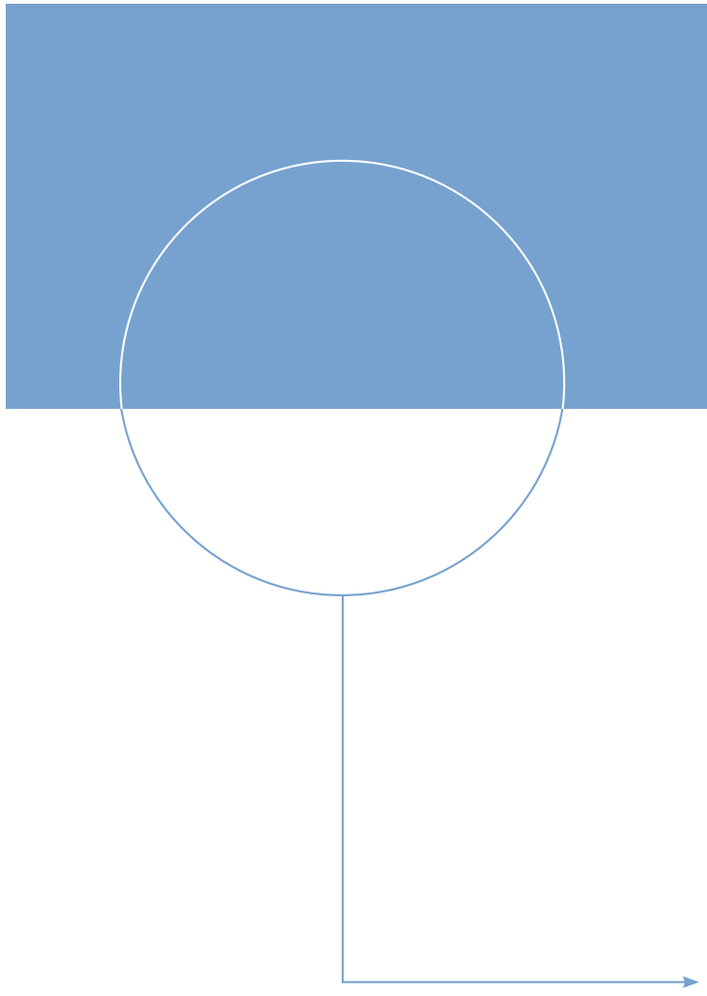

Master's thesis

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Peer Review and Feedback Approach on Individual Reflection for Assisting Group Learning: A Web-Based Reflection Tool

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Applied Computer Science
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Preface

The project was carried out as a Master's thesis during the spring semester of 2019 at NTNU i Gjøvik. The project idea was suggested by the supervisor, Prof. Rune Hjelsvold, during the research planning meeting. The motivation for the project was from a course called *Experts in TeamWork*, where we had to collaborate with students from other fields of study and work on reflective notes. The thesis project resulted in a web application which is based on the theoretical concept of reflective learnings. The readers should be familiar with the concept of *learning from experience*.

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Acknowledgment

I would like to thank my supervisor Prof. Rune Hjelsvold, for his invaluable feedback and guidance during this project. I would like to thank NTNU i Gjøvik for providing me with the opportunity to complete my Master's degree.

A special thanks to my friends for their feedback, support, and a pleasant time together.

I would also like to thank my parents for their support and love throughout my study.

M.T.

Abstract

Reflective learning is a useful approach to transfer experience into knowledge. The importance of reflective learning has been realized over many research. Often, the lack of proper guidance results in a superficial and incomplete reflection. A guided reflection approach narrows the focus on only important aspects so that the students can trigger intended learning. A group reflection is directly related to individual reflection. The behavior and thoughts of individuals are important to provide a different perspective on the situation. The emotional changes also influence the self-motivation of students towards learning. There are various tools for reflection like journals, log entries, and diaries. However, manual analysis of the data is tiring. Many of the students in higher education use technological devices in their daily learning activities.

This thesis project focuses on finding the perception of students on the influence of guided reflection with the features like sentiment analysis and peer-review feedback approach. The project also produces a web-based application to serve as a tool for the reflection writing process. Seventeen higher education students participated in the user review testing to provide their opinion on the application and its features. The result shows that the student's perception of the impact of guided approach with sentiment analysis and peer-review approach was positive. The structured reflection process with the application made the reflection process more manageable and easy to retract the data for future reference.

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1 Introduction[1]

Reflective learning is a useful tool in the process of learning. In most of the higher education, students are required to reflect on their learning process and write reflection essays [2, 3]. Dewey (1910) introduced the idea of reflection as learning by doing, which is an active process of learning [4]. The reflective learning process helps to convert the experience into knowledge by relating to similar experiences. Reflection is a process of finding new knowledge with the help of previous experiences and beliefs. The process may cause the initial knowledge to change or enhance to a concrete understanding. Many people perform the reflective process, maybe not in academic procedures. They re-evaluate their experience time and again to try to learn from it. Regular and proper use of the reflective process could help to improve the learning process in many fields. Mostly reflection is associated with individual learning, but it can be used in a collaborative environment to learn from each other in the group. The process of sharing experience could help everyone in the group to enhance their learning and foster new knowledge [5]. For collaborative or group learning, self-reflection is important. Each individual should have an unbiased perspective over the situation, which helps the group to get new knowledge. Reflection in group project environment usually follows *reflection-on-action* approach by Schön (as cited in [6]). The group learns by reflecting on the situation in hand. The reflection during the project work provides a basis for an immediate solution and also improve group communication. Communication is important in group work. Individual reflection and knowledge sharing help to improve learning.

Writing is one of the important skills required in higher education. It is considered an important learning activity in the reflective learning process [7]. The tools like journal writing, diary writing, and reflection notes help in the process of reflection [8]. Reflection is not only about self-assessing but also recording them. The process of writing helps to structure the reflection process. This makes it easier for students to access past reflections easily.

This thesis focuses on the guided reflection writing process in a collaborative environment. With a guided approach, the reflection process can be focused and the guidance can help to make the writing constructive. In learning, self-analysis might not be enough. Valuable inputs from other people can be helpful to get more insight into the learning process. Peer review and feedback has been found to be a useful tool to help the students learn from each other to improve reflective writing skills [9]. Most importantly in a collaborative environment where everyone should participate and provide their opinion, reflection and feedback are important.

[1] This thesis report is further work based on the Research Project Planning and Advanced Project Work course. So some of the contents may be similar to those reports.

1.1 Problem Description

The reflective learning process is not only useful in the fields of academics but also in a work environment. Many people consider reflection has helped them to excel in their fields of experience [10]. At the same time, it could be unimportant when it is used improperly. In many situations, students are not motivated enough to engage in the reflective learning process or they pretend to follow the process [10]. Reflective learning certainly requires self-critique and time to analyze the events, which is not an easy task. This makes learning via writing difficult. The lack of motivation could be because of a lack of proper explanation of the importance and the effects of the learning process [3]. This lack of knowledge and motivation to use the reflective process has overshadowed its importance. Even when the students are forced to reflect on learning, the lack of knowledge on the process hinders them from writing properly. They might explain some unnecessary details while missing out the analysis of important learning.

A proper guidance process is required to help students with their reflective writing. Students will have a proper understanding of things to include in their reflection and also how to properly analyze for better learning. The reflection process is about being able to easily access previous similar experiences. The tools for reflective writing include diaries, journals, notes or questionnaires. However, these tools don't allow for easy access to reflection writing. Also, these writings are easily lost or damaged.

Reflection is not just about analyzing the situation but to retrace the similar events. The retractable feature helps to resolve the issue faster. Emotions and sentiments of an individual during the experience are important which helps to access the situation and implement better action. Not all reflective approaches consider emotion as an important factor in the process [11]. The emotions of an individual during a certain event helps to trigger the reflection process. However, the tools mentioned do not provide immediate feedback on emotion to reflect. The quality of text and emotional behavior during reflection could help to improve the reflection process. Also, a better reflection should be readable and understandable when accessed in the future.

In a group based project, people with different knowledge and background work together. The knowledge and experience of each person in the group are crucial to the efficiency of the team. People usually discuss in the group for finding the solution to different situations. The possibility of interaction and availability of historical data helps the group to reflect on the current situations. Most of the reflective tools are suitable for individual reflection and do not support for group reflection. The interaction and efficiency are better in a group with reduced uncertainty and positive emotions [12]. The reflective tools should provide the opportunity to share individual feelings and thoughts which should be unbiased. Sharing reflection as discussion could affect one's thought and might trigger learning. A mechanism is required so that group members can review each other's reflection. Also, the peer-review process is found to be helpful in the process of reflective learning [9]. However, the possibility of identifying a peer might restrict the learning student to express the reflection. The process of feedback should be anonymous so that the student will be able to write their experience in detail.

1.2 Background and Motivation

As a master's student at NTNU, we are required to learn via the reflection writing process. It is considered one of the important qualities of master's students to self analyze the learning and relate to the learning theories. The writing was first introduced to us during the first semester of our studies. We got more understanding and knowledge on the reflective theories during the second semester in a course called *Experts in TeamWork* (EiT). In this course, we were required to practice reflection activities and then provide feedback to each other to write group reflection. The reflection in these courses helped us to analyze our effort and the actions during the project work. In the beginning, the reflections were more descriptive than reflective. The process of reflection helped to analyze experiences from a different perspective before assuming the conclusions. We were, at times, unsure of how to write a reflection and which of the things are considered reflection. Most of the times we were using the reflective learning process for team building exercises but they were limited to providing feedback and communication. The lack of proper guidance in reflective writing made the process less important. We were required, in the course, to write a group reflection report at the end of the course. The lack of understanding of the process affected the writing.

In the modern education system and many of the higher education, students have embraced computerized learning. Students are more familiar to use a computer than to carry journals for reflection. However, students lack the knowledge to write reflections properly. Reflection writing is a process and it is different than other academic writings. It is also different from informal journal writing. The reflection writing process requires describing the experiences and also analyzing them to deduce new knowledge or understanding which will prove to be beneficial in future experiences. Without guidance, it might be difficult for students to write a proper reflection. This was felt during the reflective writing process in the EiT course. My supervisor, professor Rune Hjelsvold, provided me with a suggestion for the reflective learning process for my project work. After my experience with the reflective learning process, I realized that it would be an opportunity to learn more about the reflective process. And being a computer science student this seemed to be a suitable project to learn on how to use theoretical learning in technology.

1.3 Research Question

This project will research the following question:

- Understanding the usefulness of technology integrated guided reflection tool in higher education
- Students attitude towards automated feedback on text readability and sentiment for assisting reflection
- Students opinion on the peer-review model on guided self-reflection to help collaborative reflection in a group project

1.4 Proposed Contribution

The project will make use of theoretical approaches of reflective learning to automate and structure the process. The main contribution of this project will be the development of a reflective writing tool. The tool is intended for a group learning environment in higher education. The developed prototype from the project will provide information for the possibility of the usability of the computerized reflective tools. The tool can provide a basis for future work and implementation in different areas of learning. Furthermore, the research from this project will help to understand students' attitude towards the reflective process and learnings.

1.5 Outline

The remaining of the chapters are structured as follows. Chapter 2 discusses different theoretical concepts related to reflective process. It also analyses some of the similar projects and researches are done in this field. Chapter 3 explains in detail the process and steps taken towards the application development. All the planning and decision making for the project are discussed. This chapter also explains the experiment process. The decisions made in this chapter are then used in Chapter 4 for the development of the web application. The features and application use scenarios are explained in this chapter. The results from the experiment are illustrated in Chapter 5 and discussed in Chapter 6. Chapter 7 provides a summary of the work with a conclusion and discussion on future work.

2 Theories and Related Work

2.1 Reflection Theory

Reflective learning is a famous term used in the field of education. Dewey (1910) and Schön (1983) are known to have influenced the idea of reflection [4, 10]. Reflective practice was first introduced by Dewey (1933) and he mentioned it as the process which can help to transfer experiences into knowledge (cited in [13]). Reflective learning is an active approach to learning compared to traditional learning methods. Students are required to critically analyze the learning to understand the use and implications. Also, this process is found to have longer learning effects [10]. The process is not only to analyze the current learning but also formulate for similar future situations. Various theories have been developed over the years to model the reflective process. Models suggested by Bain et al. [14], Schön (1974) (cited in [6]), Kolb's learning cycle [1] are some of the influencing works in reflective learning.

People make mistakes and try to learn from mistakes. They do this process time and again to succeed. Unknowingly or knowingly they perform the reflective learning process. Schön's (1983) model distinguished the process of RL as *reflection-in-action*, which happens during the learning or experience and *reflection-on-action*, which happens after the learning by recalling the event [15]. Both of the processes are connected to each other. A student takes different approaches during the process of learning. The approaches come from immediate decision making and realization from past experiences. This *reflection-in-action* provides an understanding of consequences and generate new learnings during the proper evaluation of the action. This can be properly documented so that it can be used as a reference for future learning situations. Though the focus of reflection writing is on the *reflection-on-action*, the former is equally important in the learning process. Boud et al. [16] and Kolb et al. [1] explain reflective learning as a cyclic process. And their approach of understanding reflective process is almost similar. The cyclic process helps to better understand the importance and use of the reflective process.

From the Figure 1;

- **Concrete Experience**: Learning and experiences acquired from eg. class lecture or activities
- **Observation and Reflection**: Analysis of the event and the learning experience
- **Abstract Conceptualization**: Conclude the analysis with new learning and conceptualize the theory
- **Testing Implications**: Analyse the new knowledge in the context of a new situation or learning experience

The cyclic process goes on to produce new leaning followed by conceptualizing and future implications. Bain et al. (as cited in [6]) suggested that a proper framework is required to support

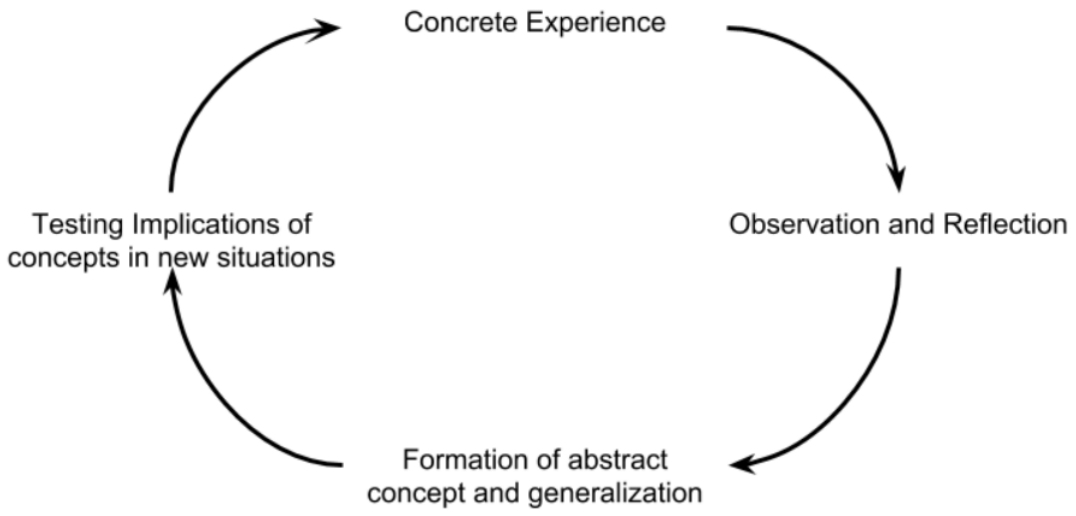


Figure 1: Kolb's experimental learning cycle [1]

reflective learning. They proposed 5R Model (Reporting, Responding, Relating, Reasoning and Reconstructing) to provide different levels of learning steps. It can be seen as Kolb's learning cycle which provides a step for relating the current experience with similar past experiences. The reflective learning process is not just exploring the new knowledge but also evaluating the learnings of the past for future references.

