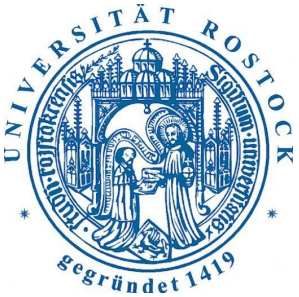
Supporting Participatory Re-Design Activities for Collaborative Online Tools by Storyboarding



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Abstract

Storyboarding is effective in participatory design. The goal of participatory design is to include all participants (stakeholders, UI and UX designers, developers, and researchers) in the design process to produce the best possible final product design. Many researchers considered the storyboard a useful tool for ideation as well. In the context of interaction design, storyboarding assists in illuminating interactions between users and the interactive system under consideration by displaying both the system's user interface and its usage context. Design teams get a sense of the flow of users' experiences with the help of effective storyboards [11]. The objective of the thesis is to explore the usefulness of storyboarding in supporting participatory redesign activities for collaborative online tools as used in educational settings (e.g., BBB, Zoom). In this exploratory study, we presented groups with either two storyboards or with brief textual descriptions, while they were providing comments and suggestions on the specific scenarios depicted in storyboards and described in textual form in a controlled environment. The results suggest that when participants were given both storyboards, they generated more design ideas than when they were given descriptions of scenarios in more abstract text form. Similarly, this study findings also show that when users are presented with storyboards generate more re-design ideas that support other perspectives as compared to their own perspectives.

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CHAPTER 1: INTRODUCTION

A storyboard is a method of organizing a narration and all of its images, words, and details. A visual representation of a verbal story is created via storyboarding, which helps filmmakers understand the entire story by moving from abstract to concrete. When developing a storyboard, it is important to consider how the scenario looks visually and determine what kinds of problems need to be resolved before the idea can be understood. Concepts can be simplified and made clear by translating action into visual appearance [22]. The storyboard is not only used in the film industry but also in interaction design and human computer interaction, it considers a popular technique for displaying system interfaces and usage scenarios. 'user-centered design' (UCD) refers to design techniques in which end-users influence how a design takes shape. Users are active in UCD in various ways, but the crucial principle is that they are involved in some way in the design process and in scenario-based design, the use of a future system is explicitly described early in the development process. The system development process is guided by narrative descriptions of envisioned usage situations. This thesis investigates the usefulness of storyboarding in supporting participatory re-design activities for collaborative online tools, as used in educational domain (e.g., Zoom).

This master thesis presents an exploratory study in the area of co-design activities. The goal of this study is to see how storyboards and brief textual descriptions affected the participants' ability to redesign groupware, specifically Zoom. We divided participants into five groups. The participants of three groups (OS1, OS2, OS3) were presented with storyboards, and the participants of two groups (OT4, OT5) were presented with brief textual descriptions. The participant's redesign ideas are collected through group discussion. A controlled experiment is conducted with 5 groups under 2 conditions.

The results show that when participants were given both storyboards, they proposed more design ideas than when they were given descriptions of storyboard scenarios in more abstract textual form and when users are presented with storyboards generate more re-design ideas that support other perspectives as compared to their own perspectives.

This master thesis remaining sections are structured as follows. The background information such as user-centered design, scenario-based design, storyboarding, and online collaboration tools are described in Chapter 2. The objectives and procedures of the current study are presented in Chapter 3. It also includes information about participants, experiment design, data collection, and experiment analysis and findings. The obtained results are discussed in Chapter 4. Chapter 5 sums up the thesis and make some suggestion for further research.

CHAPTER 2: THE BACKGROUND INFORMATION

This chapter first gives a background on user-centered design. Then it describes the storyboarding and scenario-based design in detail, which are relevant in the context of the thesis. Finally, online collaboration tools for teaching and learning are described.

