Another way of messaging a particular person is by going to their profile and then selecting the option "*message*". [15]

3.1.2 Short emotional feedback

In order to improve the communication quality, Moodle 3.3 released a new feature - supporting emojis [15]. Now the users can add emojis anywhere where text can be added [15]. This includes forum posts, headlines and messages [15]. However, users cannot use emojis to rate courses or any kinds of learning materials.

²Source: <https://docs.moodle.org/33/en/File:33CollapsibleComments.png#file>, July 2017

3.1.3 Fulfilled requirements

Through the chat and discussion forum Moodle fulfills requirements *R1.2*, *R1.3* and *R4.1*. Furthermore, the chat itself enables the instructor-instructor interaction (*R1.5*). The annotation tool supports teachers in their interaction with the content (*R1.4*), however the feature is not available for students. Therefore, requirement *R1.1* is not fulfilled. The chat enables synchronous discussions and the forum - asynchronous ones (*R2.1*, *R2.2*). Moodle does not provide any tools for short emotional feedback (*R3.2*).

3.2 Coursera

Unlike Moodle Coursera is a platform which focuses on making online courses by universities all over the world available to everybody. It was first founded in 2012 and has so far 25 million users, over 2000 courses and is supported by almost 150 universities. Each course on Coursera has a different structure depending on the authors' teaching methods. Therefore, some courses might include features which others do not have. [16]

3.2.1 Interaction features

Since the courses on Coursera are mainly intended for self-education at home, without having any actual contact to the tutors or the other participants, it is extremely important for the users to be able to communicate through the eLearning platform. A discussion forum serves this purpose. There the users can share knowledge and experience, however such forums might sometimes be very extensive and full of redundant information. As a solution to that, at the beginning of 2017 Coursera introduced a new feature - *highlighted posts*. When a user starts a thread in the discussion forum they can select the most helpful responses and highlight them. As a result to that, those posts appear on the top of the discussion with a label "*highlighted post*" on them so that all other participants can see that these particular responses were most constructive. Thus the most useful information is stored at the beginning of every forum thread. Highlighting a post is also a way of showing appreciation to the person who wrote it in the first place. [16]

Since April 2017 Coursera offers an annotation feature for iOS users. They can take notes on videos only and the notes include a screenshot of the video, a text transcript to the moment when the screenshot was taken and the user's personal notes. Later the user can go through all their notes and with the help of the video transcripts remember the important points they annotated. However, this feature is still not available for Android or web users. [16]

3.2.2 Short emotional feedback

Coursera users can rate courses in which they have participated. For this purpose they are given a five-star rating scale where they can pick the number of stars reflecting their level of satisfaction. More stars represent a better impression of the course and a better experience with it. The participants can also submit a short reasoning for their rating and thus other Coursera users can see both the ratings and the feedback to a course before enrolling in it. However, they cannot give feedback concerning their emotions. [17]

Furthermore, each member of a course can rate the provided learning materials. For this purpose a simpler rating scale is used - a thumbs-up icon for helpful materials and a thumbs-down icon for unhelpful ones. Participants can rate only videos, readings and quizzes. Their feedback can only be seen by the course instructor and none of the other members. This feature is used to help teachers organize their courses better. [17]

3.2.3 Fulfilled requirements

Similarly to Moodle, Coursera supports *R1.2*, *R1.3* and *R4.1* due to the fact that it provides a discussion forum. The learner-content interaction is supported only partially since the annotation feature is only available for Android users and only videos can be annotated. Coursera provides only one interaction mode, namely asynchronous communication (*R2.2*). The opportunity to rate a material with a thumb-up or down can be considered a type of short emotional feedback (*R4.2*). It is a way of determining whether someone likes or dislikes the material. However, no emojis are used and thus, no other emotions can be expressed. Therefore, we can consider the requirement only partially fulfilled.

3.3 edX

EdX is an online learning platform which, similarly to Coursera, offers *massive open online courses* (MOOCs), however in its dimensions it is slightly smaller. It has more than 10 million users, offers almost 1300 courses and is supported by over 110 universities. Yet, edX has some useful features to offer, which Coursera does not. The courses in edX are supported by an open-source platform called *Open edX*. [18]

3.3.1 Interaction features

The *Student Notes* feature enables students to annotate plain texts in their courses. A blue pencil icon appears at the bottom-right corner of the screen (Figure 3.4) when the content is annotatable. When the user selects text, a pencil icon occurs above the

selection. After clicking on it, the user can enter personal notes and then save them, as shown in Figure 3.3. The learner can search her or his notes in the *Notes* tab. All annotations appear as a block consisting of the selected text from the original source and the personal notes. Once the user has found the necessary annotation, she or he can go to its exact location in the course by selecting the link below *Noted in*. EdX users can annotate images and videos in a similar way [19]. However, this feature is not yet available for exercises, video transcripts and PDF textbooks. [18]

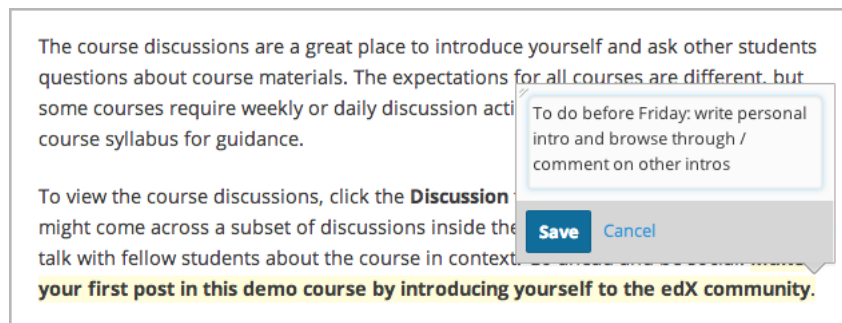


Figure 3.3: Annotate highlighted text on edX ³

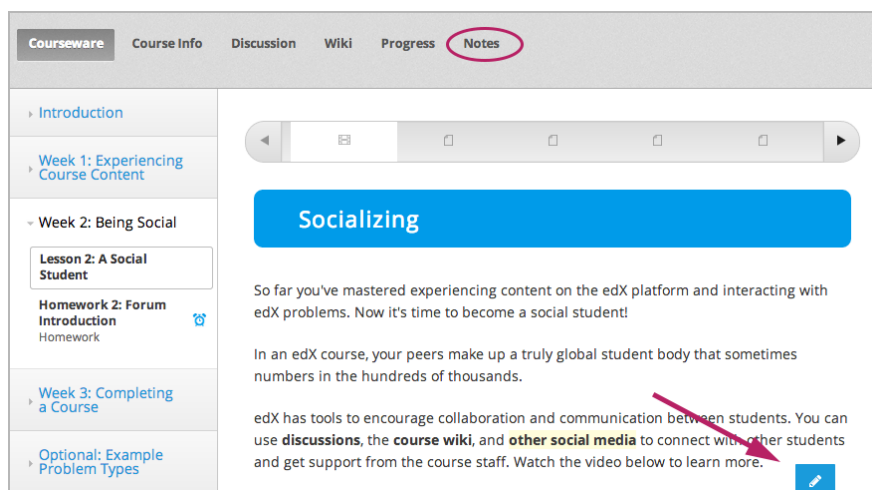


Figure 3.4: Student notes on edX ³

A further feature enables edX users to add *tags* to their notes as shown in Figure 3.5 [18]. The motivation behind this feature is to allow learners to organize greater sets of notes better. They can use tags in order to arrange notes by category and content [18]. Thus, they can later have an overview on all their notes concerning the same topic. Furthermore, when searching for an annotation in the *Notes* tab, one can sort the notes by tags, so that those with most frequently used tags appear on top of the list [18]. Tags make annotations easier to find, especially in the case that the student has many of