2.2 Guided Reflection

The guided reflection process is a structured approach to reflective learning. Reflection is a process to guide and help in the learning process by analyzing the experience. Writing a reflection can be confusing and students may not know what to include in their reflection essay. The process of writing about the experience and analyzing is broad as there is no scoping of which things to include. [4] mentions that most of the student's reflection is superficial and vague. It has been found that the students tend to write descriptive and incomplete reflection than analytical (Betts 2004 and Hobbs 2007 as cited in [10]). For example, students can describe the situation and their actions in detail while missing to analyze and explain learning outcomes. Students should be able to realize and evaluate different aspects of the reflection process. However, it is not an easy task.

The guided reflection process is structured with questionnaire prompts to help students [17]. Reflection is a multi-step process on its own (see Figure 1). But in guided reflection, a set of activities is designed to help students in a specific area of learning. With guided prompts for reflection, students can focus on different aspects of the learning process. Focusing on different aspects helps

to bring out more of the important information required for learning. [6] mentions that proper guidance helps in critical and elaborate thinking towards learning.

Students' perspective on the learning can defer from what is expected to learn and usually students expect guidance from their teacher [17]. It is not possible for teachers to provide guidance to students all the time. The guided learning approach tries to scaffold the reflection process to focus on the important aspect of the learning. Self-motivated and driven nature of students will push them towards learning new things and experiences. The process of guided reflection assists students so that they can be effective with their learning process and be more productive. [4] mentions that though students write reflections, most of them are bound to mistakes and lack quality. The reflective learning process lacks proper guidance for students to link experiences to knowledge. This study uses a learning experience to associate with service-related activity for a better understanding of the context from a different perspective. The guidance was supported by questionnaires to draw a detailed description and analysis of the understanding. The model used by this study is very important to realize the importance of guided reflection structure.

2.3 Impact of Emotion in Reflection

Students go through different emotional thoughts during the learning experience. It is important to consider the influence of emotion in reflective learning. Many of the studies and approaches in reflective learning tend to forget the effect of emotion. The emotions provide a different perspective to each student to reach different learning outcomes. It has been found that students experience various emotions and their activity and behavior are influenced by their emotions [11, 18]. The review [11] emphasizes how emotions play the role of catalyst for critical reflection. The emotions during the experience help them to remember and write the situation in detail. Emotion and sentiment are part of the experience. Knowledge, experience, and emotion are utilized to better understand the event and write reflections [19]. Understanding emotions can help to realize the situation from different perspectives. During the event, pressure and emotional stress might have influenced the actions. The emotional states trigger to realize what is happening and what could be the immediate actions [20, 11].

This emotional understanding helps with self-criticism. People make decisions in different emotional states. Reflecting on the emotional state can provide insight into why the action was necessary and what were the consequences because of that. Also, the critical analysis could be on how to act differently to obtain a better result for a similar situation. Students show better learning performance when they have positive emotions and negative emotions hinder the learning [21]. The emotion of a student changes based on the situation they are at. If they are around enthusiastic friends, they may feel the excitement and positive emotions while they may feel negative and show anger in the presence of people they don't like [18]. It is similar in the case of learning. The students may feel motivated and interested in learning if the teacher is able to impart positive influence or the group they study with are excited about learning and sharing. Similarly, feedback could create such positive emotion and influence learning.

2.4 Peer review based Reflection

Peer review in reflective writing is a process of sharing the experience and knowledge among the students. Reflective writing helps to self-realize the learning aspects. Peer review can help to improve the thinking process and provide insight from a different perspective. They can share their own related experience and learn how others have analyzed in the reflection. It is easier for students to compare and analyze to find how they can improve. At the same time, their opinion or feedback on the reflection could help others to improve as well. The feedback approach can trigger deep thinking to the reviewer as they have to analyze the reflection [22, 23]. The process of peer assessment triggers students' engagement and improve learning. While providing feedback, students become more active and involved in the learning process. They require to analyze the information to provide proper feedback. This can prove beneficial in group learning cases. In group learning, active peer communication helps to share each others understanding to widen the knowledge base. Providing feedback improves the skill of judgment and decision making. While the feedback receiver can critically analyze their strengths, weaknesses, and need for improvement [23]. One of the important aspects of the peer review process is the confidentiality of the information. It can impact on the process of reflection and feedback. The knowledge of the reviewer's presence could trigger critical thinking in the student [22] however, some students might feel vulnerable to sharing their ideas [19] among familiar people. The sense of confidentiality can help the student to write more freely but more thoughtfully knowing somebody will read and provide feedback.

It has been seen that peer observation helps in professional development and encourages improvement with peer support. [19]. Sharing of ideas helps to realize the things from a different perspective. One might have overlooked some aspects which might be a matter of importance and others will help to identify. It is possible that the thought of criticism and confidentiality affects how one writes their reflection. The study mentions that the focus should also be on the possibility of discussion and understanding of the need and process of peer review. This could prove to be beneficial in understanding and providing critical reflection while learning from each other. [20] explains the situation where sharing of previous experience helped to come off with a better solution to act in a critical situation.

2.4.1 Feedback Rubrics

Providing feedback is not an easy task. The reviewer must assess different aspects and try to provide thoughtful and critical suggestions. In reflective learning, feedback should be more suggestive and helpful for the writer to improve the learning process. [19] mentions that some students have difficulty providing feedback. They don't feel comfortable to provide feedback because they might think of how others will react. Also, in some cases, students don't know which aspects they should focus while writing the reflection. To assist the feedback process, the concept of *feedback rubrics* is used. Feedback rubrics is an assessment process based on the criteria [24]. A set of rules are defined to assess the reflection. The criteria are categorized into levels with an explanation. This helps to understand what is required and what is missing from the reflection. This makes easier for the reviewer for assessment. They only need to analyze and assess based on the rubrics provided.

2.5 Technologies in Reflection

Reflection process makes use of tools like journals, diary to support and record the learning for the future. Technologies in the reflective learning process can be helpful. The writing tools and techniques can be computerized for helping the students in the learning process. Technology facilitated learning process can change the unidirectional learning (teacher to student) to bidirectional learning (teacher-student sharing). The use of technology in learning can provide for easy accessibility of the resources and record the information for future use. One of the important aspects of reflective learning is the possibility of accessing the reflection for future use. For that, reflection management is important. The integration of technology provides with the option to log all the necessary information. It also improves communication and collaboration with the possibility of sharing without delay [25].

Using technologies in the learning process have many benefits. Besides recalling and recording, it makes the visualization of data easier. The reflection data can be analyzed and only the interesting information can be provided for easy review. The information can be properly managed and structured. Furthermore, these data can be analyzed to find new information. This process can help the students to find new information towards their learning experience [26]. It is also a tedious task for teachers or reviewers to analyze students' reflection manually. Students' learning is hindered by their emotional state. Understanding the emotional state can help the reviewer to provide appropriate feedback. Sentiment Analysis of the reflection diary is one of the ways [21]. This paper explains a sentiment analyzing system which takes the reflection text from the students and finds the polarity of the sentiment. They also use word-emotion associations to find a different emotional state. It also mentions that there are not many researches with sentiment analysis in reflective learning. This project could help to assist in that research area.

2.6 Related Works

There is not much work done in computer-based reflective learning. The reflective learning process has been a written and context focused approach. However, [8, 27] are some of the approaches which use technology to assist the reflective learning process. A computerized tool helps to easily recall historical reflections and provide new knowledge in real time. The real-time update feature of the computer system helps for instant collaborative learning with other students in the same project [27]. The paper explains the approach of annotated video tool for reflective learning. They use self-annotation and group annotation to see the difference in students' engagement and influence of reflective learning. The tool provides an opportunity to reflect at a different time during the video, but it lacks a proper reflective approach to learning. The tool works as a discussion for understanding rather than a reflective process with a description of a problem, relatedness of the previous knowledge. The approach does not provide an opportunity for constructive feedback as it lacks proper structure. Besides, the approach is suitable for tutorial lectures scenario and not for self or group reflection on different situations. Similarly, [8] uses a web application approach to aid reflective learning. A web-based issue tracking application is used to record all the activities in the group

project. However, the use of the computer system was limited to issue tracking only. This approach includes the self-analyzed of feeling over time to visually illustrate the difference in students' satisfaction. Though the use of the computer system was limited in the analysis, a generic retrospective model is developed. The model is an important basis for this project. The project designs a model to integrate self-reflection with collaborative reflection. In the model, frequently updated reflection representations are recorded by individuals for daily projects. The reflection can include notes, log and sentiment graph. It can be shared and based on past experiences, collaborative reflection is created. A study [28] by Chi-Cheng et al. focuses on the performance of reflective learning by the peer-review approach. The study uses a web-based portfolio assessment to analyze the frequency of reflection reviewed by the students. The study shows that the students who reviewed the reflections written by other students provided them with a better opportunity for learning and analysis of their own reflection. The students were required to provide constructive feedback and grade the process based on predefined criteria. It can be seen that peer-review helps both the reviewer and the writer to improve the reflection. Furthermore, the feature of tracking in the computer (web) application helps in similar future learning situations.

[25] aimed to study the effects of the reflective learning process in students at higher education. The research was based on an online learning approach with guided learning. The study used the longitudinal approach for the guided reflection approach. It mentions that most students in higher education have no prior knowledge of reflective learning and are unaware of its importance. It uses a spreadsheet with a questionnaire template to guide students for writing their reflections. This approach highlights the importance of technology and guided approach in the reflective learning process. This study is one of the starting references for this thesis project. Similarly, a study was conducted by Mario Mäeots et al. to find the significance of web-based reflective tool in learning process [29]. The study was focused on secondary level chemistry students. It shows that although there was no statistically significant effect of the tool, it was realized that the tool helped the students to understand the reflective learning process. The application was inquiry-based by scaffolding the reflection process to guide students.

MIRROR is a project focused on assisting employees with their learning at the work environment. A computer-based learning model was developed by this project [30]. The model provides guidance for individual and collaborative learning. The process is easily mapped to be integrated with technology. And this process flow is connected with the collaborative learning approach. A master's thesis project was completed by students at NTNU regarding the reflective learning process. This project [26] was focused on implementing the game elements to the reflection process. The project resulted in a mobile application that used the game elements to keep the users motivated. The application uses the concept of *Timeline* to record the reflection of the user. It can be seen from the study that the game elements can prove to be useful in the learning process. However, the impact of game elements and competitive triggers could affect learning.

User behavior is one of the reasons for a different approach to learning. The analysis of behavior at the time of events could help in understanding the situation from a different perspective. [31] suggests a framework implementing a self-tracking approach in reflective learning. Reflective learn-

ing is about revising the past events to analyze an alternate scenario or develop new knowledge for future reference. The suggested model integrates the reflective learning process with Quantified Self (QS) tools that track the user behavior to aid in reflection. The QS tools track the behavior and emotions like stress, anxiety, choice of music via integrated software and hardware devices. The aspects of human behavior can be a catalyst for triggering details for reflection. Another proposed model by [32] implements the Boud's approach. The model is theoretical and requires integration with technology. The model describes a process with interactions that could be implemented to assist reflective learning. Lectical Reflective Judgment Assessment (LRJA) is a web-based application to assist with providing a reflective assessment with scores [33]. The application is a demo and it does not provide much information on the assessment process.

2.7 Summary

The core idea for this thesis project is based on the *Guided Reflection* approach. Reflective learning is a continuous and cyclic process. The process helps to analyze the current situation and actions while taking past experience into account to trigger new learnings. The learnings could be useful in similar future scenarios. This project will focus on the reflective process of *reflection-on-action* as proposed by Schön (1983). This concept will be implemented with the help of computer technologies. Reflective learning is also a stepwise process. With the help of technology, the process can be structured and the data can be managed properly. Technology integration also helps to analyze the information and extract important details. Visualization of important details at one place can help to understand the information easily. Analysis of reflection on quality and emotional state could help the student to improve. Technology can assist to automate this tedious and time-consuming task. Furthermore, students tend to write more descriptive than analytical reflections. They explain the situation and their actions but usually forget to analyze the learning outcomes. The guided process will assist students to improve the learning process. It can be seen that emotion and peer review are influencing factors in the learning process.

The concept on satisfaction graph and activity log [8] is an important aspect of this thesis. Different emotions experienced by the students influence their learnings. Feedback and a positive environment help students to motivate themselves. Learning can be improved by the process of peer review. The active participation from the students can lead to self-motivation and improved skills in learning and decision making. Also, constructive feedback helps the students to realize their need for improvement. Following the guidance of *Guided Reflection*, the feedback process is also guided with feedback rubrics. Rubrics are criteria based assessment which helps the reviewer to properly analyze and provide feedback critically. The process of feedback helps both receiver and provider. The reflection process is intended for group learnings so it is more important to have the active participation of students in group communication and idea sharing.

3 Method

3.1 Technology Assessment

Before starting the project, technologies and programming languages were analyzed. The analysis helped to find the available and suitable technologies that could be used in application development. The technologies suitable for the project are discussed below.

Natural Language Processing Toolkit

Natural Language Toolkit (NLTK)[1] is the famous and widely used natural language processing (NLP) platform. It provides numerous data processing packages and functionalities. The toolkit also provides a number of corpora resources for linguistic analysis. The available packages and corpora resources make it one of the best NLP toolkit. It is also widely used. The availability of a large number of resources makes the toolkit very useful. Also, NLTK provides a very famous lexical database for the English language called Wordnet[2].

Django

Django[3] is a web-based framework for Python programming language. It helps to develop web applications easily and also maintain them. It provides various services and features to help in the development process. Also, it is easier to integrate other Python packages and services required. The framework provides full-featured model-view-controller (MVC) architecture allowing easy navigation and modeling. As a full-featured framework, Django comes with various helper functions and security measures. It also has its own templating language to display Python data in the view.

Flask

Flask[4] is a Python-based microframework for web application development. It does not provide a rigid file structure. The structure of the application depends on how the developer wants to design. The framework provides basic features like routing and server setup. However, it is easier to integrate other packages.

Heroku

Heroku[5] is a cloud-based service for deploying applications developed in different programming languages. It helps to build the application resources and run the application in the cloud platform. The service is not entirely free but provides free service for limited resources. It provides various

[1] http://www.nltk.org/
[2] https://wordnet.princeton.edu/
[3] https://www.djangoproject.com/
[4] http://flask.pocoo.org/
[5] https://heroku.com

useful add-ons to integrate into the service, both free and paid. The services and explanatory documentation help to easily use the service.

MySQL

Mysql[6] is one of the famous and widely used relational database management system (RDBMS). It is an open source technology that has most of the features free to use and some of the features are proprietary.

PostgreSQL

Like Mysql, PostgreSQL[7] is also an open source technology for database management and it is free to use. It is known as an object-relational database management system (ORDBMS). As an object-oriented, classes, inheritance, etc. are directly supported by the database schema.

3.1.1 Choice of Technology

The technologies were compared against the project specifications. NLTK was selected as it is a widely used NLP toolkit. As it is an open source and has community support, it is more preferable to implement in a project. The technology assessment was done with an inclination towards Python programming language. The reason for choosing Python programming language was because of NLTK. NLTK is a Python-based toolkit and documentation is also available for Python. There are packages in other programming languages for NLTK but the functionalities are limited.