2.1 User-Centered Design Introduction and History

The user can sometimes feel frustrated and unable to execute a simple activity as a result of the unintuitive design of everyday objects. For example, how many of us have purchased a VCR and struggled to use it, missed recording our favorite programs because we misinterpreted the instructions, or had to live with the clock blinking at midnight because we did not know how to stop it? Isn't it is feasible to create more useable systems? The phrase 'user-centered design' (UCD) refers to design techniques in which end-users influence how a design takes shape. It contains both a broad concept and a wide range of methodologies. Users are active in UCD in various ways, but the crucial principle is that they are involved in some way in the design process. Some kinds of UCD, for example, consult users about their needs and involve them at specific points during the design process, such as requirements collecting and usability testing. On the other end of the spectrum, UCD approaches incorporate users as collaborators with designers throughout the design process, allowing them to impact the design significantly [1].

The phrase 'user-centered design' was coined in Donald Norman's research lab at the University of California San Diego (UCSD) in the 1980s, and it became widely used after the publication of a co-authored book, User-Centered System Design: New Perspectives on Human-Computer Interaction [2]. In his important work, The Psychology Of Everyday Things (POET), Norman elaborated the UCD concept in more detail [3].

In POET, he understands the user's demands and interests and concentrates on the design's usability. He makes four essential recommendations on how a design should be:

- Make it simple to establish what actions are feasible at any given time.
- Make the conceptual model of the system, the alternative actions, and the results visible.
- Make it simple to assess the system's present condition.
- Follow natural mappings between goals and needed actions, between actions and the resultant impact, and between observable information and system state interpretation [3].

The user is placed at the center of the design due to these suggestions. The designer's responsibility is to make the user's task easier and to ensure that the user can use the product as intended and with the minimum effort to become familiar with it. Norman pointed out that the lengthy, difficult-to-read product manuals are not user-centered. He advises that a brief brochure that can be rapidly read and makes use of the user's existing knowledge of the world should be included with the products.

It is not enough to tell designers that their products should be intuitive; certain design principles must be used to guide the design. Norman proposed [2], the following seven design principles are vital for making the designer's job easier:

- Make use of both real-world and mental information. By creating conceptual models, create user-friendly manuals before the design is implemented.
- Simplify the task structure. Make sure not to overburden the user's short-

term or long-term memory. On average, the user can recall five items at once. Maintain consistency in the task and provide mental aids for simple retrieval of knowledge from long-term memory. Confirm that the user has command over the task.

- Make everything visible: bridge the Execution and Evaluation gulfs; the user should be able to figure out how to operate an object by viewing the appropriate buttons or devices for carrying out an action.
- Make sure the mappings are correct. Using graphics to make things more understandable is one option.
- Utilize the force of natural and artificial constraints to give the user the impression that there is only one way to accomplish.
- Make room for mistakes. Plan for any potential error that may occur; this way, the user will have the option of recovering from any possible fault.
- When everything else fails, standardize. Develop an international standard if something cannot be built without arbitrary mappings [3].

Norman's work emphasized the importance of thoroughly investigating the users' requirements and preferences, along with planned uses of the product. The requirement to involve actual users, frequently in the context in which the product is being produced, is a logical step in the user-centered design discipline. As a result, users are directly involved in the development process. Their participation resulted in more effective, efficient, and safe products as well as increased product adoption and success [4].

2.1.1 User-Centered Design Guidelines for Collaborative Software

Scholtz et al. [5] constructed user-centered design guidelines for designing collaborative software.

Their constructed list includes:

- Collaboration tools must support context at various classification levels.
- Collaboration technologies can facilitate conversation as well as content exchange. One mode may be more essential than the other for any given team.
- Collaboration tools can be used in an asynchronous, synchronous, or mixed mode. The tool's supported mode should be aligned with the team's preferences.
- As data collection and analysis are closely linked, a collaborative analysis tool must support both.
- Task coordination is made easier by collaboration technologies that offer individual user status.
- Provide tools for categorizing evidence by the story.
- Create features to help with entity processing.
- Analysts worry that complete information integration may lead to security lapses and leaks.