³Source: <https://open.edx.org/features/student-notes>, July 2017

them. Nonetheless, tags help learners recognize similar contents in the course materials and thus organize the flow of their thoughts better.

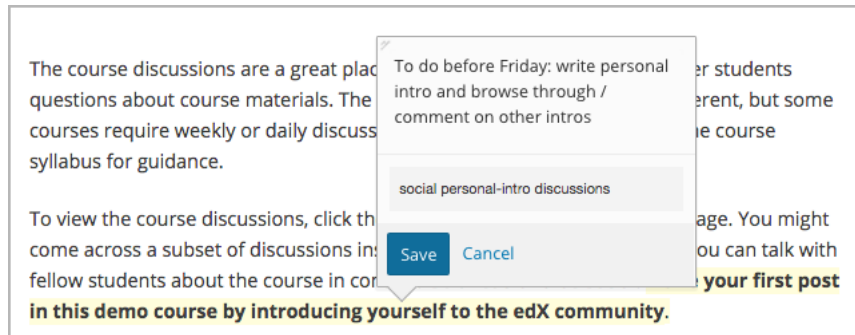


Figure 3.5: Adding a tag to a note on edX ⁴

As a communication tool, the users of edX are provided with a discussion forum for each course. When starting a new thread in the forum, the user can indicate whether the post is going to be a question or a discussion. In addition to that, when responding to a forum question, the user can denote her or his post as an answer. This can be done by the administrator as well. [18]

The possibility to divide course members in *cohort-specific* groups allows the course organizers to start discussions which only the members of chosen cohort groups can see and take part in. [18]

3.3.2 Short emotional feedback

On edX users can post anonymous reviews to the courses, where they can rate the course content, the instructor and the provider separately. Similarly to Coursera, the edX rating scales are depicted with five stars and the user selects the appropriate number of stars she or he wishes to give. One can write a short review of the course as well. However, no emojis are used in order to send short feedback to the course administrators. [18]

3.3.3 Fulfilled requirements

EdX fulfills requirements *R1.2*, *R1.3* and *R4.1* because it disposes of a discussion forum. Furthermore, the system supports learner-content and instructor-content interactions (*R1.1*, *R1.4*) through the provided annotation feature. Teachers or tutors cannot communicate privately through the eLearning system, therefore requirement *R1.5* is not fulfilled. Similarly to Coursera, edX supports only asynchronous discussions (*R2.2*). No tools on edX enable short emotional feedback (*R2.2*).

⁴Source: <https://open.edx.org/features/tags-notes>, July 2017

3.4 ILIAS

ILIAS is an online learning system which has been developed in Germany and is one of the first ones to be used by universities [20]. It uses integrated tools in order to facilitate teaching and learning at universities and business companies.

3.4.1 Interaction features

ILIAS disposes of an annotation feature which allows users to add notes to their desktop or directly to learning materials. In order to create a general annotation on the personal desktop, the user has to go to the *Notes and Comments* section, enter text and then click on *Add Note*. When annotating a specific learning material, one can choose whether they want to make their notes public or keep them private. Just like desktop notes, private notes can be saved and viewed repeatedly. There are multiple ways to call the annotation function on learning materials in ILIAS. Regardless of how the user accesses this function, the annotation layout is the same. An additional field opens in the right margin of the screen so that the user can enter text and see previous notes listed one beneath the other. Furthermore, the user can specify whether the annotation as a question, something important, a pro or a contra statement. All notes are visible on the personal desktop and by clicking on them one can go directly to the document for which they are relevant. [21]

When the user decides to make a public annotation on an ILIAS object, it is no longer called a note, but a comment. In order to be used, the comment option has to first be activated by the administrator. Comments can be either entered in a field below the original content of the object or in the right margin next to it. All other users who have access to the document can see the comment, again both below the text or next to it. [21]

Users can add tags to their annotations in order to be able to organize them better. Private tags appear on the right side of the personal desktop and by clicking on them the user can go directly to the object where the annotation was added. If made public, the tags build tag clouds and can be seen by other participants in the *Info* section of the object. The more often a term is used as a tag the larger it appears in the tag cloud. Thus users can naturally distinguish between more common and probably more useful annotations and those, which are less relevant. Furthermore, the tag clouds allow users to find other users with a similar way of thinking. [21]

In order to communicate with the instructors and other participants on more general topics, the users can post in a discussion forum. In contrast to Moodle or Coursera discussion forums, where there is one for each course and only its participants have access to that forum, in ILIAS all discussions are available to all users. Each discussion

has a topic, given by the one who started it, thus users can take part in all discussions, which they find relevant. A further communication option are the *chat rooms*, which can be created by anyone who is given the necessary permissions. In the chat room one can invite as many users as wanted and once they have accepted to participate in the group they can chat with the others. This is a useful feature for those, who rather keep their discussions private or only contact particular people. [21]

3.4.2 Short emotional feedback

ILLAS provides its users with a five star rating scale for quality evaluation of all learning modules. When setting a rating function, course administrators can specify *rating categories* and thus enable participants to evaluate different aspects of the learning materials, for instance usability, layout or intelligibility. This feature reminds of the evaluation feature used by edX, however if no rating categories are specified, the users have to rate a module as whole. The system does not use emojis as a feedback option. [21]

3.4.3 Fulfilled requirements

ILLAS is the only system presented in this thesis, which supports all kinds of interaction between the diverse entities (*R1*). The chat, discussion forum and annotation feature enable communication between all course participants as well as interaction with the content. Furthermore, both kinds of interaction modes and immediate feedback are supported by the same features (*R2, R4.1*). However, there are no tools for emotional feedback provided (*R4.2*).

3.5 Beyond eLearning systems

As can be observed by the the descriptions above, popular online learning systems tend to use different forms of rating scales in order to receive short feedback about their materials and courses. However, none of them uses emojis for this aim. Our purpose is to integrate modern social feedback techniques into eLearning, therefore we particularly want to use emojis instead of rating scales. For this reason, in the next subsection we present a social network where the emojis have these exact applications.