Developing web applications is easier with a proper framework as it provides various built-in functions to assist the development process. For the project, Django was selected as the development framework. Compared to Flask, Django is a full-featured framework which has various features already available. In Flask, many of the packages are needed to be integrated to have the same level of support. For example, Django provides database migration for easy database management while a third-party migration package is required to install alongside Flask for the same functionality. Also, Django has elaborated documentation and is suitable for expendable projects.

In many of the Python projects, PostgreSQL is the preferred database system. In comparison, PostgreSQL and MySQL are similar with few better features in PostgreSQL. I already have knowledge of the MySQL database system. With PostgreSQL, there may be a learning effort with new technology. Also, the project requirement is easily handled by MySQL. For these reasons, MySQL was selected over PostgreSQL.

Heroku, free cloud service was selected to deploy the application. It also provides a free MySQL add-on that was integrated into the application. The platform provides easy implementation of the application and also installs all the required Python packages for the application.

HTML, CSS, and Javascript are an integral part of a web-based application. These technologies are required to display the application data and also allow users to interact with the application.

[6] https://www.mysql.com/
[7] https://www.postgresql.org/

3.2 Prototyping

3.2.1 Wireframing and Model Designing

Wireframing is an important process of visualizing the requirements before the project development. During the planning phase of software development, this process helps the designer to think from a different perspective. The visual design helps to see how the content and functionalities can be implemented before the actual application is developed [34]. Wireframing process could be paper-based or computer-based (eg. Balsamic[8], Axure[9]). The design in the early phase helps to amend any requirement mistakes or add any missing ones. Like wireframing, model designing is a process listing all the important entities in the system and visualizing the relation between them. The visual representation of entities is illustrated with entity-relationship (ER)-diagram. ER-diagram is modeling of database structure showing how the entities are related [35]. The modeling helps to understand how the data are involved in the relationship and data constraints in the model.

After planning the initial requirements, ER-diagram was designed to see how the entities in the system should relate to each other. Figure 2 illustrates the relationship of the entities. With the help of the relationship diagram, database modeling was done. This relationship diagram also helped in the process of wireframing. The attributes of each entity and relationship provided more information for system requirements. After designing the relationship diagram, wireframing of the system was done. For this process, the paper-based approach was used. With a paper-based approach, it is easier to amend and update design while the computer-based approach requires learning the system and understanding the tools provided. The wireframing process helped to visualize where to place components and how the system pages should look. One of the wireframes is shown in Figure 3, other wireframes are added in Appendix A.

3.2.2 Guided Process

The initial study and design provided with basics for application development. The important task of the application development was to design question prompts for the reflection process. The first phase of application development was to design questionnaires. The guided reflective writing process requires asking the right questions that will trigger the reflection process. For the guided process, Bain et al. 5R model [14] and Johns' model of structured reflection [36] were studied and used as a basis. Table 1 shows the questionnaires designed for the application. [6] implements Bain's 5R model which is reduced to 4R after combining two of the five sections. It mentions that a lot of people find Reporting and Responding to be confusing when they are two different sections. Table 2 shows how the different sections designed for the application are related to the mentioned model. The questionnaires try to help students analyze the situation to write in detail and also analytically.

There are four sections in the designed question prompt each trying to focus on the different aspects of the learning. *Situation* section is to describe the situation and all the necessary information about the experience that needs to be analyzed later. *Experience* section asks students to relate their

[8]https://balsamiq.cloud/
[9]https://www.axure.com/

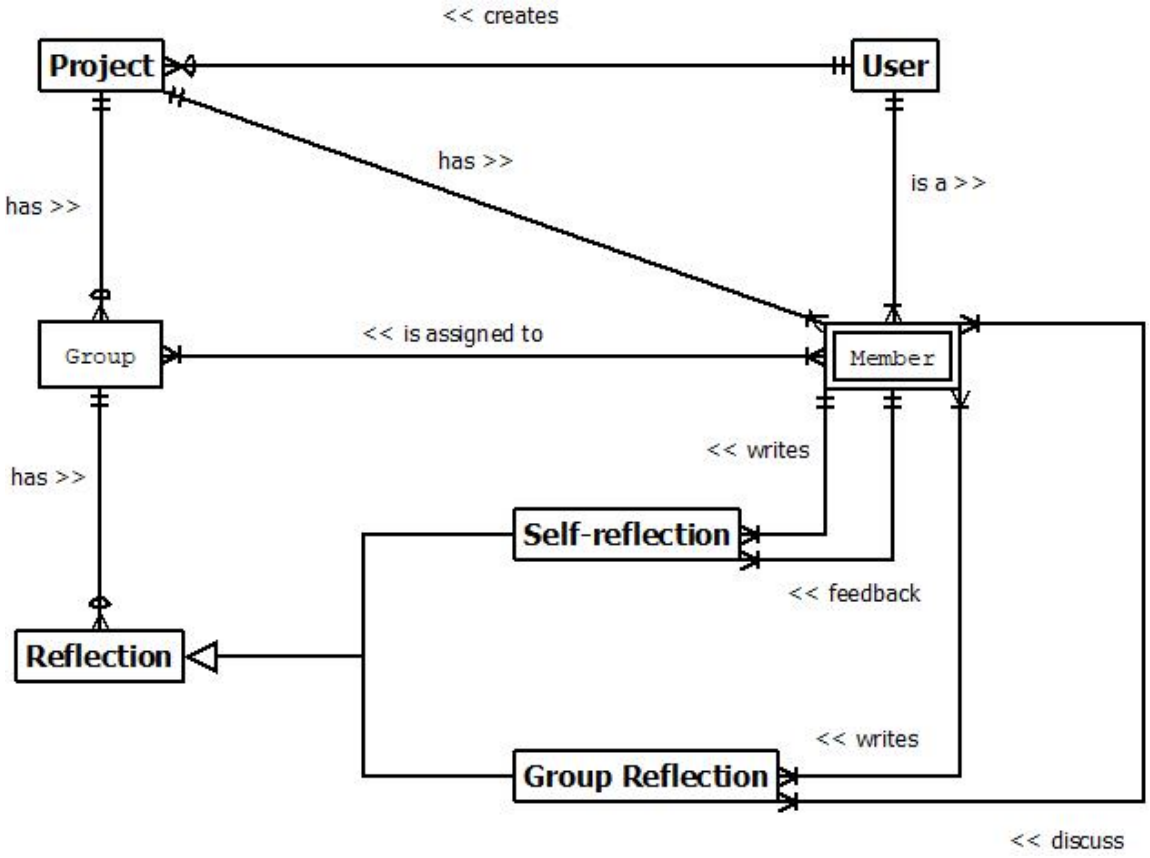


Figure 2: Entity Relationship diagram for the system

current experience with a similar situation they have been through before. The past knowledge of a similar situation provides a basis to analyze how things have been done differently compared to the last experience. *Reasoning and Analysis* section is the main reflective part of the process. In this section, students try to analyze the situation with the knowledge they have. The section guides the students to assess their emotional behavior, actions, and consequences. The analysis is intended to help them realize the situation from a different perspective. Finally, *Learnings and Conclusion* section is the learning outcome from the situation. After reflecting on the situations, students should be able to deduce new learning and solutions. The important aspect of the reflective process is learning. The current situations should help to gain new knowledge that will be helpful in future situations.

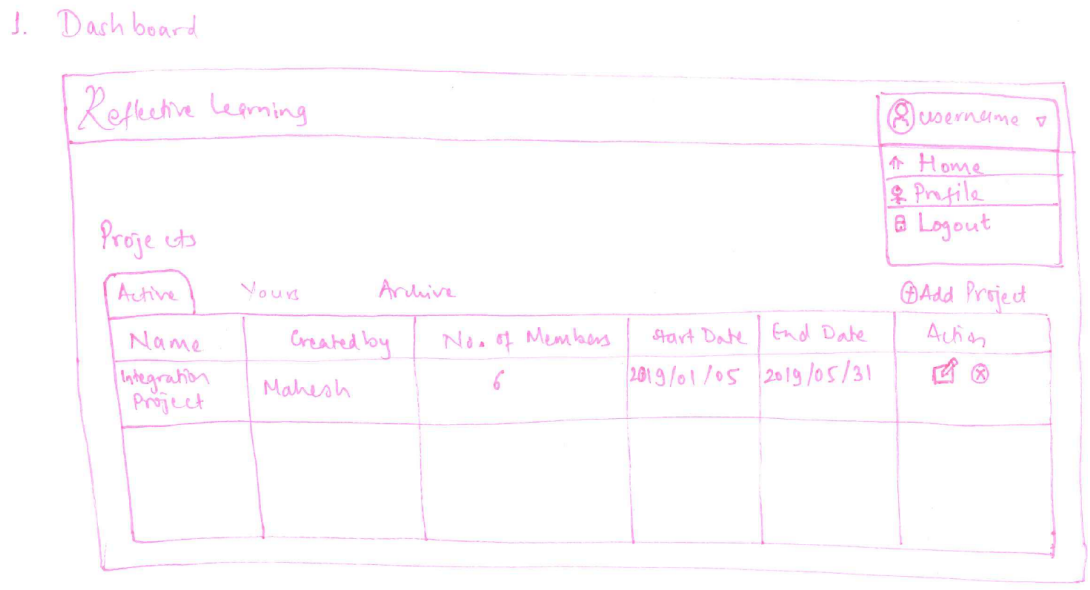


Figure 3: Wireframe for Dashboard of the application

Situation
Simply explain the situation or experience without drawing conclusions
Experience
Explain previous similar situation. Relate the conditions and assess your knowledge on the current situation.
Explain how your previous experience on the situation helped.
Reasoning and Analysis
How did you react to the situation and why? Explain consequences.
What factors (internal and external) do you think influenced the situation/your action? How? Why do you think those are the factors? Analyse from different perspectives.
How did you feel during the situation? How the factors influenced your emotion and action? How did you think other people in the group felt and why do you think that?
Learnings and Conclusion
Analyse alternate solutions and their consequences. Considering the factors, how will you act to similar situations in future?
What were the learnings from the experience? How has this experience changed your initial/previous beliefs and knowledge? How do you feel after reflecting on the situation?

Table 1: Question prompts for guided reflection writing

4R Model	Application Question Sections
Reporting and Responding	Situation
Relating	Experience
Reasoning	Reasoning and Analysis
Reconstructing	Learnings and Conclusions

Table 2: Comparision of question prompt sections with 4R model

Another important aspect of the learning process is, providing feedback or assessment rubrics. It was suggested by the supervisor in one of the discussions that it might be better to look at the assessment rubrics. Criteria based feedback approach has been noted to be powerful in providing constructive feedback [37]. It is necessary to analyze which of the criteria are required to assess the reflection. It helps to model the learning intention from the process. Since the reflection process is about what the students write than how they write, assessment on the writing style and structure was seen as unimportant. It was realized that how the students construct the learning and explaining was important. Comparing the question prompts, three criteria were selected; explanation of related experience, analysis of reflection, and arguments on learning. A feedback rubrics (see Table 3) was designed referring to [38] and [39] [10].

	4	3	2	1
Reflection	Demonstrates superior skills of critical thinking, understanding of the presented concepts. The reflection is insightful and thoroughly analyzed with well-supported viewpoints.	Demonstrates skills of thoughtful understanding of the concept with general supportive viewpoints.	Demonstrates the minimal skill of reflection and understanding of the concepts. The thoughts and arguments are not properly supported. The reflection could use revision.	Demonstrates a lack of reflection skills and the thoughts and arguments are not supported. The reflection should be revised.
Experience	Discusses learning experience related and specific experience to support reflection.	Discusses relevant or closely related experience to support reflection.	Vaguely explains the previous knowledge to support reflection.	No previous experience is discussed.
Learning	Shows a high-level understanding of the experience by presenting multiple learning scenarios with supported arguments.	Shows a general understanding of the experience and presents at least one scenario with supported arguments.	Learnings show a lack of understanding of the experience and the presented learnings are not supported or lacks support.	Shows no clear understanding of the experience and learnings lack support or shows no implications of learning outcomes.

Table 3: Criteria based feedback rubrics

3.3 Designing Survey Questionnaires

For the user testing and feedback on the application, a set of survey questionnaire was developed. The initial approach to designing the questionnaire was to list the important features related to the research question and formulate them into survey questions. The questions try to capture to what extent participants agree with the statement. The answer was ranged from *Strongly Disagree* to *Strongly Agree* and participants had to select one. There are questions asking the participants to provide their opinion on the features and also the feedback on the application. The questionnaires

[10] http://readwritethink.org/files/resources/lesson$_{images}/lesson963/Rubric.pdf$

were modified and updated continuously to remove unimportant and redundant questions. It was realized that there were many questions for participants to answer. To make the survey process more user-friendly, the questions were grouped together and only one section was presented at a time. Each group asks about the related features so that the participant can focus on a few features at a time. The questionnaire can be found in the Appendix D.

4 Implementation

4.1 System Overview

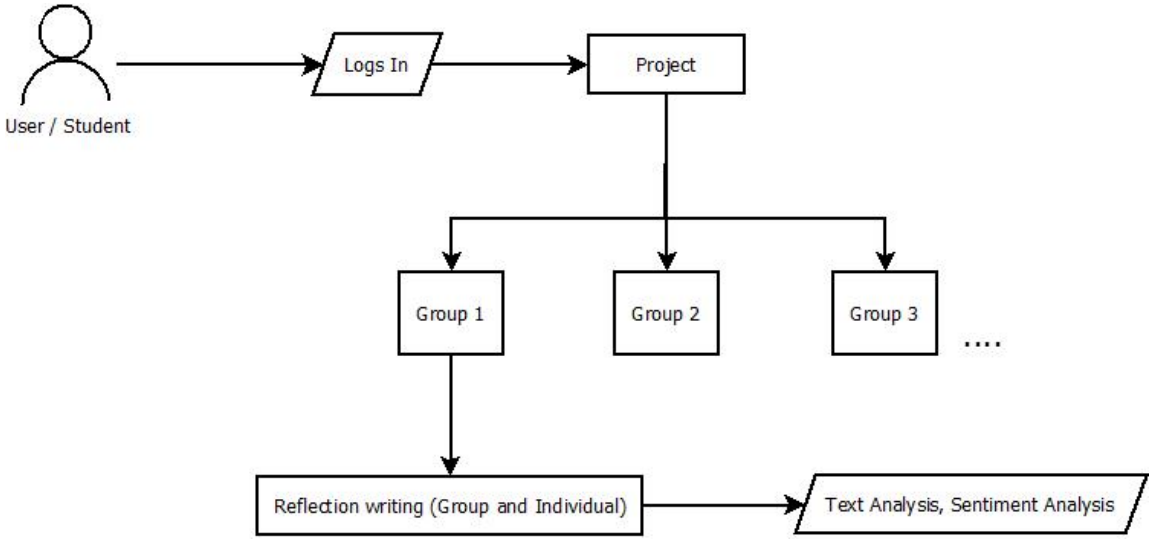


Figure 4: System overview flow chart of the application

The application is managed in a hierarchy based manner. The application is designed for group-based learning in higher education. The first level is *Project*. A Project can be referred to as the learning course or project work itself. In most higher education, there are smaller groups in a course. Or in a project, different groups could be focusing on the different aspects of the project work. Considering these situations, the concept of *Group* was implemented. In the group, self-reflection and group reflection are managed. The membership is based on a project rather than a group. A user with certain *username* is added to a project by the project owner (probably a course teacher). The members are assigned to different groups. The user can be part of one or many groups depending on the need of the group. The system and process flow of the application is illustrated in the Figure 4.