2.1.2 Crucial User-Centered Design Principles

Gulliksen et al. [6] described key principles for user-centered design systems. User-centered design systems are based on the following core principles:

User focus All project members must know the activity's goals, the context of usage, who the users are, their conditions, goals, and tasks, why and how they accomplish their tasks, and how they communicate, cooperate, and interact. These assist in creating and maintaining a focus on the needs of the users rather than a technical focus. Identifying user profiles, contextual queries, and task analysis must be natural parts of the development process. Verify that all project participants have met with actual or future users, for example, by visiting the workplace. To retain a user focus, descriptions of typical users, tasks, and scenarios could be posted on the project room/area walls [6].

Active user involvement Users should be directly involved in the development project as well as related activities such as organizational development and the design of new work practices. The users must be representative of the target audience. Plans for including users should be specified right from the beginning of the project. Determine suitable user participation phases and indicate where, when, and how users should participate. Emphasize the value of meeting users in context, such as in their workplace [6].

Evolutionary systems development It is impossible to know exactly what you are going to develop from the start. As a result, user-centered system design (UCSD) needs an approach that enables continual iterations with users and gradual releases. This is done so that clients can review design solutions before they are made permanent. An iteration should include a proper study of the users' needs and usage context, a design phase, a documented evaluation with concrete ideas for changes, and a redesign based on the evaluation results [6].

Simple design representations Utilize design representations and vocabulary that all users and stakeholders can understand to fully realize the implications of the design on their future use situation. Use prototypes (sketches and mock-ups) and simulations. Abstract notations like use cases, UML diagrams, or requirements specifications are insufficient to provide users and stakeholders with a clear idea of the future use situation. In addition, the representations must be useable and effective. The idea is for all engaged parties to have a common knowledge of what is being constructed [6].

Prototyping Multiple paper sketches, mock-ups, and prototypes should be used to aid the creative process, elicit requirements, and visualize ideas and solutions. Prototypes should be created and tested with real-world users. Before implementing anything in code, it is critical to start with low-fidelity materials, such as rapid sketches. Begin with a high-level conceptual design and work your way down to the details. if possible, produce numerous prototypes in parallel, as these assists de-

signers in retaining an open and creative attitude toward what is being developed [6].

Explicit and conscious design activities The user interface and interaction design are unquestionably crucial for the system's success. Remember that the user interface is the system to the users. The design of the system under development (SUD) in terms of user interaction and usability should be the outcome of intentional and committed design activities. The SUD's construction should follow that design. Far too frequently, UI and interaction design happens due to someone performing some coding or modeling, rather than a result of professional interaction design as a controlled and prioritized activity [6].

Usability champion There should be an experienced usability specialist or a usability group in the development team. From the beginning of the project and throughout the development process and system lifecycle, the usability designer should be dedicated to the project as an engine for the UCSD process. The usability designer must be granted the authority to decide the system's usability and the future use situation [6].

Holistic design The software does not exist in isolation from other aspects of a work environment. When building software to assist with work activities, the work structure, work methods, roles, and so on must be adjusted. All aspects should be developed concurrently. Work/task practices and organization, user interface and interaction, online help, manuals, user training, work environment, health and safety aspects, and so on are all included. Other factors of the usage context, such as hardware and social and physical contexts, must also be considered in the integrated design process. One individual or team should be in charge of overseeing the integration of all parts [6].

Processes customization Usability cannot be accomplished in the absence of a user-centered process. However, there is no such thing as a one-size-fits-all process. Thus, the actual contents of the UCSD process, methodologies utilized, activity

sequence, and so on must be tailored and changed to the specific company and project depending on their own needs. A UCSD process can be built on a commercial or internal software development process in which activities are added, eliminated, or adjusted. Existing methods and approaches may be reused as long as they follow the basic principles [6].

A user-centered attitude should always be established UCSD needs a user-centered approach throughout the project team, the development organization, and the client organization. Everyone working on the project must be aware of and dedicated to the importance of usability and user interaction. Still, their level of understanding will vary based on their function and the stage of the project [6].

A professional attitude Different features and parts of the system design and development process need specialized knowledge and abilities. Therefore, analysis, design, and development work should be carried out by empowered interdisciplinary teams comprised of, system architects, programmers, usability designers, interaction designers, and users [6].