3.5.1 Facebook

In February 2016 Facebook released the so called *emoji reactions* as an extension of the previously used thumbs-up or "like" buttons [22]. Nowadays Facebook users can give their opinion to posts, pictures, videos and comments by selecting one of these

reactions. The emotions express six different feelings or reactions - like, love, laughter, surprise, sadness and anger [22]. Since 2009 Facebook was using only thumbs-up icons, however, users kept requesting a thumbs-down icon as a representation of dislike. This was a very controversial topic because of the enormous positive influence of the "like" button on brands, advertisement and web publishers [23]. The "dislike" button was expected to damage the business connection between Facebook and the brands, which advertise their products on the social network [23]. Therefore, the emoji reactions came as a settlement by compromise.

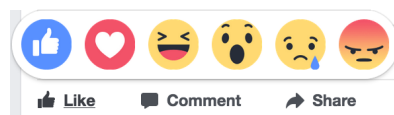


Figure 3.6: Selecting an emoji reaction

One year after the release of the emoji reactions, Facebook stated that the "love" reaction was used most. Within one year there were 300 billion reactions used and half of them were "love". However, this statistic does not include the usage of the popular "like" button. [24]

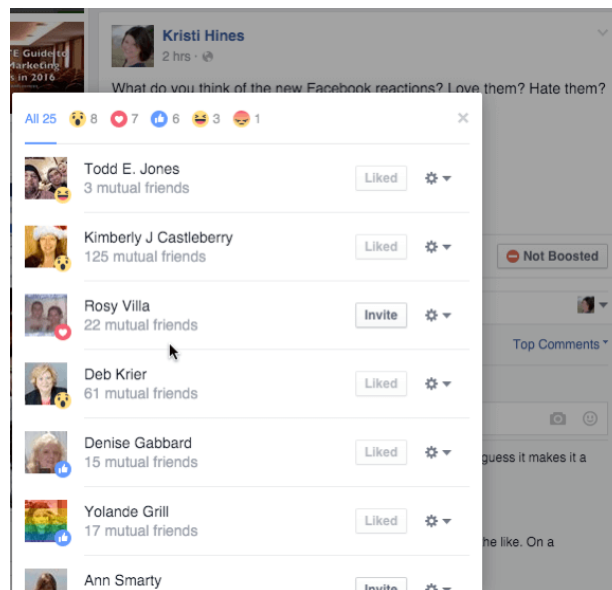


Figure 3.7: Seeing other users' reactions ⁵

Beneath each post Facebook users can see three options - "Like", "Comment" or "Share". As shown in Figure 3.6, by placing the mouse on the "Like" option a pop-up window displays all possible emoji reactions and the user can select one of them. This functionality

⁵Source: <https://www.quora.com/Facebook-reactions-is-it-a-change-in-social-media-approach>, July 2017

works for comments as well. Furthermore, the number of people who reacted to the post is displayed below it, as well as the kinds of reactions given. Out of simplification reasons, one can only see the three most frequently used emojis. After clicking on this summary one can see the exact list of names of people and their reactions to the post. An example can be observed in Figure 3.7. [25]

The decision on which kinds of reactions the new emojis should depict was based on a careful analysis of one-word comments on posts as well as the most commonly used emojis and stickers in the Facebook chat. According to Julie Zhuo, who participated in the emoji reactions project, Facebook users were most likely to express love, sadness, shock or humor in a visual way, i.e. through emojis or stickers. However, the chat provides a very extensive palette of emojis which overlap in their emotional meanings. Therefore, it was important to select only emojis which represent completely different feelings in order to avoid redundancies. Another important aspect is that the expression of each emoji had to be clear irrespective of the cultural background of the user. As a result, Facebook came up with the six already known emoji reactions. [22]

3.6 Summary

Current eLearning systems have already recognized the necessity of communication tools for a better learning process. Most of them have integrated tools for supporting learner-learner and learner-instructor interactions, probably in attempt to most accurately recreate the conditions in a real classroom. However, annotation features are just starting to become popular and are not yet widely available for students. At present, the labsystem does not dispose of any of the most typical interaction features, observed in the online learning platforms described above. Therefore, we want to improve the quality of the labsystem by implementing a feature which enables interactive material annotations.

Table 3.1 summarizes the fulfilled requirements by each system, presented in this chapter. The last row depicts which requirements the labsystem should fulfill in the scope of this thesis.

eLearning systems	Requirements									
	Interaction between entities					Interaction modes		Usability	Feedback forms	
	<i>R1.1</i>	<i>R1.2</i>	<i>R1.3</i>	<i>R1.4</i>	<i>R1.5</i>	<i>R2.1</i>	<i>R2.2</i>	<i>R3.1</i>	<i>R4.1</i>	<i>R4.2</i>
Moodle		✓	✓	✓	✓	✓	✓	✓	✓	
Coursera	~	✓	✓				✓	✓	✓	~
EdX	✓	✓	✓	✓			✓	✓	✓	
ILLIAS	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Labsystem		✓	✓				✓	✓	✓	✓

Table 3.1: Summary of the requirements fulfilled by each examined eLearning system. Fulfilled is marked with "✓", partially fulfilled - with "~". Empty fields indicate an unfulfilled requirement.

One can easily notice that all examined eLearning systems support learner-learner and learner-instructor interactions, asynchronous discussions and immediate feedback (*R1.2, R1.3, R2.2, R4.1*). This is due to the fact, that these features are dependent upon each other. In other words, if a system supports asynchronous (or synchronous) discussions it automatically enables learners to interact with their instructors and peers. In the process of communication one can always receive feedback and tips. On eLearning platforms synchronous discussions can be held through chats. Not all of the reviewed systems dispose of a chat, which explains why synchronous discussions were not supported as much as asynchronous. Furthermore, the chats provided by Moodle and ILIAS support instructor-instructor interactions (*R1.5*). Three out of four systems enable instructor-content interaction and two of them enable learner-content interaction (*R1.1, R1.4*). However, Coursera is planning to integrate more annotation tools and thus allow learners to interact with all kinds of learning contents and not only video materials. From all online learning systems only Coursera partially offers short emotional feedback (*R4.2*). One can express whether they like or dislike a material. However, the typical for social networks emojis are not applied for this purpose by any of the systems. We believe that an interactive eLearning system should apply such features, since social networks have been specifically designed to foster communication.

We consider all reviewed online learning platforms usable (*R3.1*), because of the great number of users they have. However, whether the interaction with the system is smooth and unobtrusive can only be determined precisely after a user survey.