4.2 Application Features

Authentication and Authorization

Authentication is the first part of the application flow. Students need to register with their username and password. The authentication feature is provided by the Django framework for administrative

use. This feature was customized to fit the application requirement. The application registration only asks for name, email and password. The email requirement was removed in this project to address the personal data security protocol by the Norwegian Centre for Research Data (NSD). Figure 5 shows the interface for registering the account.

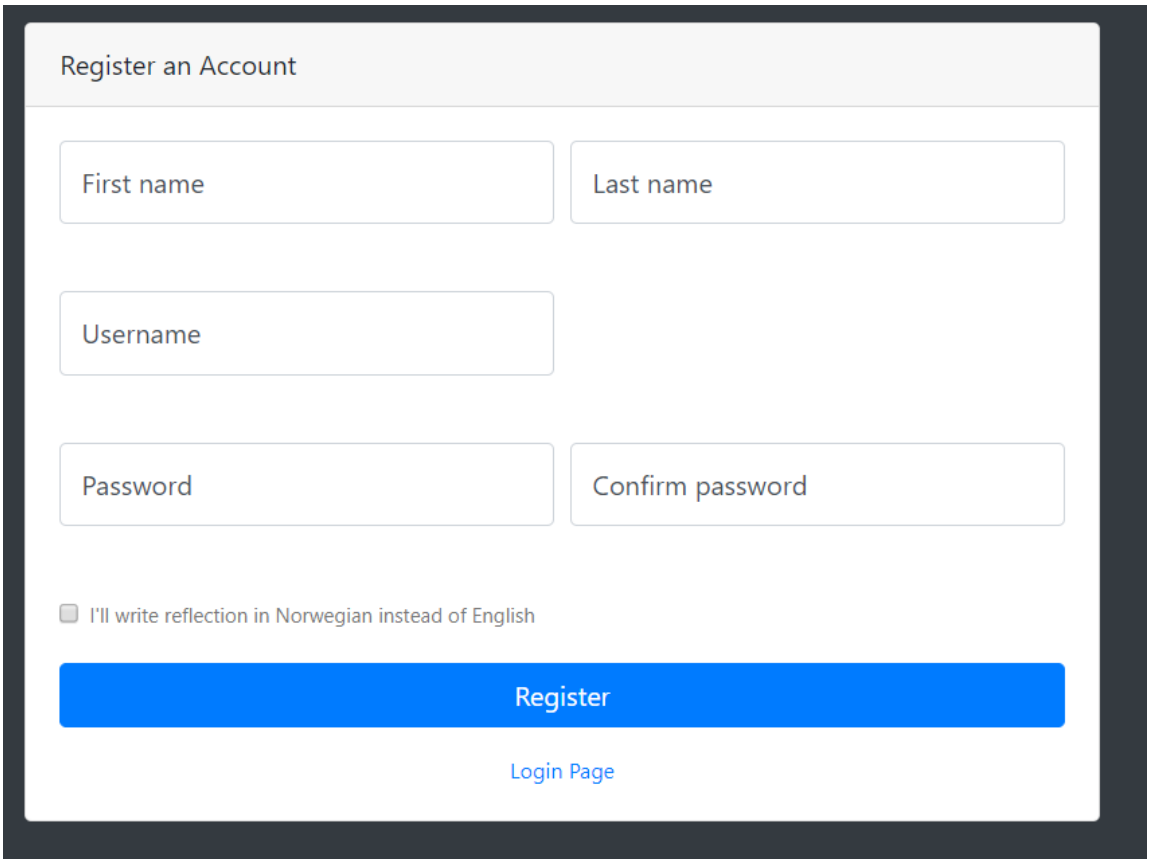


Figure 5: Interface for registering for the application

Project, Group and Members

As discussed in System Overview, application has options to create *Project* and *Group*. The application dashboard shows the list of Projects a student created or is a part of. A Project has a deadline to define the active time period. A Project consists of *Group(s)*. A Group is a place where all the reflection activity takes place. The users are added to a Project by the owner. Depending on the requirement, members can be assigned to one or more Groups. The authority in the Project and Group is role based. Only the owner can manage the Groups and Members. Figure 6 and 7 shows the interface for how to manage Project and Group. Figure 7 is the individual Project management page. This page allows managing Groups and Members in that Project.

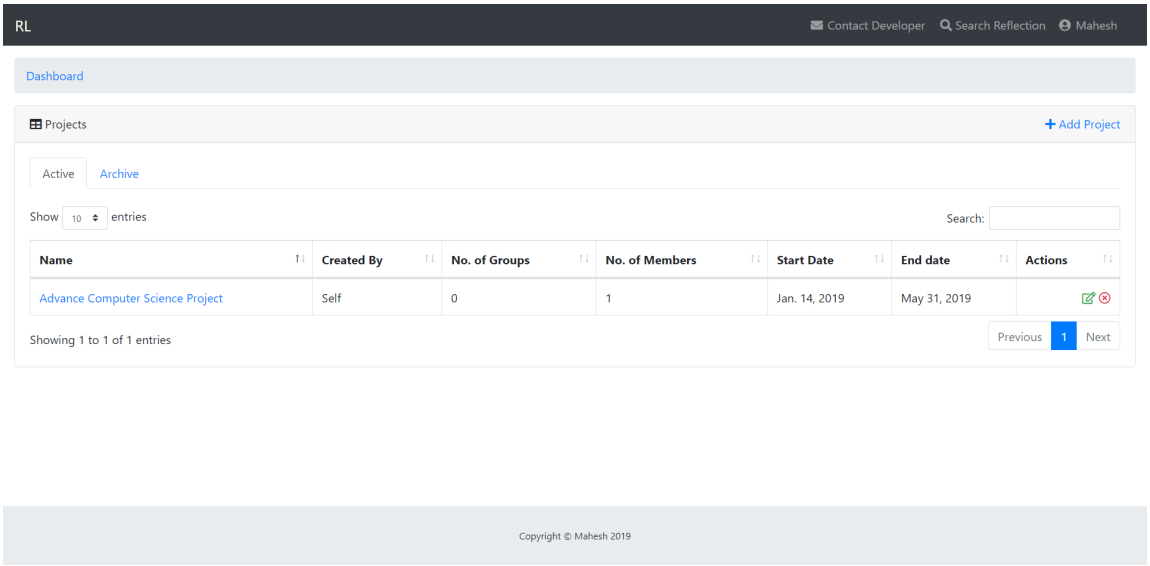


Figure 6: Interface for Project in the application

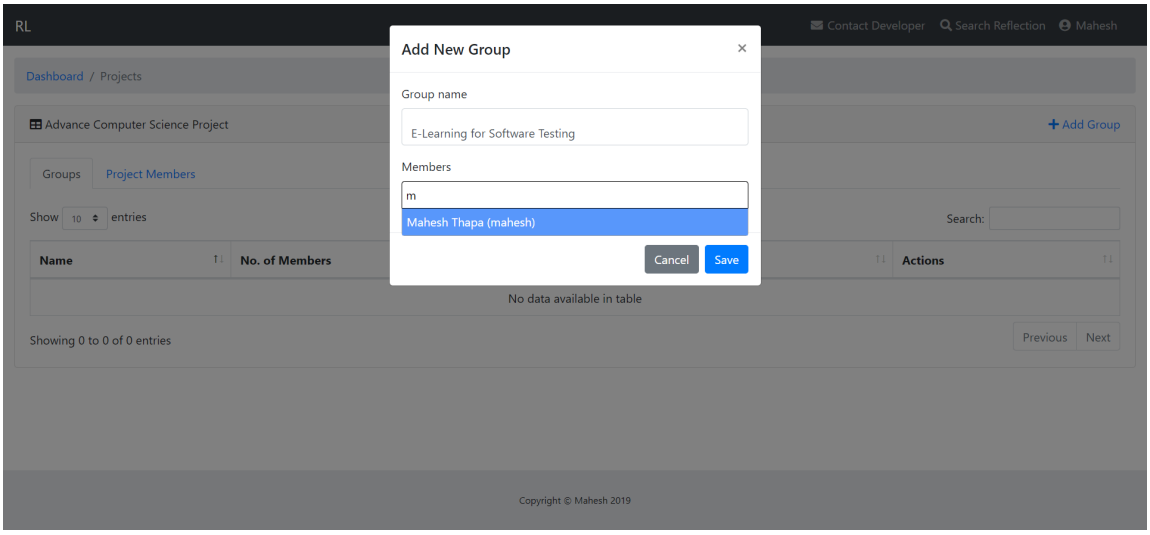


Figure 7: Interface for Group in the application

Search

Search is one of the important features in the reflective process. Reflective writing requires the rediscovery of the reflection for future use. Learning from past experiences is a part of the reflective learning process. The ability to search reflection in which students were part of, helps them to learn and relate to the current learning scenario. The search feature in the application allows students to

search individual and group reflections based on the keywords, tags or date range. Figure 8 shows the interface for search feature.

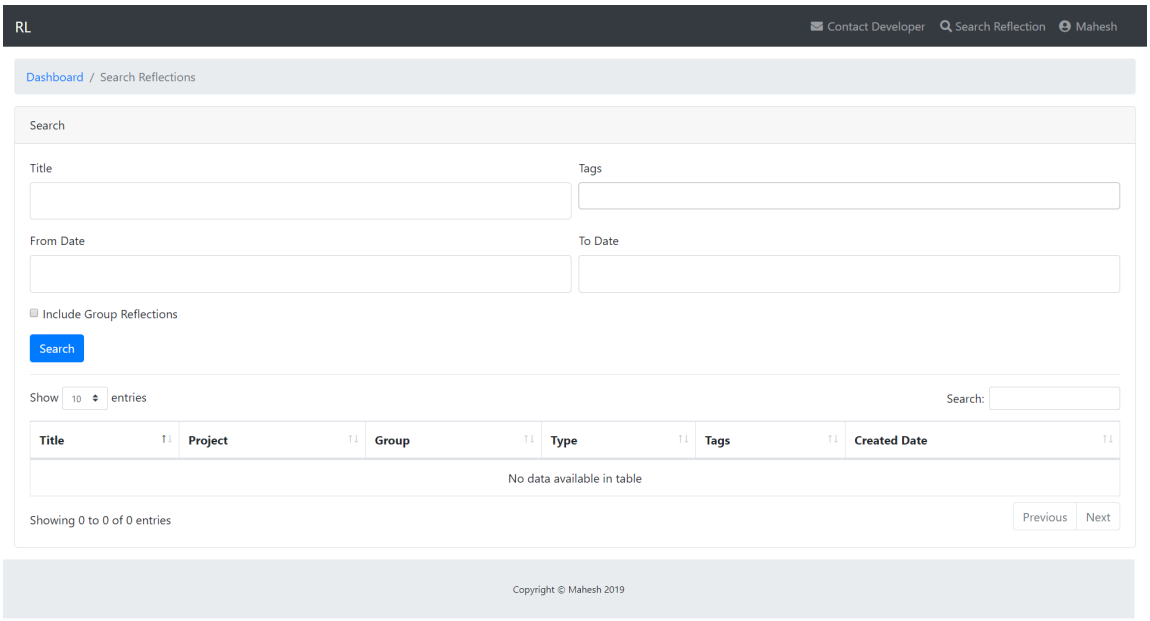


Figure 8: Interface for Searching reflections in the application

Reflection and Feedback

The core functionality of the application is writing the reflection. The application uses the question prompt (see Table 1) to guide students to write their reflections. There are two type of reflection *Group* and *Individual*. Individual reflection is personal and each student writes their own. Figure 9 shows the interface which includes the guided questions for reflection writing. To help the learning process, other students in the group can provide feedback based on the criteria defined in Table 3. Similar to Individual reflection, Group reflection has the same questions. Any member of the Group can create a group reflection and everybody can contribute to it. Group reflection is created from the discussion among the group members rather than the feedback like for Individual reflection. For that reason, only the option for suggestive discussion is implemented. The ability to share and discuss should help the students to learn from other's reflection and feedback.

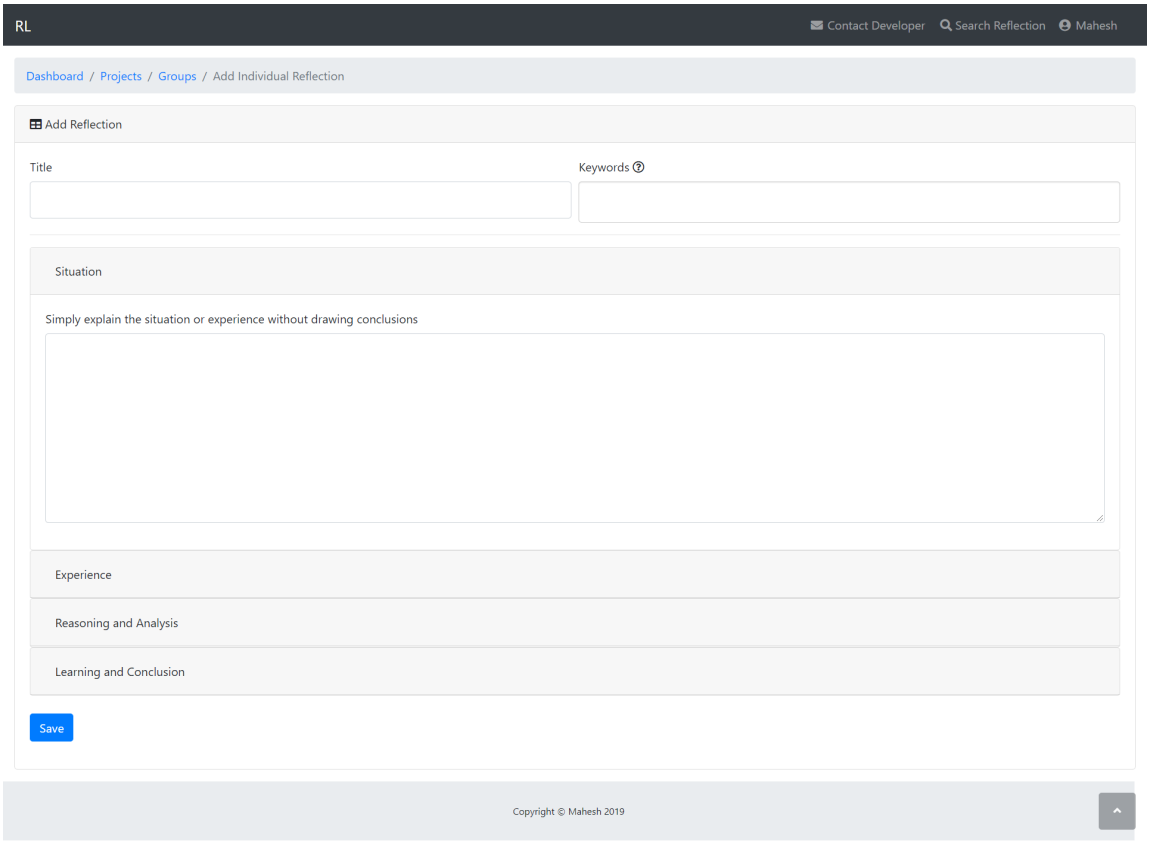


Figure 9: Interface for adding self reflection in a group.