2.2 Scenario-Based Design

The scenario-based design was created by information scientists Mary Beth Rosson and John M. Carroll in the software development industry. In scenario-based design, the use of a future system is explicitly described early in the development process. The system development process is guided by narrative descriptions of envisioned usage narrative descriptions of envisioned usage scenarios serve as the framework for the system development process. A scenario is a story. They are made up of a setting, or situation state, one or more actors with their own motivations, knowledge, and abilities, and various tools and objects that the actors interact with and use. The scenario is a way to think about how things work together to reach a particular outcome. These actions and events are linked together in a way that includes the goals, plans, and reactions of the people who were in the scenario [7].

By describing how people will use a system to accomplish work tasks and other

activities, scenario-based design shifts the focus of the design process away from defining system operations. Instead of analyzing and modeling specific tasks of human behavior and experience, scenario-based design is a quick and easy way to imagine future uses [7].

2.2.1 A Simple Example

Figure 2.1 illustrates three brief scenarios in which a member of a club interacts with other club members via various network tools. In each of these scenarios, the individual's objective is to visit a club and socialize with her friends. Three scenarios illustrate how computer network technologies might accomplish such a goal. These scenarios are potential solutions to Sharon's needs. Still, the user experience varies significantly, ranging from asynchronous text-based reading and posting to a real-time graphical simulation of a meeting point [7].

Designers can quickly create scenarios like these to help to bring imagined possibilities to concrete. Figure 2.1 contrasts three contemporary approaches to online interactions, but not as a list of features or functions. It compares three instances of human-computer interaction with three cases of personal experience [7].

A. Science Fiction Club in a Web forum
After three years at Virginia Tech, Sharon has learned to take advantage of her free time in-between classes. In her hour between her morning classes, she stops by the computer lab to visit the science fiction club. She has been meaning to do this for a few days because she knows she'll miss the next meeting later this week. As she opens a Web browser, she realizes that this computer will not have her bookmarks stored, so she starts at the homepage of the Blacksburg Electronic Village. She sees local news and links to categories of community resources (businesses, town government, civic organizations). She selects "Organizations", and sees an alphabetical list of community groups. She is attracted by a new one, the Orchid Society, so she quickly examines their Web page before going back to select the Science Fiction Club page. When she gets to the club page, she sees that there are two new comments in the discussion on Asimov's *Robots and Empire*, one from Bill and one from Sara. She browses each comment in turn, then submits a reply to Bill's comment, arguing that he has the wrong date associated with discovery of the Zeroth Law.
B. Science Fiction Club in a Community MOO
After three years at Virginia Tech, Sharon has learned to take advantage of her free time in-between classes. In her hour between her morning classes, she stops by the computer lab to visit the science fiction club. She has been meaning to do this for a few days because she knows she'll miss the next meeting later this week. As she starts up the Blacksburg community MOO, she can see that the last person using this computer must have been interested in orchids, because the welcoming text describes her location as an orchid garden, along with Penny and Alicia, who are discussing some new exotic varieties. The text description mentions an exit to Main Street, so she leaves the garden and starts moving south. Along the street she runs into George, who is working on a banner for the fair. She gives him a quick hello, and continues southward until she sees an eastward exit will take her to Eastenders Pub; this is where the Science Fiction Club meets. She enters the room and is told that Bill and Sara are already there, along with a pitcher of Newcastle Brown. She can tell from their current comments that they have been discussing the timeline from Asimov's *Robots and Empire*.
C. Science Fiction Club in a Collaborative Virtual Environment
After three years at Virginia Tech, Sharon has learned to take advantage of her free time in-between classes. In her hour between her morning classes, she stops by the computer lab to visit the science fiction club. She has been meaning to do this for a few days because she knows she'll miss the next meeting later this week. When she tries to start up the online collaborative environment, she finds that this computer does not have the client, so she waits for a minute or two while it is automatically downloaded and installed. After she logs in, she is taken back to her previous visit location, and sees the familiar panoramic view of her livingroom, her to-do lists and sketchpad, and the interactive map of Blacksburg. She positions and zooms in on the map until she can see downtown buildings She enters the Eastenders Pub subspace, where the science fiction club usually meets. She sees a panoramic image of bar, faces that show Bill and Sara are here, a food and drink menu, and various standard tools. The map updates to show a floorplan of the Pub—the dining room, the darts room, the office, and the main bar. Bill and Sara are using a chat tool and a shared whiteboard to sketch an event timeline for Asimov's *Robots and Empire*. Joining Bill and Sara in the chat tool, she types "Based on the Zeroth Law, I'm afraid I must drink some of your beer".