As shown in the last row of table 3.1, our aim is to extend the lab system in such a way, that it is usable and can keep up with the already existing systems. Therefore, we will add annotation tools which support learner-learner and learner-instructor interactions (*R1.2, R1.3*). Furthermore, it will enable asynchronous discussions and immediate feedback (*R2.2, 4.1*). The one feature which will distinguish the lab system from the other eLearning platforms is the short emotional feedback represented by emojis (*R4.2*).

In the scope of this thesis we stipulate the development of two concrete features:

- **an interactive annotation feature**
- **emoji reactions**

Users should be able to annotate and give short emotional feedback in the form of emojis for every element of the lab system. A detailed plan for the development of these two features can be found in the next chapter.

Chapter 4

Design

In Chapter 2 and Chapter 3 we set the goals of this thesis, substantiated them and gave an overview of systems which already implement such features. We discussed diverse techniques for achieving them as well as their typical applications. In this chapter we give a detailed description of our method of approach. The main focus stays on interactive learning and short emotional feedback. For each implemented feature we will provide statistical information for teachers.

It is essential to remember and understand the labsystem elements, presented in Chapter 2. They are the base for the design of the new features.

4.1 Interactive annotation feature

As stated in Chapter 3, the labsystem has to fulfill the following requirements, concerning interaction:

- It supports learner-learner interaction (*R1.2*);
- It supports learner-instructor interaction (*R1.3*);
- It enables asynchronous discussions (*R2.2*);
- It enables users to give each other immediate feedback and tips (*R4.1*).

Our aim is to achieve this through an interactive annotation feature. It should enable the annotation of elements p , m , i and s . Making all notes visible for the other course participants would foster interaction between them. Thus, learners and instructors would be able to discuss each of the iLab elements and give each other valuable feedback during the communication.

In chapter 2 we discussed possible layouts for material annotation. Since our purpose is to allow users to interact through the annotation feature, we need to choose a layout

which suits best this application. A discussion requires enough space and has to be easy to follow. Furthermore, it should not disrupt the original content. This cannot be achieved though sticky notes because they are too small. They can be positioned anywhere on the screen and thus do not provide structure for a discussion. Footnotes do not fit the characteristics of the lab system well. A page of a lab usually consists of more than one elements. If all annotations are located at the bottom of the screen it would not be clear to which element each annotation refers. A marginal layout offers enough space for interaction, however, similarly to the footnotes, the link between element and annotation stays unclear. The users would have to address the exact lab content at the beginning of every annotation.

Having an annotation section beneath each element on a page makes the content-annotation reference clear. It might seem that interlinear annotations disrupt the flow of the original content and do not provide enough space for discussions. However, one can avoid that by choosing an appropriate design. Space on the screen can be saved by making the annotation sections collapsible. In such a way they do not disrupt the original text. After opening the annotation section users are provided with enough space to develop a discussion. Whenever they do not want to read other annotations they can simply close the section and concentrate on the content of each element. Bearing that in mind, we consider such a layout most suitable for the purposes of the iLab course.

Users should be able to add their notes below each *p*, *m*, *i* and *s* element of the lab system. Annotations will be visible for all course participants. Thus, when a user has added a note, all other users will see it and will be able to comment it. Consequently, an asynchronous discussion arises. Furthermore, designed in this way, the interactive annotation tool enables learners to communicate with instructors and peers through the lab system. Immediate feedback and tips can be given in the process of this communication.

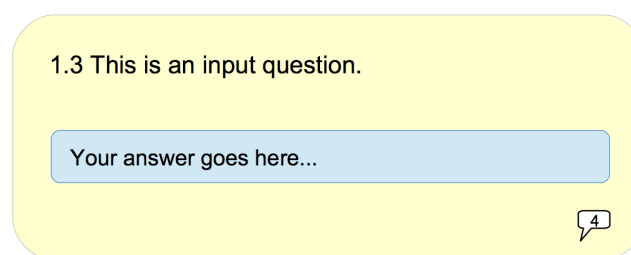


Figure 4.1: Example of an icon representing the collapsed interactive annotation feature

In order to keep the page well-arranged and its content clear, the annotation panes should be collapsible. In such way one saves space on the screen and brings the more important contents to the fore. A small icon in the bottom right corner of each element would indicate the presence of a comment block, as well as the number of already posted comments. In order to keep the icon small and inconspicuous, the number of

annotations is displayed in the speech bubble itself. An example of this can be seen in Figure 4.1. Only after clicking on this icon, the user will be able to see the content of the annotation section and add notes herself.



Figure 4.2: Example of embedded annotations in two layers.

The layout of the annotation sections is crucial for fulfilling the four requirements defined above. In order to support diverse interaction and asynchronous discussions, the annotations have to be well-structured. We expect users to discuss different topics in the same annotation section. If all notes appear in one layer, i.e., beneath each other, in chronological order and in the same size, the structure of the discussion would be lost. Users would not be able to find the reference between the diverse annotations and follow each topic. Designing the annotation section in an embedded way would improve the transparency of the discussions. If a user has added a comment and another user wishes to give an answer or opinion to this comment, the system should indicate it by placing the second annotation in a different layer. Thus, one can easily discern to which topic an annotation refers. An example can be seen in Figure 4.2.

That rises the question of how many layers the system should provide. Being able to annotate each annotation has the advantage that the discussion is very well structured. The relation between diverse annotations is perfectly clear. However, the annotation section becomes overladen and thus less usable, especially if the user has to unfold annotations in lower layers. We believe that two layers provide a good balance between usability and clarity. More than two layers would make the discussions confusing.

4.2 Evaluation of annotations

For the course administrators it would be helpful to have an overview of the number of annotations per element. A topic which provoked more discussions can be considered important and might require further examination. Therefore, we will create a bar chart for each assignment. The horizontal axis will represent the elements, appearing in the order in which they appear in the lab. In order to represent the elements, we will use their unique addresses. The vertical axis will represent number of annotations.

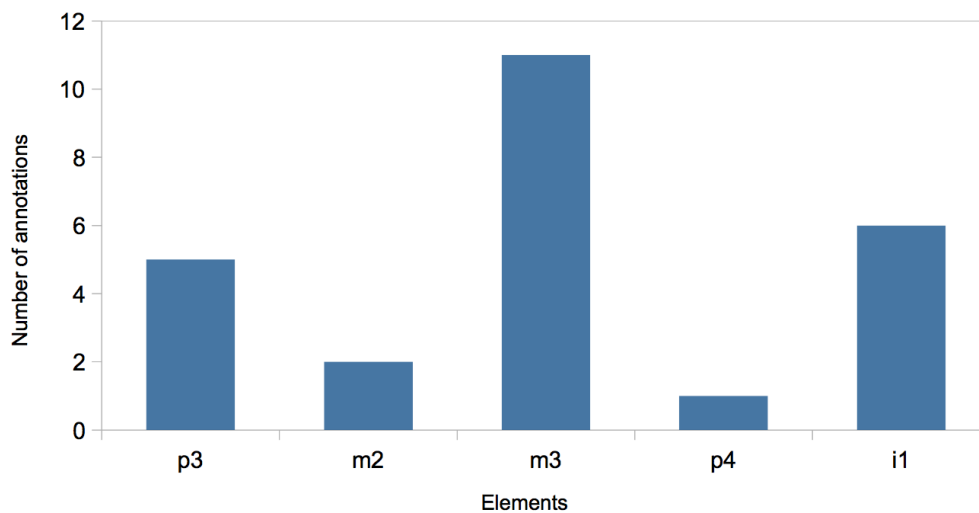


Figure 4.3: Example of a bar chart representing the number of annotations per element.