Readability Index and Word Frequency

Readability is the measure to check how easy it is for a reader to understand the text. The use of compound words, words with more syllable and longer sentences tends to be complex for readers to understand. A Python-based text analysis project was done in the previous project course considering the need in this thesis work. The result of the project was a Python package that would generate two readability indexes; Automated Readability Index (ARI) [40] and Coleman-Liau Index (CLI) [41]. NLTK was used to process the text and generate quantitative data for calculation. The equations for calculating ARI and CLI are given below.

$$ARI = 4.71\left(\frac{characters}{words}\right) + 0.5\left(\frac{words}{sentence}\right) - 21.43$$

where *characters* is the total number of characters in a reflection text, *words* is the total number of words in a reflection text, and sentence is the total number of sentences in a reflection text.

$$CLI = 0.0588L - 0.296S - 15.8$$

where L is the average number of characters per 100 words in a reflection text, and S denotes the average number of sentences per 100 words in a reflection text.

The Python package also generated a word list to calculate word frequency. To generate only useful words, stopwords were removed from the list. Stopwords are the frequently used words like *is*, *the*, *a* etc. These words are considered noisy data and improve the performance of data calculation when removed [42]. Along with readability index and word frequency, the package also calculates *Lexical Diversity* which is the percentage of unique words used in the reflection text.

Sentiment Analysis and Graph

Another important integration is the sentiment analysis of the reflection text. NLTK provides the library function for sentiment analysis of the text. The sentiment reflects positive, negative or neutral emotions. The user reflection text is analyzed to calculate the sentiment. The sentiment is calculated in the range of [-1, 1]. Zero is the neutral sentiment, any score above is positive and below is negative. The score closer to zero are more neutral than either positive or negative. Due to this narrow margin, the neutral sentiment was increased to 0.2 towards positive and negative.

The reflection is not a single day process. In group learning, each member writes a different reflection on different occasions. The sentiment of each member is calculated based on the reflection text of the day and illustrated in a graph. The graph quickly displays how each member feels on a certain day of the group learning process. Figure 10 illustrates the sentiment of group members in different reflection date.

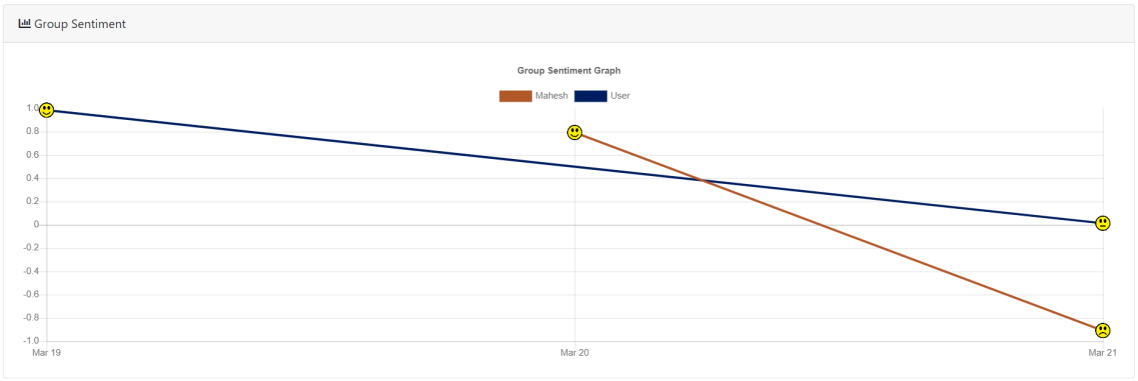


Figure 10: Graph showing sentiment of group members in different reflection dates

Data Visualization

Readability index, word frequency, and sentiment analysis are part of data visualization. These data are extracted from the reflective text of students. The visualization process helps to extract and display important details from the text. It is difficult to manually analyze the text data. Text analysis provides information in quantitative measures. The generated graph from the information is easy to understand. For example, in a group, with sentiment graph members can understand how each other feels without having to read through all the reflections. This can help to improve group

sharing and communication. Also, to analyze the cause and how to improve on the information in hand.

Additional Feature: Writing Language

Along with all the features, an extra feature of *language* was added to the application. The application now allows the possibility to choose between Norwegian and English. While creating the account, the user can select if they want to write their reflection in Norwegian or English (see Figure 5). Googletrans[1] package was used for the process. The process of translation was required to calculate the sentiment of the text. Sentiment analysis function does not provide an option for language so the translator is required. If the user had selected to write in Norwegian then the text is parsed through the translator to English first then the sentiment is calculated. However, the readability index and word frequency are calculated from the original text. Also, the original text in Norwegian is stored in the database. This feature was implemented as the group based users were Norwegian native students and they preferred to write in Norwegian than English.

[1] https://pypi.org/project/googletrans/

5 Results

All the raw result from the user testing experiment can be found in Appendix E

5.1 System Testing

The goal of the study is to find the student's opinion on the reflective writing tool in group-based learning. The developed application was hosted in the Heroku server for easy accessibility to the students. Before the experiment, NSD approval for the experiment was requested. Each participant was required to provide their consent before performing the application testing. The consent is available in Appendix B. The consent form briefly explains about the thesis and the application. Along with that more detailed information of the application was provided to the students before using the application. For the user testing, volunteer students from Bachelors and Masters at NTNU were contacted. The application testing was done in two groups of students; individual students and students working in a group.

5.1.1 Group Based

Two student groups working on their projects were contacted by the supervisor. The students were informed about the project and they provided their consent for using the application. There were 4 students in each group. The students used the application as a part of their daily activity for a week. At the end of the week, the students were asked to provide a response to survey questionnaires related to the application.

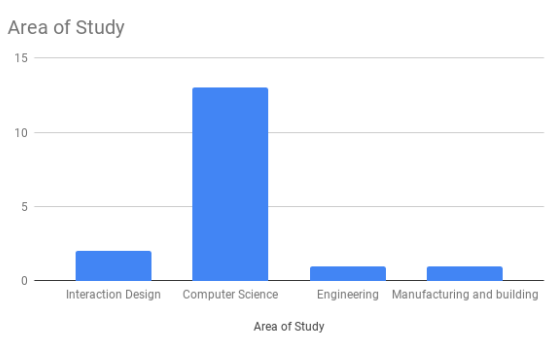
5.1.2 Individual

A proper user testing environment was set up for application testing. Students from different fields of study at NTNU were approached for application testing. The students were required to perform a set of activities in the application. These sets of students did not use the application over a longer time period like group based students. To use and review all the available features, participants were required to perform a set of tasks in the application. The task list is added in Appendix C. After completing the tasks, participants were asked to provide a response to survey questionnaires. The questionnaire set is added in Appendix D.

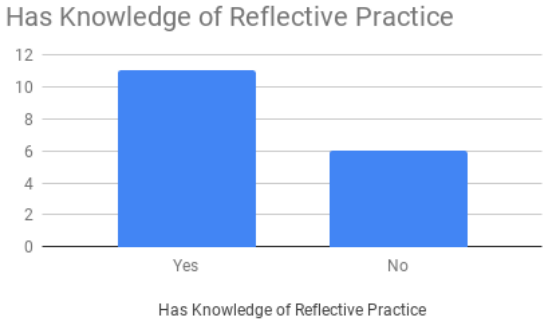
5.2 General Responses

A total of 17 students from NTNU participated in the application testing and responded to the survey questionnaires as well. Students from different faculty participated in the testing experiment. Figure 11a shows the percentage of students from a different area of studies. It can be seen that the majority (76.5%) of the participants were from Computer Science.

Of the total participants, 11 of them said they have some knowledge of the reflective learning



(a) Area of study of the participants



(b) Participants with knowledge on reflective learning process

Figure 11: Total participants = 17

approach.

5.3 Automated Feedback

The majority of participants saw the need for automated feedbacks like readability index and word frequency. They agreed that these feedbacks would help them to improve their reflection writing skills. There was only one participant who disagreed.

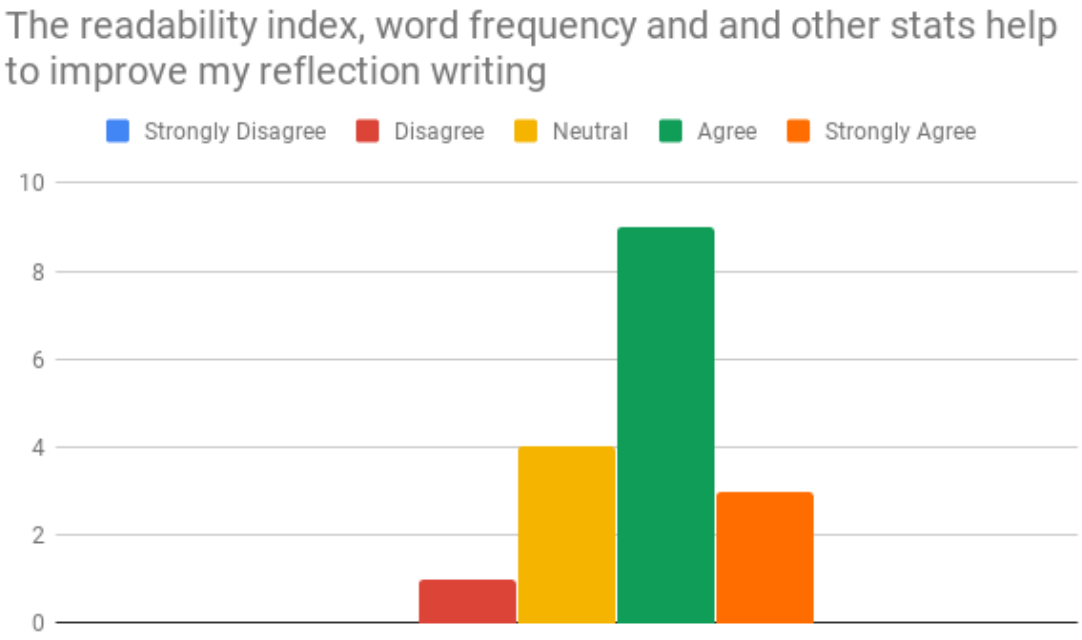


Figure 12: Participant's opinion on the integration of readability index and word frequency

5.4 Reflection and Sharing

It can be seen that most of the participants have the same agreement towards the guided reflection approach. 15 out of the 17 participants said that the guided approach would help them in their reflection writing process. Also, a similar number of participants liked the sharing of the reflection and feedback feature. Similarly, more than half of the participants said that individual reflection assists the group reflection process.

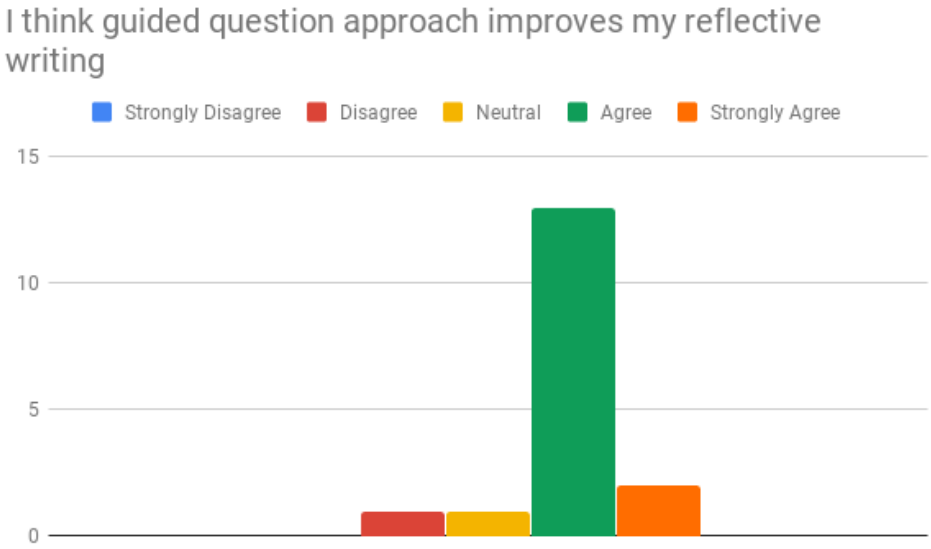


Figure 13: Participant's opinion on guided reflective approach

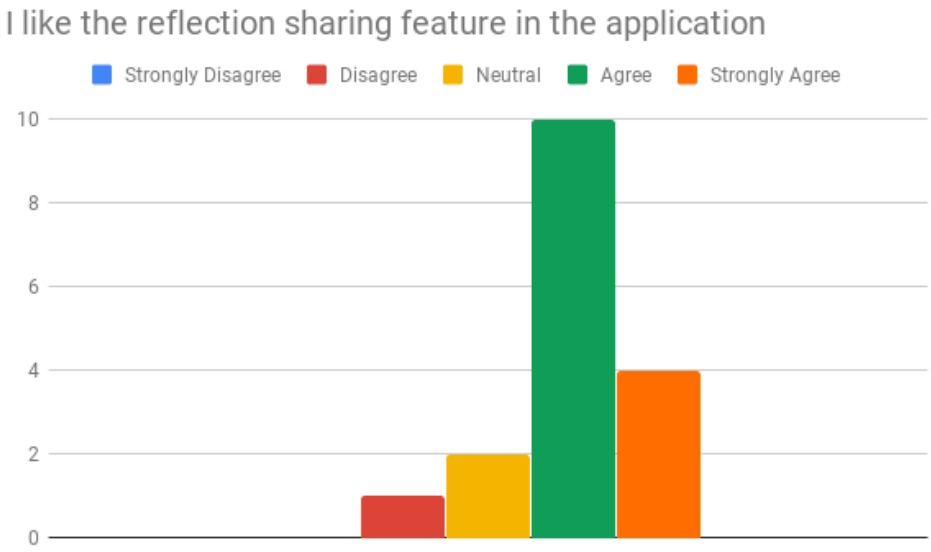


Figure 14: Participant's opinion on sharing reflection

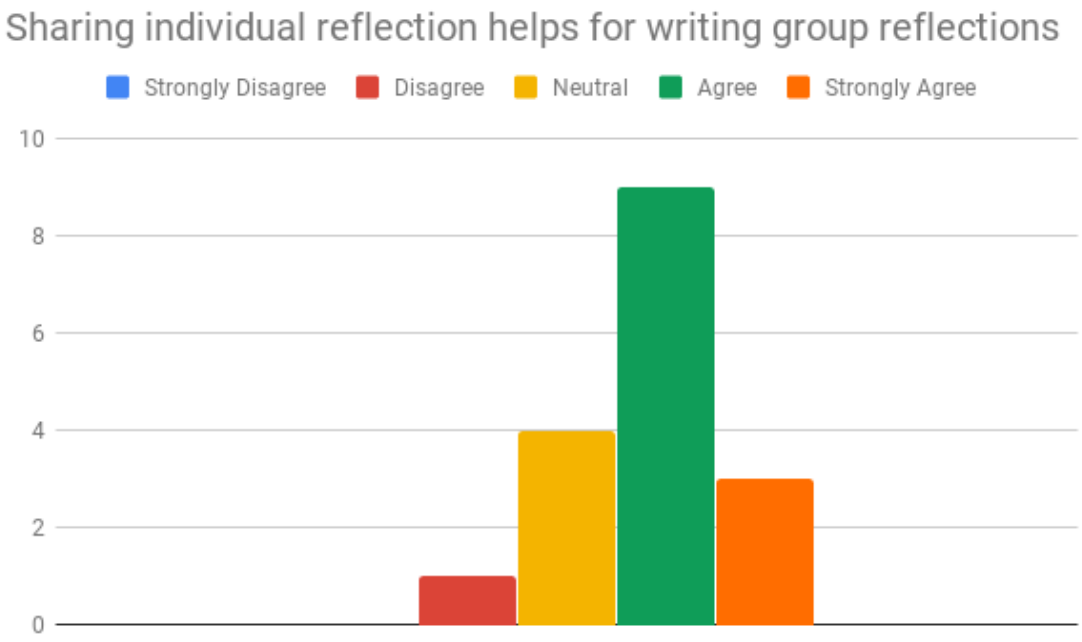


Figure 15: Sharing reflection and group reflection

5.5 Sentiment

The majority of the participants seem to find the sentiment graph helpful for the group reflection process. Almost half of them strongly agreed that academic emotions like happy, sad, anxiety, etc. are important in the group reflection process. However, participants were equally divided into two groups regarding how the questions on feelings and sentiment helped the reflection process. One group was unsure and neutral if the questions were helpful while another group agreed that the questions in the process were helpful.