Figure 2.1: Shows three scenarios in which a university student attends an online club meeting [7].

2.2.2 Scenario-Based Design Benefits

This section covers the advantages of scenarios and the design activities that incorporate them, in order to understand why scenario-based design is advantageous.We compare scenarios with user stories. Storytelling is used in many parts of the design process. Unfortunately, the end result is frequently unplanned stories that are not always well-organized. Scenarios are more ordered and presentable than user stories, wrapping them together to highlight critical design challenges. In addition, scenarios are well-suited as a medium for people of various backgrounds and disciplines to interact and collaborate in a design team due to their use of layman's language and flexibility in the medium of depiction. Carroll et al. [8] described the features of scenarios and examined how they address technical issues in information systems design. They identified the following characteristics:

Scenarios are multi-faceted Scenarios allow multiple perspectives and varying degrees of interaction. For example, they can describe the divergent views of various stakeholders in a project. As a result, determining the consequences of a particular scenario for various stakeholders becomes easier. Additionally, the scenario can reflect the design stage by describing the appropriate level of interaction. From here, stakeholders can evaluate the design maturity, whether it is still in the form of ideas, rough concepts, or detailed specifications ready for build [8].

Scenarios enable concurrent action and reflection Scenarios assist developers in finding a balance between action and reflection in their design work, without the action obstructing the reflection and vice versa. Proposing solutions can be accomplished through the use of scenarios. The resulting scenarios provide developers with immediate and concrete hypothetical use cases against which to base their solutions. Rather than performing actions continuously and reflecting on the solution only at the end, the ability to perform actions and reflections in smaller iterations reduces the risk of producing undesired solutions [8].

Scenarios are both concrete and malleable Scenarios are concrete because they show a single example of the open-ended design situation. In addition, they show a single interpretation of it. There is a lot of information about how people use products that could make designers feel overwhelmed. In this case, you need to narrow down the information and pick out a few concrete scenarios that are important to start. Scenarios can also be changed. It is easy to change or add to them if the interpretation turns out wrong or if new information about the situation comes up [8].

Abstractions and categorizations of scenarios are possible Scenarios can easily expand as the design evolves and new concepts are discovered. Cover the important usage scenarios, but keep them concise. You will not feel overwhelmed as you begin to create a product. A few years later, when new information comes to light, new scenarios can be added, and existing scenarios can be improved. The collection of scenarios can be abstracted and categorized to make a well-structured source of information about the field of design. Such knowledge can be used for other design projects that have the same characteristics. For example, well-known safety standards are based on situations that have happened a lot and have been gathered over a period of time. Using scenarios as its medium, the domain knowledge is easier to find. A design team could think about how to use scientific knowledge or new technology in the design from a different point of view. Future-oriented scenarios could encourage the development of a specific type of product or technology by proving that it is crucial [8].

Scenarios encourage user and stakeholder participation Scenarios are used to start design discussions in the middle of work processes, where users and stakeholders are the experts in their field. The people who will use the product should be a part of the process of making it. This is called participatory design, and it is based on the idea that everyone should be able to help make decisions about their own lives. Furthermore, skilled users can help make the project go well and create high-quality products when they are involved in the design process. There are ways to get people and other people involved in the design process. In any of these meth-

ods, scenarios are used as a common language between designers, users, and other people interested in what they make. Using scenarios, everyone can communicate quickly. Designers can come up with solutions by telling scenarios, and users and stakeholders can check them out right away or come up with new ideas by telling different scenarios [8].

2.2.3 Using Scenarios in Design

Scenarios can be used at different points in the design process, such as understanding what users need and how they work, developing requirements, coming up with ideas, and communicating product concepts. Scenarios let you put product details in the background while focusing on what people do and their contexts. Scenarios help people understand the meaning of different designs by putting them in the context of how people use them, their motivations, and their surroundings [9].