4.3 Emoji reactions

Users shall be given the opportunity to give short emotional feedback for each p , m , i and s element. The annotation feature and the emotional feedback are connected. Therefore, it is appropriate to place the emoji reactions next to the icon for annotations, as shown in Figure 4.4.

In order to save space, we will not display the number of selections for each emoji directly on the screen. Instead, the size of the emojis will vary depending on the number of people who selected them. The function we use for adjusting the size is explained more thoroughly in the next chapter. The exact number of selections will appear in a pop-up above each emoji. Users would be able to trigger that pop-up by hovering over an icon.

For the purpose of the iLab courses, it is particularly important that the labsystem users can indicate their feelings regarding the content of an element in the case that:

- They liked the content.
- They were confused by the content.
- They found the content boring.
- They did not like the content.

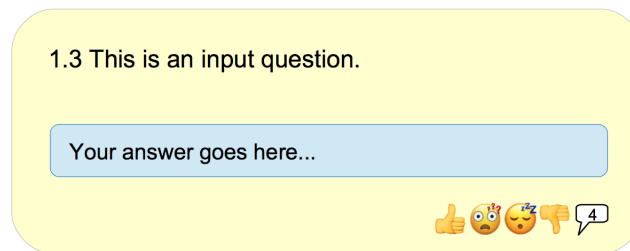


Figure 4.4: Example layout and positioning of emoji reactions.

We asked 29 people to choose an appropriate emoji for each of the cases listed above. For each feeling we suggested three different emojis. Then we asked the participants to pick the one which according to them most accurately represents that feeling. Figures 4.5, 4.6, 4.7, 4.8 depict the proposed emojis and the participants' choice for each feeling representation.

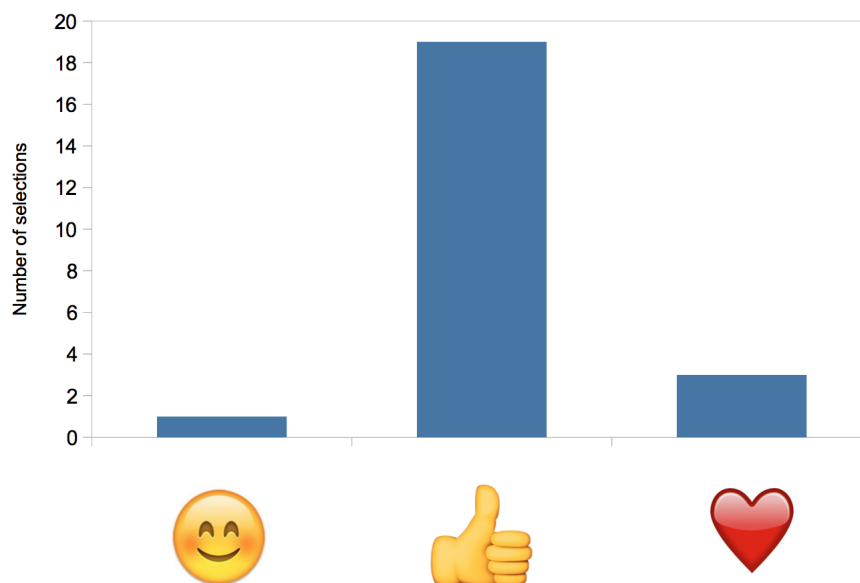


Figure 4.5: The survey participants' choice for an emoji, which serves to indicate that they liked the content. The horizontal axis depicts the proposed emojis. The vertical axis indicates how many people selected an emoji.

When asked which emoji they would use in order to indicate that they liked the content of the material, almost all participants chose the "thumbs-up" emoji (4.5). Three subjects

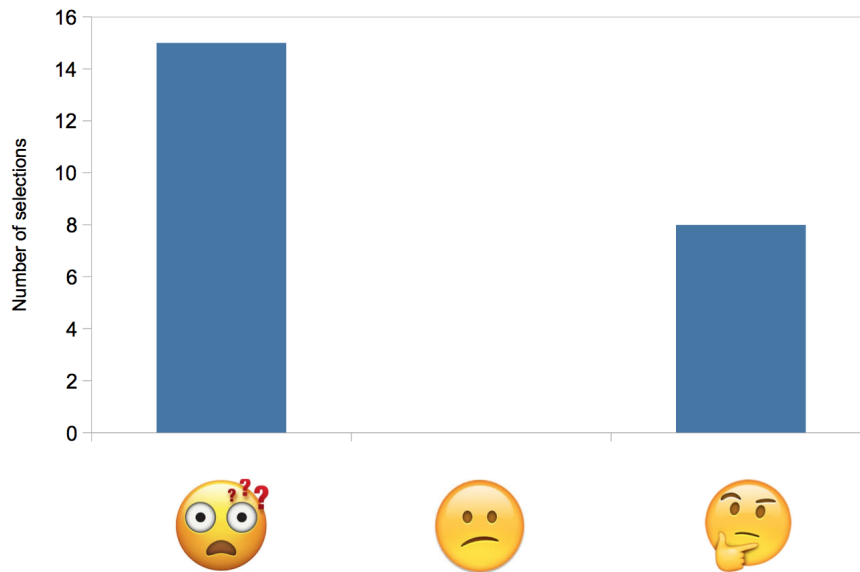


Figure 4.6: The survey participants' choice for an emoji, which serves to indicate that they found the content confusing. The horizontal axis depicts the proposed emojis. The vertical axis indicates how many people selected an emoji.