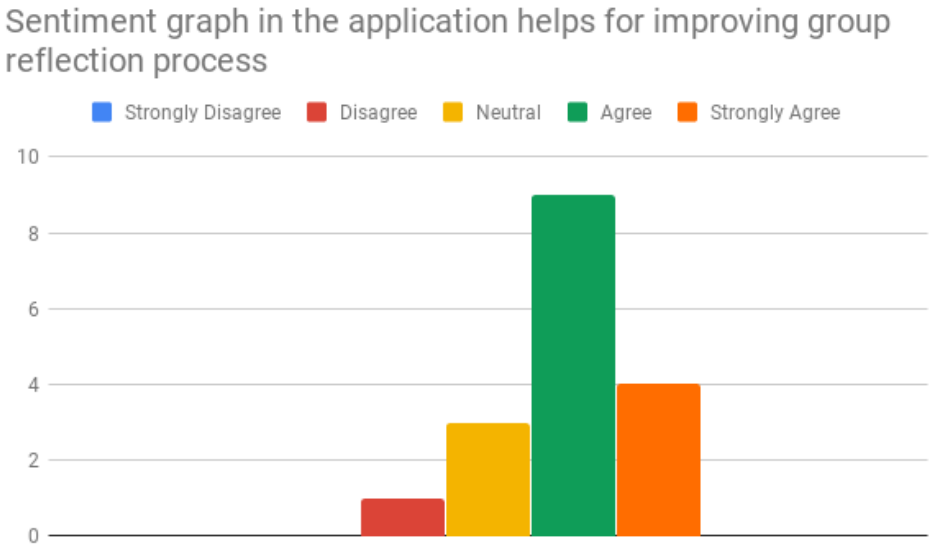


Figure 16: Importance of sentiment graph

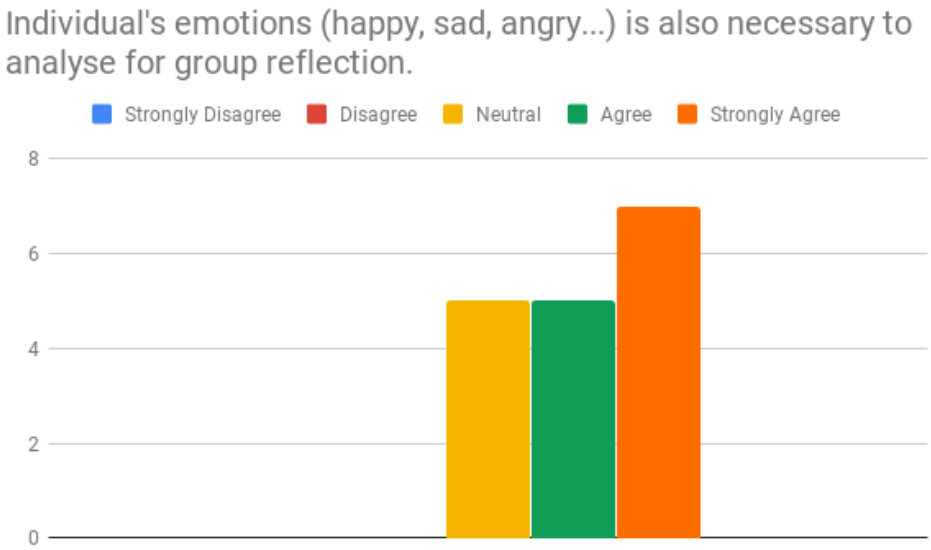


Figure 17: Participant's opinion for the need of academic emotions

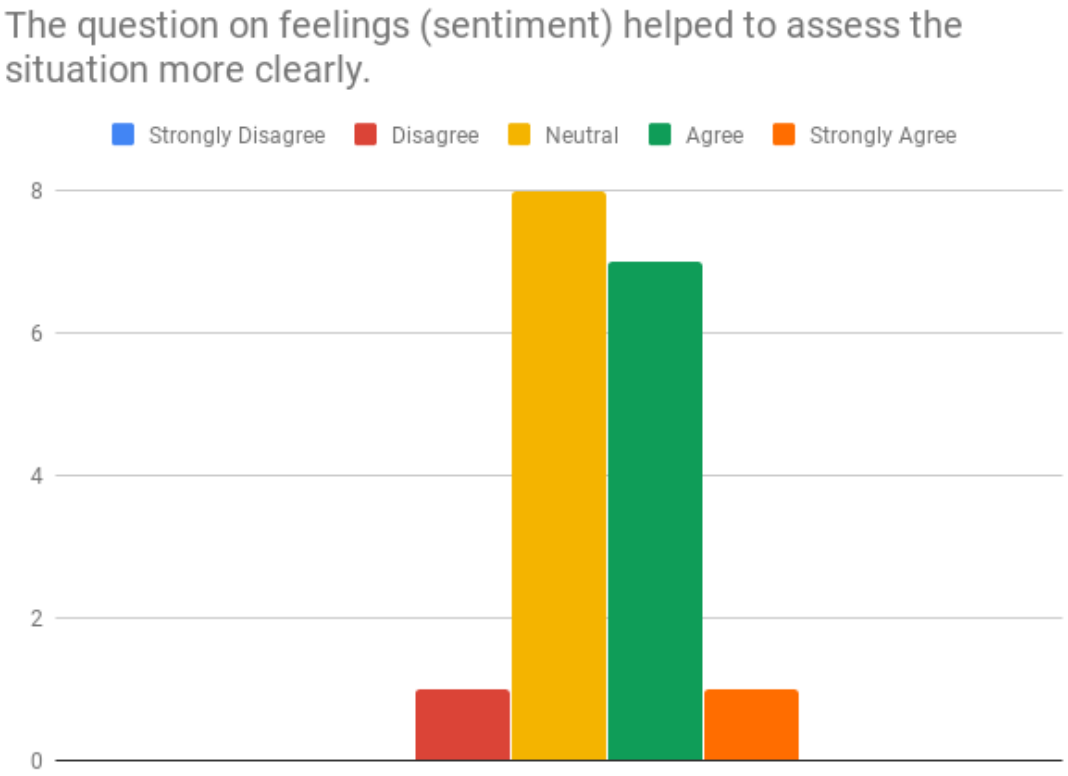


Figure 18: Guided question on feelings

5.6 Usability

More than 70% of the participants mentioned that the application was easy to use. However, the majority of them were unsure of using the application in an academic scenario. While four were certain on the usability, five only agreed. Half of the participants said the application time does not affect their work. There were 5 participants who disagreed and said that the application was time-consuming to use.

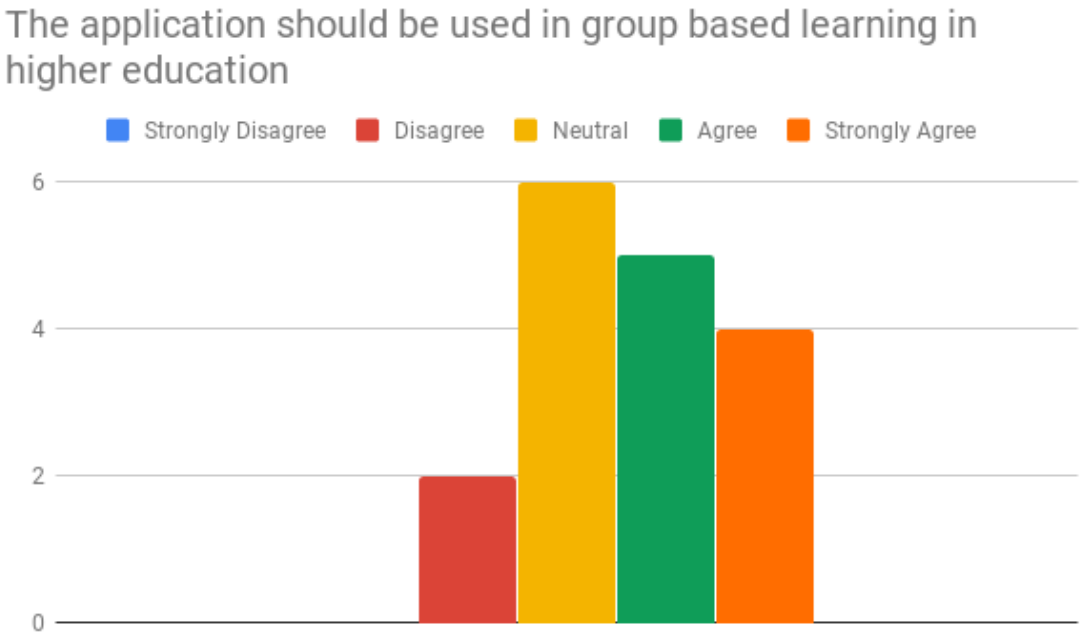


Figure 19: Usability of application in higher education

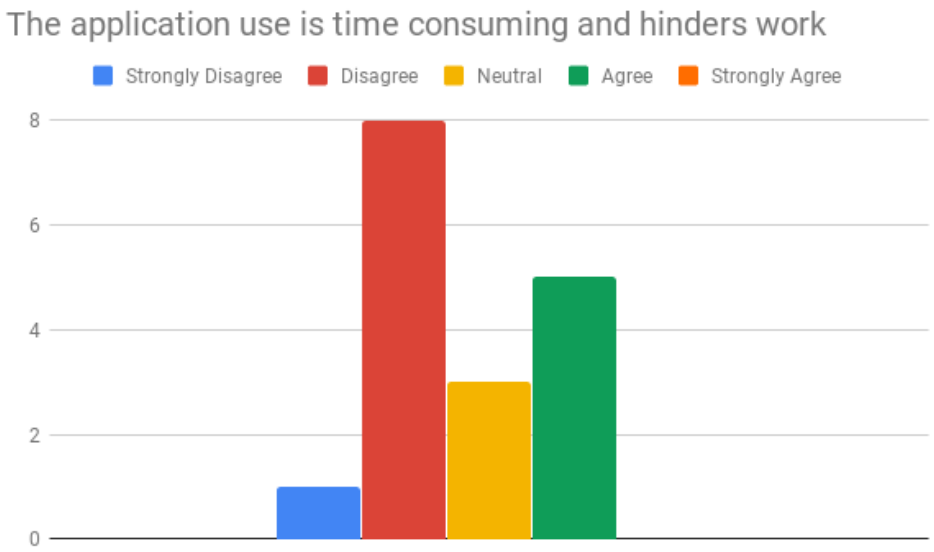


Figure 20: Application as time consuming

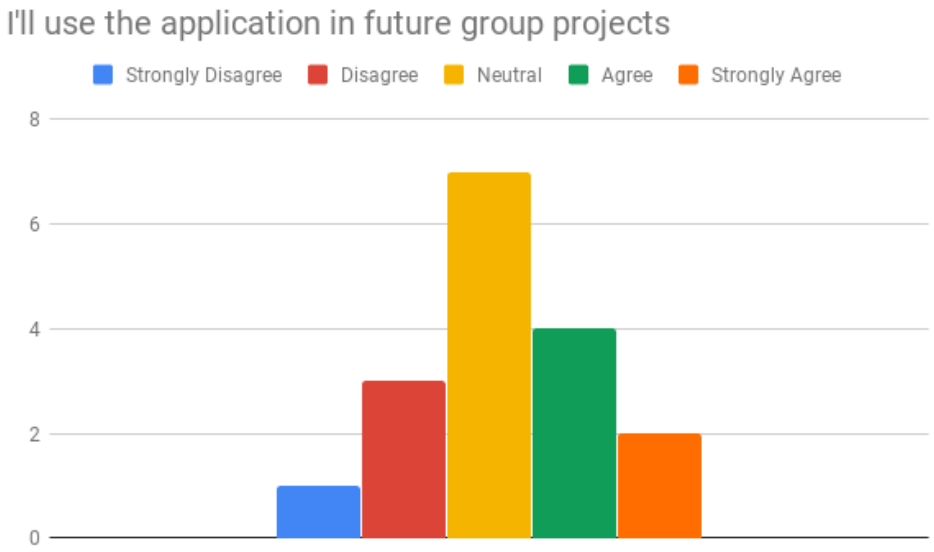


Figure 21: If participants want to use the application in future

6 Discussion

6.1 The Application

The application was developed for the thesis research as a prototype so there are some features missing in the application. The application was designed with the thought to include other features on top of the core functionalities. This was a better approach to development. The core functionalities are an important aspect of this thesis. Other features give the idea of the possibilities of how the application can be improved. The application uses very few third-party packages. Third-party packages can make the development process easier but the frequent changes could affect the application dependencies and difficult to maintain. With less of these dependencies, it is easier to maintain, update and upgrade the application in the future. However, with bugs and issues in third-party packages, the application update process needs to wait until the package developer fixes the issue or another package needs to replace the old one. The future development and maintenance cost is also minimal with fewer dependencies.

The application in the current state is applicable in academic scenarios like group-based learning environments. The project and group management is one of the important features in the application. This properly structured process helps to manage the data more systematically. This can, for example, be used in any educational institute with teachers as project owners and student's study groups as a reflection group. Guided reflection process with feedback rubric is the core functionality. The stepwise process makes the application easy to understand and use. The core functionality assists students in the process of reflection and provides feedback to each other. Confidentiality feature makes feedback receiver and giver not identifiable in the group. Which also makes it easier for students to share ideas and constructive feedback without hesitation. The idea for the feedback rubric is that the student will not provide inappropriate feedback.

Another important feature of the application is the sentiment graph. The graph shows the sentiment change of each member of the group over time. This will influence the group and help to foster learning. This is also one of the weaknesses of the application. The sentiment analysis of the text in academics, especially reflection text, lacks proper research and studies. Most of the analysis use the review based corpora like movie reviews, product reviews, twitter posts, etc. as a dataset. These datasets do not match with the purpose of the sentiment in reflection writing [21]. This makes the sentiment analysis in the application not reliable. However, the implementation was to understand how the feature integrates with the other aspect of the reflective writing process. Also, this helped in understanding the expectation of the students towards reflection writing tools. Since there are not many reflection writing tools, it was necessary to understand which of the factors are needed and which of them don't align with the usability.

6.2 Result Discussion

From the results, it can be seen that many of the participants are from the faculty of *Computer Science*. The initial intention for the project was to include students from EiT which mostly includes *Computer Science* students. Also, the motivation for the project was from EiT course. However, the objective of the application was to assist students in higher education with their learning. There were fewer participants from EiT course so students at NTNU from different faculty were contacted for participation. Most of the participants mentioned that they had knowledge of the reflective approach. However, they seem to lack information on how to use and get benefit from this approach. The participants required information on the process of reflection and it's importance in learning. The participants were focused on the analysis part of the reflection by recalling the event and action while ignoring the concept of alternative approaches and learning outcomes from the situation. There seemed variation in understanding of the reflective concept among the students. Proper guidance towards understanding the concept and importance could trigger self-motivation in students. It is one of the key skills to learn in higher education. The skill can transfer learning experiences in the work environment later in time. [10] also suggests that the students who practiced reflective learning during the course found the process essential in their work environment.