By writing a scenario, we can explain the purpose of the system, service, or product in a short, clear, and interesting way. Unlike, drawings or mockups, scenarios describe events that happen over time. This makes them suitable for explaining causal relationships. This makes scenarios ideal for describing how a product can be used [9].

Inclusion of the time dimension, the versatility of form, and versatility of content are three major characteristics that make scenarios so powerful in the design of the practical product [9].

Scenarios also help people from different fields talk to each other. As new systems, services, and products are usually made by teams, it is not enough to think about how the users will use the system and make sure to include their point of view in the process. Marketing, engineering, industrial design, and human factors may all be part of the process of making a new product. Many people who work on projects, such as customers, project managers, network specialists, user interface designers, database specialists, and usability specialists, are also involved. Cross-disciplinary communication has been the subject of much research in recent years. Scenarios are an excellent way to help people communicate across different fields [9].

Scenarios should focus on real-life situations. As systems can be used for many

specific situations, not everything can be described with scenarios. If scenarios are based on real-life situations, they could end up with many scenarios that do not have a lot of internal structure, which makes them hard to manage. Empirical scenarios are based on history. To make things that will be used in the future, they should also be able to work in the future. It is essential to keep the number of scenarios manageable. User study findings must be condensed so that they can be used to make useful scenarios out of them [9].

Good stories are more than just a series of events that happen one after another; they also build suspense. Suspense can be created by a conflict between the protagonist's motives and her actions. Potts et al. [8] stated that a set of scenarios in systems design should include situations or behavior that is undesirable for the system, resulting in a conflict in the scenario.

2.3 Storyboarding Introduction and History

A sequence of panels or frames that visually depict and explore the user's experience with a product is known as storyboarding. Film directors use storyboarding as production illustrations in the film industry. According to Katz, Storyboards were first used in the early 1930s at Walt Disney Studios. Storyboards were made up of dozens of individual continuity sketches that were pinned up on a single wallboard. This way, animators could see the whole story at a glance. Storyboards are still widely used in the film, animation, and advertising industries. Storyboards use in the film industry for two purposes, first, as a tool for the filmmaker to visualize and clarify their ideas before production starts, and second, as a language for the entire production team to communicate their ideas [10].

In product design, storyboards are just as important. They are a valuable resource for designers because they provide a common visual language that people from all walks of life can understand. Furthermore, storyboards not only assist designers in gaining a sense of the product's handling, target audience, timing, and context, but they also assist designers in communicating these characteristics to all involved parties [11].

Storyboards are powerful tools for product designers because they tell a story about interactions, allowing readers to access the expressed ideas on two levels:

- Like in a (comic) book or a film, the reader can empathize with the user or the situation to experience the visualized interactions. As a result, the design team has a common ground on which to communicate each member's ideas. Abstractly, these ideas would be difficult to convey because they may be tied to a specific person's discipline [11].
- By withdrawing from the experience and viewing the unfolding event from the outside, the reader can reflect on the visualized interactions from his or her expertise. This objective viewpoint enables analysis, highlighting specific aspects of the interaction, and gaining a sense of time progression. This way, the storyboard visually represents numerous critical aspects of the context, serves as a reminder to the design team, and facilitates discussion by allowing team members to point to and annotate the visualized aspects [11].

Storyboards are also a popular tool in software design and the HCI field. The length of the storyboards differs from the length of the storyboards in the film. While a storyboard in a film depicts the entire length of the screenplay, storyboards in software design are brief graphic illustrations of a story [12]. Using a sequence of graphical pictures and text, a map of users across time is generated [13]. Brown et al. [14] said that stories mixed with sketches are particularly good at showing flaws, career history, and contextual information. Storyboarding is a technique for visualizing key sequences of user interactions with a system using sketches, image montages, or adaptations of prior storyboard elements. Storyboarding is also a quick and easy way to create low-fidelity prototypes with much less reproduction detail [12]. Storyboards are made up of an indeterminate number of separate sketches, known as frames, that collectively convey a coherent story. Making storyboards, like sketching, encourages visual thinking, which is essential in the design process [11]. Frames contain sketches or photos of people, objects, and surroundings, based on what is to be depicted. Texts are frequently employed to portray dialogue or people's ideas and convey a story. Arrows are another common aesthetic technique

for indicating progress or conclusion. These arrows can also go to consecutive frames [14].