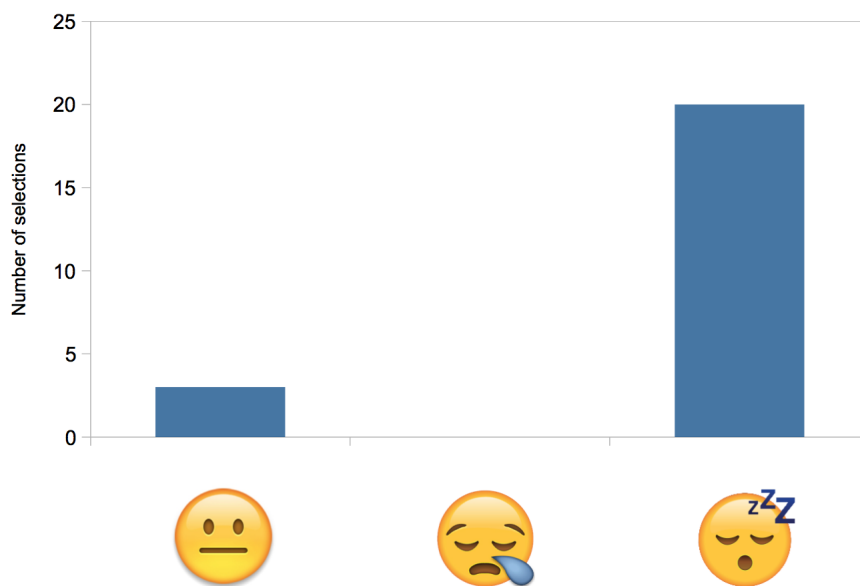


Figure 4.7: The survey participants' choice for an emoji, which serves to indicate that they found the content boring. The horizontal axis depicts the proposed emojis. The vertical axis indicates how many people selected an emoji.

selected the "heart" emoji and only one person picked the "smiley face". This could be ascribed to the fact that the "thumbs-up" emoji became especially popular with the development of Facebook.

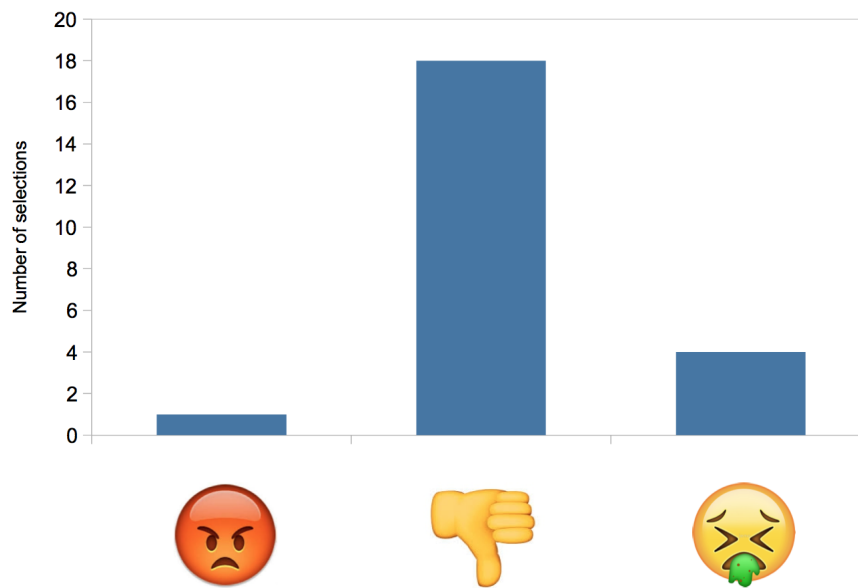


Figure 4.8: The survey participants' choice for an emoji, which servers to indicate that they did not like the content. The horizontal axis depicts the proposed emojis. The vertical axis indicates how many people selected an emoji.

We asked the participants to chose an emoji which they would use in order to indicate that they found the content of the material confusing. Eight of the participants picked the "thinking face" and all the other fifteen selected the "confused" emoji with question marks. Even though the third emoji was actually created with the purpose of expressing confusion and was therefore called "confused" emoji, none of the participants chose it (4.6).

It is important that the iLab course participants can point out whether they consider the content of an element boring. According to twenty of the survey participants the "sleeping" emoji represents this feeling most accurately. Only three people chose the "bored" emoji and none of them selected the "sighing" one (4.7).

When it comes to representing dislike, eighteen participants selected the "thumbs-down" emoji. Four of them chose the "puking" emoji and only one person picked the "angry face" (4.8). The participants' choices for emojis representing like and dislike are very similar. The two feelings are the exact opposite of each other. Logically, the selected emojis ("thumbs-up" and "thumbs-down") are contrary to each other.

4.4 Evaluation of emoji reactions

Similarly to the interactive annotation feature, we wish to have an overview of the most frequently used emojis. Figure 4.9 illustrates how the short emotional feedback statistics

would be depicted. For each element one can see the distribution of emoji selections. The four emoji reactions are represented by colors which can be seen in the legend on the right side of the graphic. The elements are represented by their unique IDs. Thus, the course administrators would be able to see which elements were the most liked, which caused the most confusion or boredom and which were the most disliked.

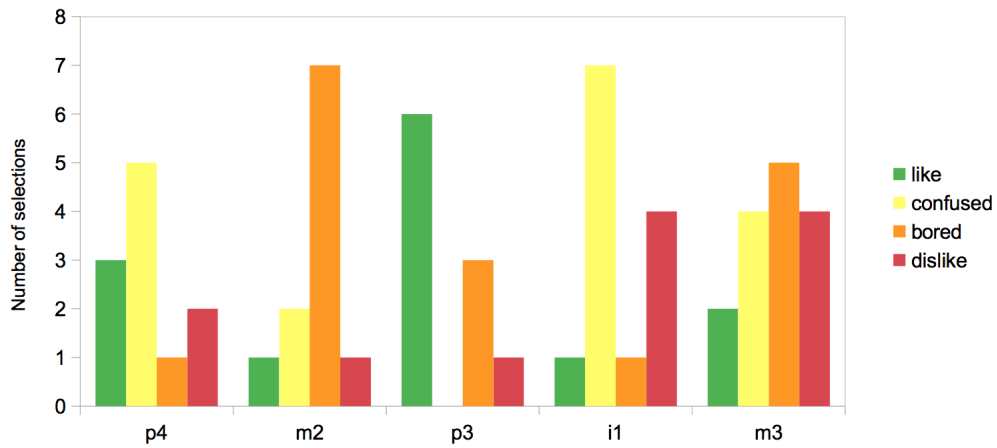


Figure 4.9: Example of a bar chart representing the distribution of emoji selections per element.

Chapter 5

Implementation

This chapter describes our approach to the implementation of the two new features. We only focus on the more specific and complicated development steps. The source code of the labssystem is written in *PHP*.

5.1 Interactive annotation feature

The annotation sections have to be collapsible. Therefore, we needed a button which serves for expanding and collapsing an annotation section. All labssystem elements have a similar design. They all have buttons with diverse functions. For instance, history buttons which show who was the last user to edit the content of a given element. The creation of a button happens in class *ElementButtons*. Later they are collected in menus in class *ElementMenus*. An element can have a top and a bottom menu, which include different buttons.

We created a speech bubble button and added it to the bottom menu of all *p*, *m*, *i* and *s* elements. An example of this was already shown in Chapter 4, Figure 4.1. By clicking on the speech bubble a hidden division opens. It contains the whole annotation section.