Though the participants were positive with a guided approach some of the participants had critical feedback on the guided questions. For example, one participant mentioned:

> The questions where confusing. They assumed I answered about some situation, but it was unclear what situation they were referring to.

The reason might be that the different sections in the reflection focus on the current and similar old situations to analyze the experience. Analyzing both situations and trying to understand the actions and learning from the current situation could have confused the participant. Other participant had feedback on having a similar question in Group and Individual reflection process. The approach to Group reflection was exactly the same to that of Individual reflection. Having the same process, it was thought that the guided questions should be similar. There was also feedback on splitting the questions to make the process less overwhelming. The participants provided more of the feedback on how to improve the application.

Similarly, participants had a positive response towards readability index and sentiment analysis. Most of them seem to like the idea of including these features in writing. One participant mentioned:

> ....the emotion graph is a nice feature to keep track of your group

However, they recommended to include different emotions other than positive and negative. Various emotions influence the activities and motivation of the students. The better achievement is found to boost the positive emotion in students which improves the learning [18]. Three sentiments, positive, negative and neutral, barely identify human emotions and complexity. For example, sarcasm could be interpreted as positive when it is not. The application implements these features to provide the visual illustration of its importance in this learning approach. Furthermore, it shows how the group sentiment changes over time. This could help in understanding the group members and reflect better on why the changes occur. This shows that various data extraction and visualization are possible with reflection text. And they are potentially important to understanding various

aspects of learning. Along with the sentiment, participants were more positive about the feature of sharing the reflection and providing feedback. When the group members are motivated it could trigger the self-motivation towards learning. Feedback from one participant sums up the attitude of most participants toward the application usefulness. When asked about what features they like, the participant replied:

> How easy it was to manage groups. How it makes you split up situations into different blocks so that it is easier to assess the situation thoroughly. How you are able to get feedback from both others and statistics about your writing

One of the least expected response was on the time-consuming factor of the application. The participants required some time to write a reflection during the test. And it was assumed that the participants would agree that the application requires more time and affect the work. On the contrary, most of them said that the application is not time-consuming. It seems that the students are motivated towards learning and this could be a part of their regular work. The self-motivated and learning nature of students must be the reason for the students to accept the application. The application has the potential to assist the students in their learning and also motivate towards the future experience. It can be seen that most of the participants agreed on the usefulness of application in a group-based learning environment in higher education.

6.3 Research Questions

RQ 1. Understanding the usefulness of technology integrated guided reflection tool in higher education

From the results, it can be seen that most of the participants were positive on the usefulness of the application. The technology integrated tool makes the application accessible to students. Also, the process in the application helps for proper management of the project and groups for guided reflection. Though there were more participants unsure if they want to use the application in their future learning, many of them suggested that the application is useful in higher education. It seems participants were positive on the idea of guiding them towards learning. Proper introduction of the concept among students could help them to realize its importance. The structure of the developed application also implies that the application has the potential to be useful in other scenarios besides academia.

RQ 2. Students attitude towards automated feedback on text readability and sentiment for assisting reflection

Text analysis for readability and sentiment seemed to be an interesting integration to the application. Participants liked the features and mentioned that the features are important in the reflection process. Although, there is no measurement on how these features influence the learning, participants perception towards its impact was positive.

RQ 3. Students opinion on the peer-review model on guided self-reflection to help collaborative reflection in a group project

Participants agreed with the usefulness of the peer-review model in the reflection process. They implied that the feedback approach helps for better understanding and idea sharing. It can be seen that the students accept the peer-review model as an important aspect of the learning scenario.

6.4 Challenges

One of the challenges in the project was finding active participants for the feedback and test process. The initial plan for the project was to find participants from EiT course as it would be relevant for the students and the experiment would have a better response. However, the participation from the EiT course was not as expected and only a few of the students showed interest. This was done in the earlier stage of the project so that alternative approaches could be implemented. Also, the project was designed for a group-based so group participation was also required. This was also a challenge to find a group willing to participate. The issues were discussed with the supervisor and he introduced the groups willing to participate. Regarding participation, it was necessary to finish the application development earlier so that it would not interfere with participant's examination schedule. Because of this application deadline and project planning had to be managed accordingly.

Another necessary challenge was to get NSD authorization. NSD authorization is required to handle the user's personal data in a project. There is usually waiting time to get the request approved. It was challenging as the application was planned to be hosted online with Heroku services. The database was hosted in the EU server and the application had authentication with email. It was seen that request with user identification in remote server took more time to get approved. Because there could be a delay for the project, the user identification element, email, was removed from the application to only require a username. The need for online service was because some of the participants required to use the application remotely. It was possible to do local testing for some participants while it was not possible for the group-based users. Alternatively, in such a situation it would have required to install the application in each user's computer or skip the process and implement individual user testing only.

6.5 Limitations

The application developed for the project was a prototype and the idea was to implement core functionalities and build others on top. The application's core functionality is complete however, it lacks other features like user-friendly designs and navigations. The application has basic features and with the interface it has, it was difficult for some students to properly use the application. Another reason for this was students' participation. The application testing needed to be performed earlier so that the test will not occur during their examination. To perform the test earlier the scope of the application was narrowed. Some students had to struggle to find how to add members to Project and Group.

The application uses sentiment analysis provided by NLTK and text sentiment analysis is not

absolute. Furthermore, the sentiment analysis functionality of NLTK is developed with the dataset from different resources other than reflective writing. The intention and purpose of those datasets could have influenced the sentiment of reflective texts.

Another important factor to consider is the sample size of user testing. The application has a relatively small sample size and this small group could have influenced the result for the project. Also, the experiment was not a longitudinal study. This was also in consideration of not disturbing the students with their study. So, a short experiment with a limited feedback approach was possible. A study with a proper time frame for testing and feedback might provide better and exciting results.

7 Conclusion

The objective of the thesis project was to deliver a web-based reflection writing tool. The reflection process used in the application is a guided learning approach. The scaffolding of the process helps the students to focus on the important aspect of the learning. Reflection is considered an important process in learning. However, many students are reluctant to use the process for their personal development. Especially in the group based learning, reflection can help to trigger different understanding and sharing of the ideas. The developed application helped in the research process to understand the perception of the students towards reflective writing and related attributes. The application included some of the important features like sentiment analysis, sharing and peer-review process. The influence of self emotion and the environment is the reason for including these features. Positive emotional changes are mentioned to trigger self-motivation and drive students towards learning.

The application is a step towards making the reflection process more manageable and useful. The students had a positive review of the usefulness of the application. Students seemed positive towards the concept of reflection and its implications. Integrating the learning process in higher education could prove to be beneficial to students. This can help them in their writing skills, decision making and analysis. The research was perception based so it is uncertain that using the application influences the learning process or not. Based on the response, the application has the potential to be useful in learning scenarios other than higher education as well. The application is a prototype and provides a basis for improvement to make the application more useful in the learning process. There are not many technology integrated reflection tools which also adds importance to this application.

7.1 Future Work

The project application has potential usefulness in the learning process in higher education. Further work on this project will prove to be beneficial. Currently developed application is a concept prototype with less focus on the interface design and user interaction. The focus was on the workable core functionality with a simple interface to work with. The user interface and interactivity could be improved for better usability. Some participants recommended that it would be easier to navigate with the proper management of *Group* and *Project*. The separation of hierarchy navigation with a managed approach could make the process easier for users. The application is not only suitable for academics but also for the workplace environment. The integration of the application with employee records could make it applicable in the workplace.

The usefulness of the application can be improved with features like grammar and spell checker for reflection writing. This helps to improve the writing skills of the students along with assisting the reflection process. With improved writing skills, an analysis of the sentiment can also be improved.

Academic emotions like sad, happy, anxious, etc. are also regarded as important by the participants. Allowing students to express their own emotions could help to improve group learning. The expressed emotion could help the group to understand the situation more correctly than with positive, negative and neutral sentiment provided by the sentiment graph. Also, the guided process in the application is static and students might feel monotonous to write answers to the same question every day. Proper scaffolding the application according to the user's proficiency could improve the usability as well. The application can analyze the improvement of the student based on the inputs like active use, positive feedbacks. The other improvement could be including administrative features and providing an option to update the guiding questions depending on the need of the project.

The current study was focused on the implementation of the *Guided Reflective* approach as a web tool. The project tried to get the students' attitude towards the implemented concept of reflection with the feedback process. As mentioned in Limitations, the user testing was based on a small sample group and the testing was based on the attitude of participants towards the concept. A longitudinal study of the same research could bring up new and interesting results. Furthermore, the study could focus on if the application improves the learning or not.

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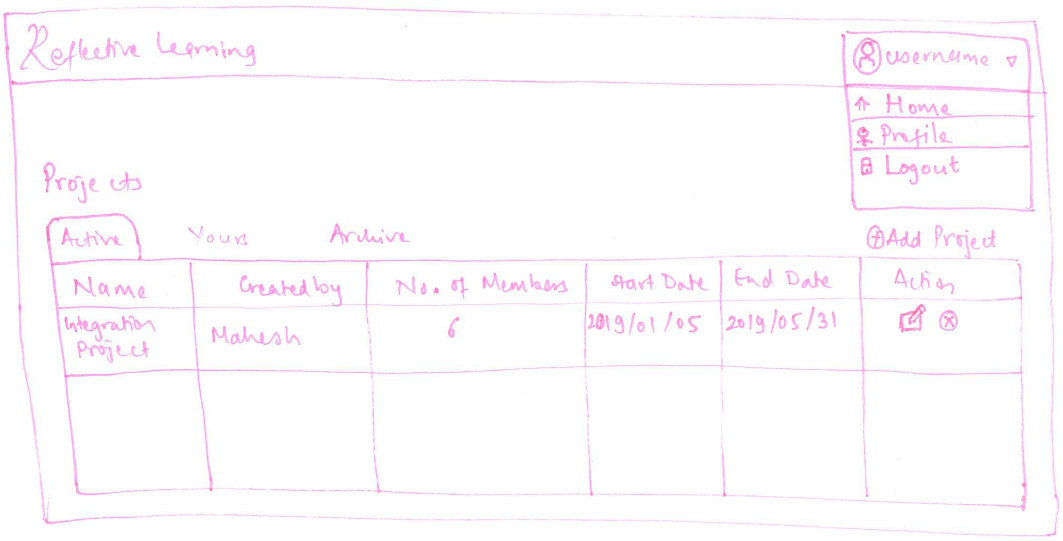
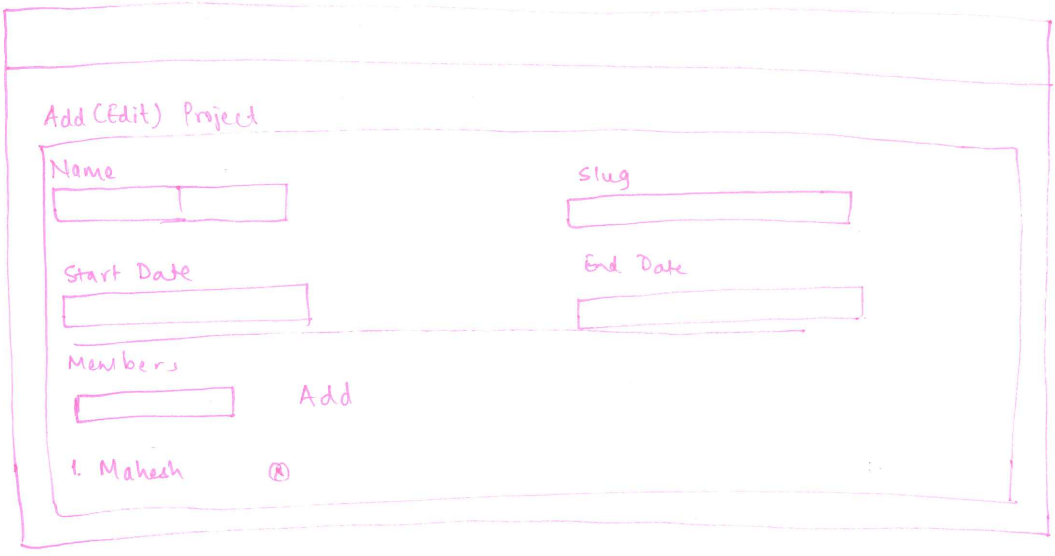
Appendices