In order to explain how the annotations in each section are displayed, we first need to clarify how an annotation is stored in the database. All annotations are kept in the *WorkingDatabase* of the labssystem. That is the database which stores short-term information. The reason why that kind of data is seen as short-term data is that a new iLab course starts each semester. The new course has new participants, new assignments and therefore, new empty annotation sections.

The table in which all annotations are stored is called *Annotations*. One row of that table stores one annotation. As can be seen in Figure 5.1, an annotation has six properties. It stores the ID of the element to which the annotation belongs and the ID of the user who wrote it. Each annotation has a unique ID, a date on which it was added and a

elemId	uid	anntId	parentId	postedOn	annotation
I2.C6.c4.i3	...	1	0

elemId	uid	anntId	parentId	postedOn	annotation
I2.C6.c4.i3	...	2	1

Figure 5.1: An example of a first-level annotation and a reply.

text body. An important property is the parent ID. Since the annotations are going to be embedded, we need to store the ID of the annotation to which another annotation refers. First-level annotations have parent ID equal to zero.

An annotation section is build by three *PHP* functions (Figure 5.2). They go through all entries in the *Annotations* table and display them in the correct order with the right embedding. In Figure 5.2 one can see the source code of those functions.

The first function - *listFirstLevelAnnt*, retrieves all first-level (parent) annotations of an element. This happens through the *selectFirstLevelAnntForElement* function which sends an *SQL* query to the database and returns its result. In the next step, the function goes through all retrieved annotations and calls the *getAnnotations* function on them. The latter creates the *HTML* representation of each first-level annotation.

There is one main difference in the representation of a parent and a child annotation. The first one has a "Reply" option in the bottom-right corner. The latter does not. In this way we achieve an embedding in only two layers.

Function *getAnnotations* checks for replies to the given annotation. If there are such it calls the third function - *getReplies*. It creates an unordered list containing all replies. The return value of *getReplies* is attached to the return value of *getAnnotations*. Thus, by calling *listFirstLevelAnnt* and passing the required parameters one can create an annotation section for each element of the labsystem. Figure 5.3 shows the layout of the actual visualization of the interactive annotation feature.

```

function listFirstLevelAnnt($elemId, $uid, $date) {
    $r = "";
    // get all first-level annotations for this element
    $result = $this->selectFirstLevelAnntForElement($elemId);

    // create the HTML representation of each first-level annotation and its replies
    while ($row = $result->fetch_assoc()) {
        $r = $r . $this->getAnnotations($row, $elemId, $uid, $date);
    }

    return $r;
}

function getAnnotations($row, $elemId, $uid, $date) {
    global $pge,$uDBI;
    $userData = $uDBI->getData4($row['uid']);
    $name = $userData['foreName'] . " " . $userData['name'];

    // create the HTML for a first-level annotation
    $result = "<li class='annt'>
        <div class='authorInfo'><img class='authorInfo' src='.././syspix/anonymous.png'></div>
        <div class='anntContent'>
            <header>". $name . " posted on " . $row['postedOn'] . "</header>
            <p>". $row['annotation'] . "</p>
        </div>
        <a tabIndex=\"\" . $pge->nextTab++ . \"\" href=\"\" .
            $row['elemId'] .
            \"\" .
            \"\" onMouseUp=\"if (document.getElementById('replySection_\" . $pge->nextTab .
            \"\") . style.display != 'block') document.getElementById('replySection_\" . $pge->nextTab .
            \"\") . style.display = 'block'; else document.getElementById('replySection_\" . $pge->nextTab .
            \"\") . style.display = 'none';\" onClick=\"return false;\" .
            \">Reply
        </a>
        <div class='labsys_mop_container' id=\"replySection_\" . $pge->nextTab . \"\">
            <form class='replySec' action='.././php/annotationReply.php' method='post'>
                Your reply: <input type='text' name='reply'>
                <input type='hidden' name='elemId' value=\"\" . $elemId . \"\">
                <input type='hidden' name='uid' value=\"\" . $uid . \"\">
                <input type='hidden' name='parentId' value=\"\" . $row['anntId'] . \"\">
                <input type='hidden' name='postedOn' value=\"\" . $date . \"\">
                <input type='submit' value='Submit Annotation'>
            </form>
        </div>";

    // check for replies
    $replies = $this->findRepliesToAnnt($row['anntId']);

    // if there are replies - create their HTML representation
    if ($replies->num_rows > 0) {
        $result .= $this->getReplies($replies);
    }

    // if there are no more replies - finish the HTML for the first-level annotation
    $result = $result . "</li>";

    return $result;
}

function getReplies($replies) {
    global $uDBI;

    // start a list of replies
    $result = "<ul>";

    // create the HTML for each reply
    foreach ($replies as $row) {

        $userData = $uDBI->getData4($row['uid']);
        $name = $userData['foreName'] . " " . $userData['name'];

        $result .= "<li class='annt'>
            <div class='authorInfo'><img class='authorInfo' src='.././syspix/anonymous.png'></div>
            <div class='anntContent'>
                <header>\" . $name . \" posted on \" . $row['postedOn'] . \"</header>
                <p>\" . $row['annotation'] . \"</p>
            </div>
        </li>";
    }

    // finish the list
    $result .= "</ul>";

    return $result;
}

```

Figure 5.2: Source code which serves for displaying each annotation section.

5.2 Short emotional feedback

The emoji reactions, representing the short emotional feedback feature, have to appear at the bottom right corner of each p , m , i and s element. Similarly to the speech bubble button, we created four new buttons, which we included in the bottom menu of each



Figure 5.3: A screen shot of the actual visualization of the two new features.

one of those elements. For the visualization of each button we used the images of the emojis presented in Chapter 4. In order to make the meanings of the four emojis even more clear, we developed pop-ups for each image. They contain the name of the emoji and the number of times it has been clicked. As can be seen in Figure 5.4, the size of each emoji is different. It depends on the number of times the emoji has been selected for that element and the total selections of the emoji in the whole collection. Thus, the users receive a visual overview of the number of emoji selections per element.

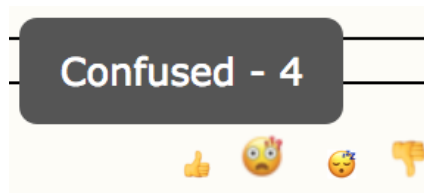


Figure 5.4: A screen shot of the actual visualization of the short emotional feedback feature. The cursor is placed on the second emoji from the left.

The information about which emojis were selected for each element are kept in the *Emoji_selections* table in the *WorkingDatabase* of the labssystem. In Figure 5.5 one can see the two tables storing the information about the emoji reactions. The table on the left (*Emoji_selections*) stores three identifiers. The first is the one of the element, for which an emoji reaction was selected. The second one indicates which user has done the selection. The third identifier is the one of the emoji itself. Another table called *Emojis* (Figure 5.5, right) stores the diverse types of emoji reactions. This implementation allows us to add new emoji reactions in the future without any complications. A user is allowed to select only one emoji per element. This is ensured by setting the first two columns of the *Emoji_selections* table as primary key.