A - Wireframes

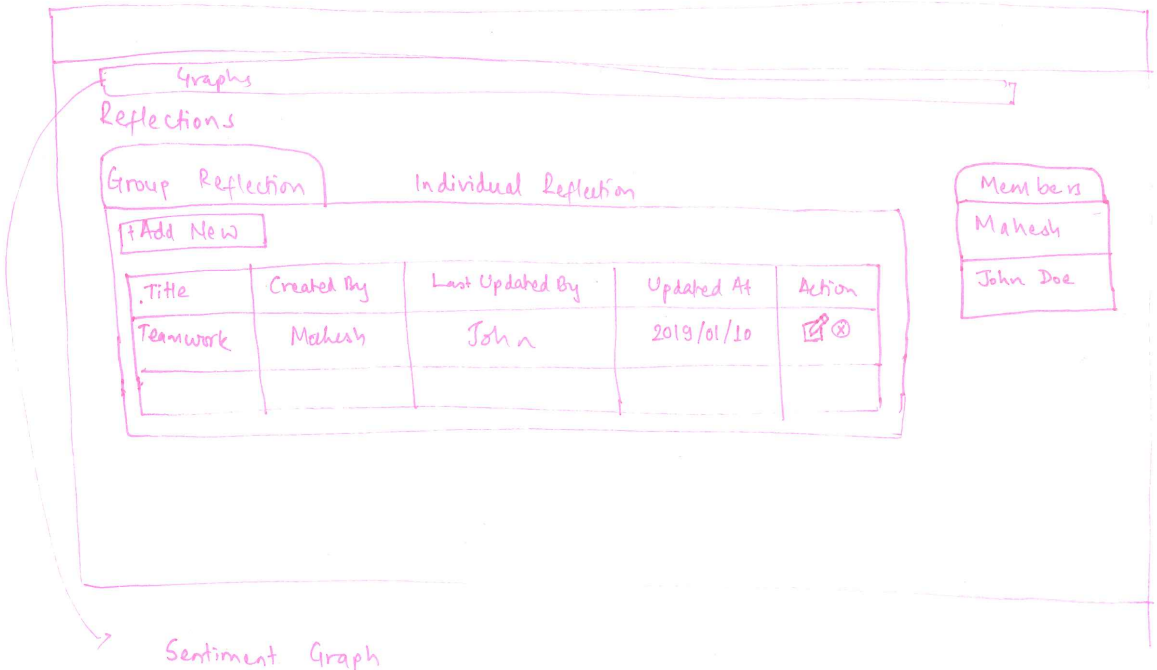
1. Dashboard

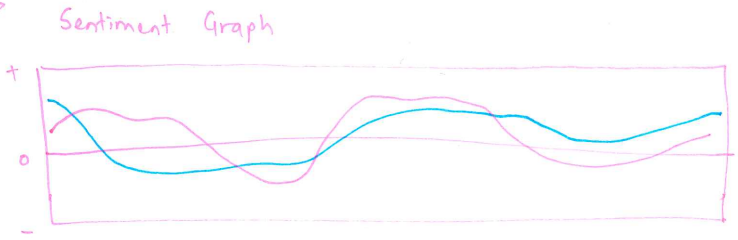


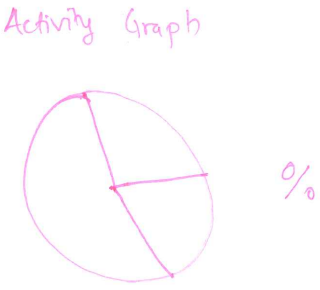
2. Add / Edit Project



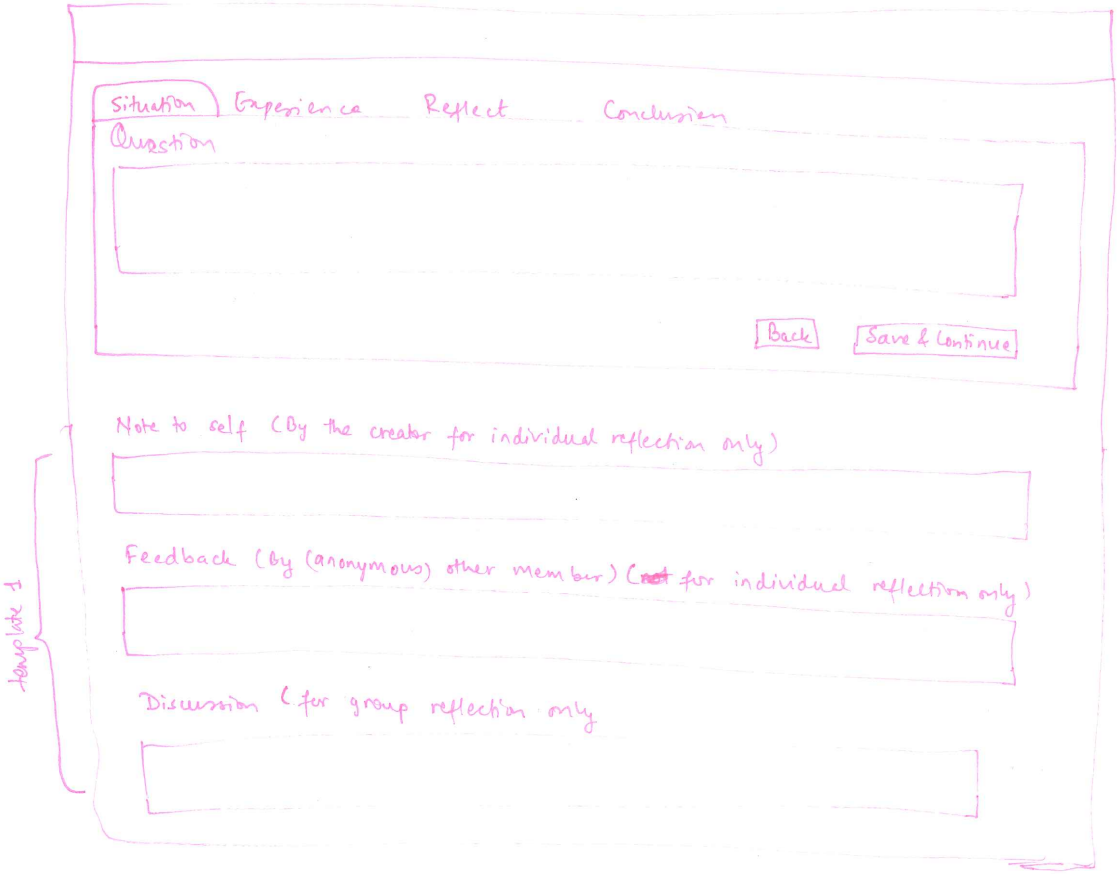
3. Project Page







4. Reflection Add / Edit



5. Reflection view mode

B - Consent Form

Are you interested in taking part in the research project

"Peer Review and Feedback Approach on Individual Reflection for Assisting Group Reflection: A Web-Based Reflection Tool"?

This is an inquiry about participation in a research project where the main purpose is to get students feedback after using a web based application. In this letter we will give you information about the purpose of the project and what your participation will involve.

Purpose of the project
Reflection process is about analysing the past experience to learn something new which will help in the future. Most of the students reflect back to the activities they performed but rarely do they write. Writing the reflection helps to make the learning concrete. A web platform for reflection writing is developed.
The focus of the process is to use the application for a certain time and find the usefulness of application. After the end of application use, students will be asked to provide feedback.

Who is responsible for the research project?
Norwegian University of Science and Technology is the institution responsible for the project.

Why are you being asked to participate?
The students are working in a group based project where they have to reflect on their work, individual and group. The application is specially designed for group based learning.
The students were contacted by the supervisor and the students showed willingness to participate.

What does participation involve for you?
If you are willing to participate, you'll have to use the web application for a sprint of your group work. After the end of sprint, you'll be asked to provide feedback on the application. Using application once should take about 15-20mins. You will use the application alongside other group members.

The final feedback questionnaire will be paper based asking about the application, it's usability and importance.

Participation is voluntary
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

- *The supervisor and the researcher are the only person who will have access to the personal data.*
- *The application will require to register with username and Name. No other identification will be asked. The application use is a group based so the username will also be identifiable by the group members.*
- *Personal data from the consent will be in personal records of the researcher until the completion of the course. The local data will not be accessible to the public.*

What will happen to your personal data at the end of the research project?
The project is scheduled to end in June 2019. All the personal data of the participant will be completely removed after the course is complete.

Your rights
So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?
We will process your personal data based on your consent.

Based on an agreement with *Norwegian University of Science and Technology*, NSD – The Norwegian Centre for Research Data AS has assessed that the processing of personal data in this project is in accordance with data protection legislation.

Where can I find out more?
If you have questions about the project, or want to exercise your rights, contact:

- *Norwegian University of Science and Technology* via
  Supervisor: *Rune Hjelsvold (rune.hjelsvold@ntnu.no) or*
  Project Student: *Mahesh Thapa (maheshb@stud.ntnu.no)*
- NSD – The Norwegian Centre for Research Data AS, by email: (personverntjenester@nsd.no) or by telephone: +47 55 58 21 17.

Yours sincerely,

Mahesh Thapa
Project Leader
(Researcher)

Consent form

I have received and understood information about the project *Peer Review and Feedback Approach on Individual Reflection for Assisting Group Reflection: A Web-Based Reflection Tool* and have been given the opportunity to ask questions. I give consent:

- ☐ to participate in *application testing and feedback survey*

I give consent for my personal data to be processed until the end date of the project, approx. *June 2019*

Signature and Date

C - Task List

TaskList for testing the application:

1. Create your account
2. Give researcher your application **username**
3. Create Project and open the project
4. Create Group (need to add yourself to the group)
5. Add user "**mahesh**" to the project and assign to the created group
6. Add your reflection (if you want to..)
    a. Assess the question prompt
7. Assess the reflection page and functionalities like Readability index, Word frequency
8. Go to Dashboard

You have been added to a new project and group

1. Open the group page
2. Review the details
3. Provide feedback to member's reflection
4. Search Reflection

Note: *If you have any queries, ask the researcher*

Situations:

In group learnings:

1. Imagine a situation where you had to discuss and some of the team members didn't agree with your solution you believe to be the best. Reflect on the situation

2. You started the day with a plan to finish a task (report writing, literature review, assignment, creating a program). You spent hours trying to understand the task and didn't finish the task by the day end. Maybe you didn't feel you contributed to the team.

3. Reflect on one of the situations from EIT course
    a. Doing SITRA exercise
    b. 2+1 feedback exercise
    c. Team formation and new to the team
    d. Discussing the project topic
    e. Your learning expectations

4. You were absent and your team members decided without letting you know. It was not decided before that, absentee will not have a say. And the idea is something you don't like

Note: *You can write about other reflective situation as well.*

D - Survey Questionnaires

Reflective Learning App Evaluation Survey

* Required

1. **Area of Study** *
   Mark only one oval.
   - ◯ Computer Science
   - ◯ Information Security
   - ◯ Engineering
   - ◯ Interaction Design
   - ◯ Other: _____

2. **I had knowledge of reflective learning process** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

3. **I have used the application to write a reflection** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

To what extent do you agree with the statements

4. **I think questions in the application assisted the writing process** *
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. **I think guided question approach improves my reflective writing** *
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

6. **The question on feelings (sentiment) helped to assess the situation more clearly.** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. **The questions assisted me to construct learning outcomes** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. **I like the integration of readability index, word frequency and other stats** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. **The readability index, word frequency and and other stats help to improve my reflection writing** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. **I think the readability index in NOT important in the reflection process** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 2

11. **I like the reflection sharing feature in the application** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. **I like the feedback approach used in the application** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. **Sharing individual reflection helps for writing group reflections** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. **I like the integration of sentiment in the application** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. **Sentiment graph in the application helps for improving group reflection process** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. **Individual's emotions (happy, sad, angry...) is also necessary to analyse for group reflection.** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. **I think sentiment graph is NOT important in the group reflection process** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 3

18. **The application is easy to use** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. **It is easy to navigate to find the information** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. **The application use is time consuming and hinders work** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. **The application helps to manage group reflections properly** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. **It is easy to manage members in a project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. **The application helps to write clear and concise reflection** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. **I think the application is useful for improving individual reflection** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. **I think the application is useful for improving group learning process** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. **The application should be used in group based learning in higher education** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. **I'll use the application in future group projects** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

28. **I'll recommend my friends to use the application in their group learning** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Feedback on application

29. **List the features you liked or see usefulness in the application** *

30. **List the features you didn't like and also mention why you didn't like them** *

31. **What other features would you suggest that would help to improve reflection process in group (or individual) learning?** *

32. **Please provide any other feedback regarding how the usefulness of application can be improved?** *

E - Results

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think questions in the application assisted the writing process	0	1	7	8	1
I think guided question approach improves my reflective writing	0	1	1	13	2
The question on feelings (sentiment) helped to assess the situation more clearly.	0	1	8	7	1
The questions assisted me to construct learning outcomes	0	3	7	5	2
I like the integration of readability index, word frequency and other stats	0	0	2	7	8
The readability index, word frequency and and other stats help to improve my reflection writing	0	1	4	9	3
I think the readability index in NOT important in the reflection process	4	6	6	1	0
I like the reflection sharing feature in the application	0	1	2	10	4
I like the feedback approach used in the application	0	1	2	9	5
Sharing individual reflection helps for writing group reflections	0	1	4	9	3
I like the integration of sentiment in the application	0	0	5	10	2
Sentiment graph in the application helps for improving group reflection process	0	1	3	9	4
Individual's emotions (happy, sad, angry...) is also necessary to analyse for group reflection.	0	0	5	5	7
I think sentiment graph is NOT important in the group reflection process	5	7	3	2	0
The application is easy to use	0	2	2	6	7
It is easy to navigate to find the information	0	1	4	7	5
The application use is time consuming and hinders work	1	8	3	5	0
The application helps to manage group reflections properly	0	2	3	9	3
It is easy to manage members in a project	0	0	3	8	6
The application helps to write clear and concise reflection	0	2	3	11	1
I think the application is useful for improving individual reflection	0	3	3	6	5
I think the application is useful for improving group learning process	0	2	2	11	2
The application should be used in group based learning in higher education	0	2	6	5	4
I'll use the application in future group projects	1	3	7	4	2
I'll recommend my friends to use the application in their group learning	0	2	6	7	2

Table 4: Participants response from the experiment

List the features you liked or see usefulness in the application	List the features you didn't like and also mention why you didn't like them	What other features would you suggest that would help to improve reflection process in group (or individual) learning?	Please provide any other feedback regarding how the usefulness of application can be improved?
The emotion icon on the graph	I feel I need all the features for better reflection, so there is no feature that I do not like	Other group members can give ratings on the other's feedback	The system could be improved on UI design so that users are attracted and feel more fun, more engaging to use it
guided reflection	maybe the sentiment is not complex enough to express the emotion of the group (if limited only to a scale happy/sad)	i dont know	The managing part (dreatin project and adding groups) should be separate from the writing part. i shuld have a page for a group in wich i'm prompted to write in a more friendly way.
I liked the metrics, and how the reflection was structured afterwards.	I did think it was kind of cumbersome to answer the questions, especially when there were 3 questions for a textbox. I think the application could improve a bit on the motivational aspects.	I wonder if a voice-to-text solution would be interesting. Sort of dictating your reflections.	Focus on the motivational aspects, make it more interactive and gradual. Overall the application was relatively easy to navigate, as it is a short test it is probably even better when used to the application.
Control questions	n/a	n/a	n/a
I liked most that the application makes reflective learning easier through its various functions and features. I also think that sentiments diagram is a useful feature.	I thin all the features that the application provides were useful for reflective learning, and bettering learning outcomes.	Cannot think of anything	Cannot think of anything
How easy it was to manage groups. How it makes you split up situations into different blocks, so that it is easier to assess the situation thoroughly. How you are able to get feedback from both others and statistics about your writing	I cant think of anything I really disliked, its more that certain features could be polished	Could be useful to be able to search up the feedback you've left on other reflections. Maybe a possibility to share images or files could be useful as well, to either illustrate or provide context. Could also be nice to have more of a profile, in case there is new groups formed where it could assist in identifying a person with a picture connected to their name.I	Unless I missed it, I would like to think it would be nice to be able to add groups to your project as you are creating the project, instead of having to make each group individually.
indexes	the sentiment graph. not too sure whats the purpose	using scales instead of words to express ones emotion	the interface is quite complicated at the beginning
Use latex to write reflection rapport and download the rapport as pdf	repeating question that has to be answered	word suggestions could be nice to have while writing	no idea
Stats, guided questions and sentiment graphs were nice	Generally, most things were fine. The UI could maybe be a bit cleaner, but I am no UI designer so I cannot provide good feedback in that regard.	Maybe it could have some presets for common group reflection exercises to make those easier to go through. I.e. SITRA, 2+1 and so on	Nothing in particular that I can think of right now.
Sharing and feedback on reflections.	Some of the questions may be too overwhelming. Could possibly divide them into more answers.	I don't know.	One question when doing the group reflection not group reflection: "How did you feel during the situation? How the factors influenced your emotion and action? How did you think other people in the group felt and why do you think that?"
The word complexity thing was cool.	I feel like the questions were too comprehensive.	Maybe not have the same questions in individual and group reflection.	The questions where confusing. They assumed I answered about some situation, but it was unclear what situation they were referring to.
Sentiment graph, having multiple groups for a project	Cant think of any	Dont know	The questions was a little confusing
Group Sentiment Graph	The questions didn't feel natural to answer.	I am not sure.	I am not used to writing reflections, but I feel the questions didn't fit in with what I worked on.
group reflection, individual reflection, mood scale, readability stats	Not sure	Not sure	.
The leading questions provide for better reflection and the emotion graph is a nice feature to keep track of your group	A bit to static questions in the way of situations. It's hard to decide if the situation is relevant.	Maybe make the questions more general, but still be directional	I think it's mentioned in the way of more general questions
I liked the emotion graph and the fact and the fact it was easy to use	i didnt like the fact that it was time consuming (12min) the hard part was acctually to remeber to do it	i dont know	in general I liked it, as mention the hardest part was remembering to do it, i also didnt like that you had to go trough all the reflection questions every day, didnt have anyhting concrete to write about everyday
I like it doesnt shows the other people who wrote the reflection, the emotion graph was funny, the reflection process	Sometimes the emotiongrpah clearly shows wrong result	ask the user how they really feel with one word	it was a fun experience, but i think it can be developed even better.

Table 5: Participants feedback from the experiment