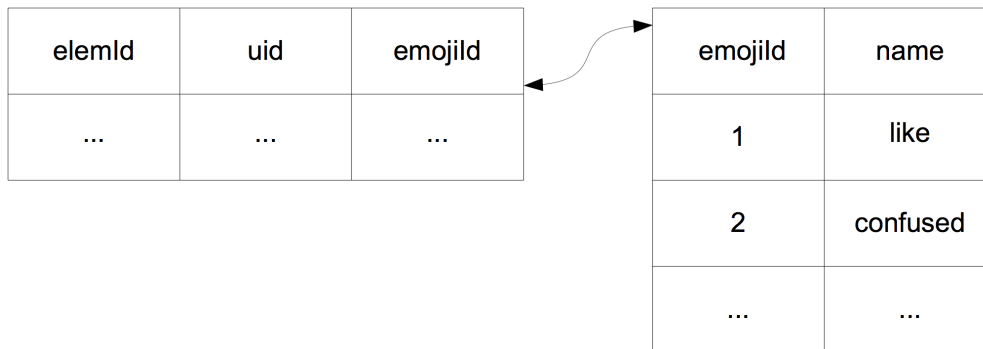


Figure 5.5: Database tables for emoji inputs.

After a user clicks on an emoji reaction the system creates a new entry in *emoji_selections*. In order to prevent unnecessary reloading of the page we use *AJAX*. The abbreviation stands for *Asynchronous JavaScript And XML*. It is used for asynchronous communication with the server. The use of an object of type *XMLHttpRequest* allows the exchange of data between the server and the browser after loading the page. We use *XMLHttpRequests* in order to store and retrieve data from the database.

When a user hovers over an emoji button, the systems sends an *XMLHttpRequest* to the server. The response to that request is the number of selections for that emoji reaction. The value is then displayed in a pop-up above the icon. The pop-up also contains the name of the emoji.

A slightly more complicated algorithm is executed when a user clicks on an emoji. After the *XMLHttpRequest* is sent, the system checks if the user has already given an input for that element. If that is not the case, a new entry is created and stored in the database. If the combination of user ID and element ID already exists in the table, it means that the user has already selected an emoji reaction for that element. If the user has clicked on the same emoji twice the system deletes the table entry. In the case that the user has selected a new emoji, the system executes an update on the already existing entry. In this manner we ensure that a user can select only one emoji icon per element. The *JavaScript* function which sends the *XMLHttpRequest* outputs an alert, which indicates whether the request was executed successfully.

5.3 Statistical visualization

Our approach to the statistical visualization of the data is similar to the one described in Burdeva's thesis [10]. For creating the graphics we iterate through all *p*, *m*, *i* and *s* elements in a collection. This is done by the *simpleIterate* function in class *LcElement*. With the help of *SQL* queries we retrieve the necessary data from the database. That is

the number of annotations and the numbers of selections for each emoji per element. For the creation of the charts we use *GoogleChartPHP* which is a *PHP Object wrapper* for the *Google Chart API*.

Chapter 6

Evaluation

In this chapter we evaluate to what extent the lab system fulfills the requirements established in Chapter 2. We defined four main requirements concerning interaction, usability and feedback. In Chapter 3 we set the requirements which the lab system should fulfill after the implementation of the two new features. These are the following:

- **R1: Interaction between diverse entities**
 - *R1.2*: Learner-learner interaction
 - *R1.3*: Learner-instructor interaction
- **R2: Interaction modes**
 - *R2.2*: Asynchronous discussions
- **R3: Usability**
 - *R3.1*: Smooth and unobtrusive interaction with the system
- **R4: Feedback forms**
 - *R4.1*: Immediate feedback and tips
 - *R4.2*: Short emotional feedback

The purpose of the interactive annotation feature is to cover *R1* and *R2*. Learners can interact with their peers by using the annotation sections. The learner-instructor interaction is already supported by the "Email-Where-You-Are" feature. This option was explained in the fifth section of Chapter 2. It allows students to send e-mails to selected supervisors through the lab system. The new interactive annotation feature enables instructors to take part in students' discussions. Thus, the learner-instructor communication is supported by two different features. Nevertheless, the first option offers private communication whereas the discussions in the annotation sections are visible for all course participants.

Due to the interactive annotation feature all labssystem users can lead asynchronous discussions (*R2.2*). Previously such communication was only possible between learners and instructors. The implementation of the new feature enables asynchronous interaction between students. In the communication process learners can exchange knowledge and support each other. If necessary, tutors can use the annotation sections to give students tips (*R4.1*). This might occur when the students cannot resolve a problem with the help of their peers alone.

After the implementation of the new extensions, the labssystem disposes of a short emotional feedback feature (*R4.2*). The learners' choice is limited to four emotions. We singled out these four options because they are especially useful for the instructors when designing an iLab course. However, more emoji reactions can be added in future.

The design of the interactive annotation and short emotional feedback features aims at retaining the usability of the labssystem (*R3.1*). The annotation sections are collapsible in order to preserve the page content clear. Furthermore, sending short emotional feedback does not require any efforts from the users. They only have to click on one of the icons. Their attention stays focused on the learning matter. Therefore, we can claim that the labssystem is designed in a usable way. Whether this is true or not can only be determined on the basis of user feedback.

Chapter 7

Conclusion

In this bachelor's thesis we demonstrated a way for integrating social network features into an eLearning system. As a result, the extended labsystem allows learners to interact and support each other. Thus, the system resembles the environment of regular face-to-face learning even closer. On the one hand, the short emotional feedback feature gives the labsystem a more up-to-date design. On the other hand, it supports the teachers in the organization of the iLab courses.

With the two new features the labsystem gives the overall impression that the students' opinions are valuable and taken into account. We believe that this makes the learners more involved in the learning process. They can work as a team not only with their peers, but also with the tutors and instructors.

7.1 Future work

Our work lays the foundation for several further improvements. In order to make the labsystem more personal, one can add profile pictures for all users. They should be able to set these pictures by themselves. Thus, the system should offer a profile managing page. There the user shall decide how much personal information she or he wishes to disclose.

Another possibility would be to add rating buttons to the annotations. They can be designed in a simple way, allowing the users to give only a "plus one" or a "minus one" vote. Then the annotations can be displayed according to the number of votes they have got, starting with the highest. In this case, rating buttons can only be added to the first-level annotations. The second-level annotations should not be mixed up. Otherwise, the sense of the discussion would be completely lost.

The work of this thesis has not yet been tested with students. A user survey could give us new ideas for improvements. It is necessary to find out if the four proposed emoji

reactions are enough for the students. Furthermore, we need feedback about the user satisfaction with the two new features.

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