2.3.1 Storyboards in the design process

In software design, many sorts of storyboards are constructed, each of which serves a distinct function and is prepared at different stages of the design process. Addressing the needs, the style of the visualizations evolves as the design process progresses [11]. Figure 2.2 depicts a typical design process, along with the storyboard types that should be allocated to each step. The analysis phase of the design process focuses on a concrete application of the software to be created at the start of the process. There are no specific and detailed designs for functions and design yet, but a scenario storyboard is used to explain the product's tasks and purposes. Content model storyboards, can be used in the actual design process to show what functionalities the product should have. Users engaging with the system are depicted in context storyboards, while the user interface is sketched out in user interface storyboards. Finally, walkthrough storyboards can illustrate the finished system in-depth and step by step with all functionalities during the last phases, prototype creation, and testing [15].

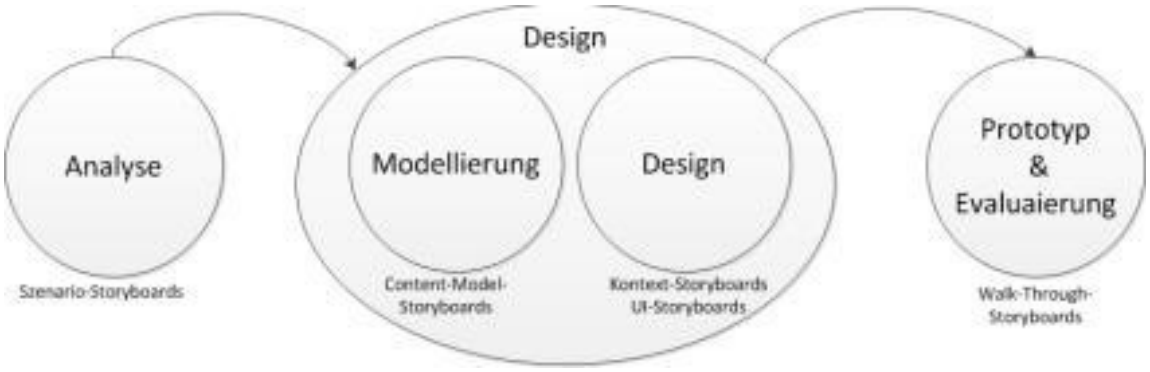

Figure 2.2: Illustrates the various types of storyboards used during the various stages of the design process [15].

2.3.2 Overview of the Elements of a Storyboard

Truong et al. [12] performed comprehensive empirical investigations on storyboarding with the assistance of professional designers, HCI professionals, HCI students, and those who are new to storyboarding. Three studies were carried out in total:

- Identifying crucial characteristics of storyboards developed by professional designers and HCI (human computer interaction) graduates [12].
- Interviews with professionals and beginners to gain a better understanding of the procedures and obstacles involved in storyboarding [12].
- Storyboard consumer impact and enthusiasm: a controlled experiment with systematic modification of storyboard characteristics [12].

Truong et al. [12] identified five critical characteristics of the storyboards:

Level of detail The amount of detail a designer wants to convey in a scene is determined by the number of people and items they want to depict. Photorealism and how many aspects of a scene should be replicated are equally important considerations. Several techniques, such as image editing and vector programs, are used to increase the level of detail. When importing pictures, image editing programs may be used to decrease the amount of information and simplify the images. Stick figures are another example of reduction. If there are too many details, the storyboard viewer may become lost in the minute details and miss the real core point. A designer can direct the focus of the viewer's attention and allow them to focus on other elements by decreasing the degree of information. For example, figure 2.3 depicts two images, one with a high degree of detail and the other with a low level of detail [12].

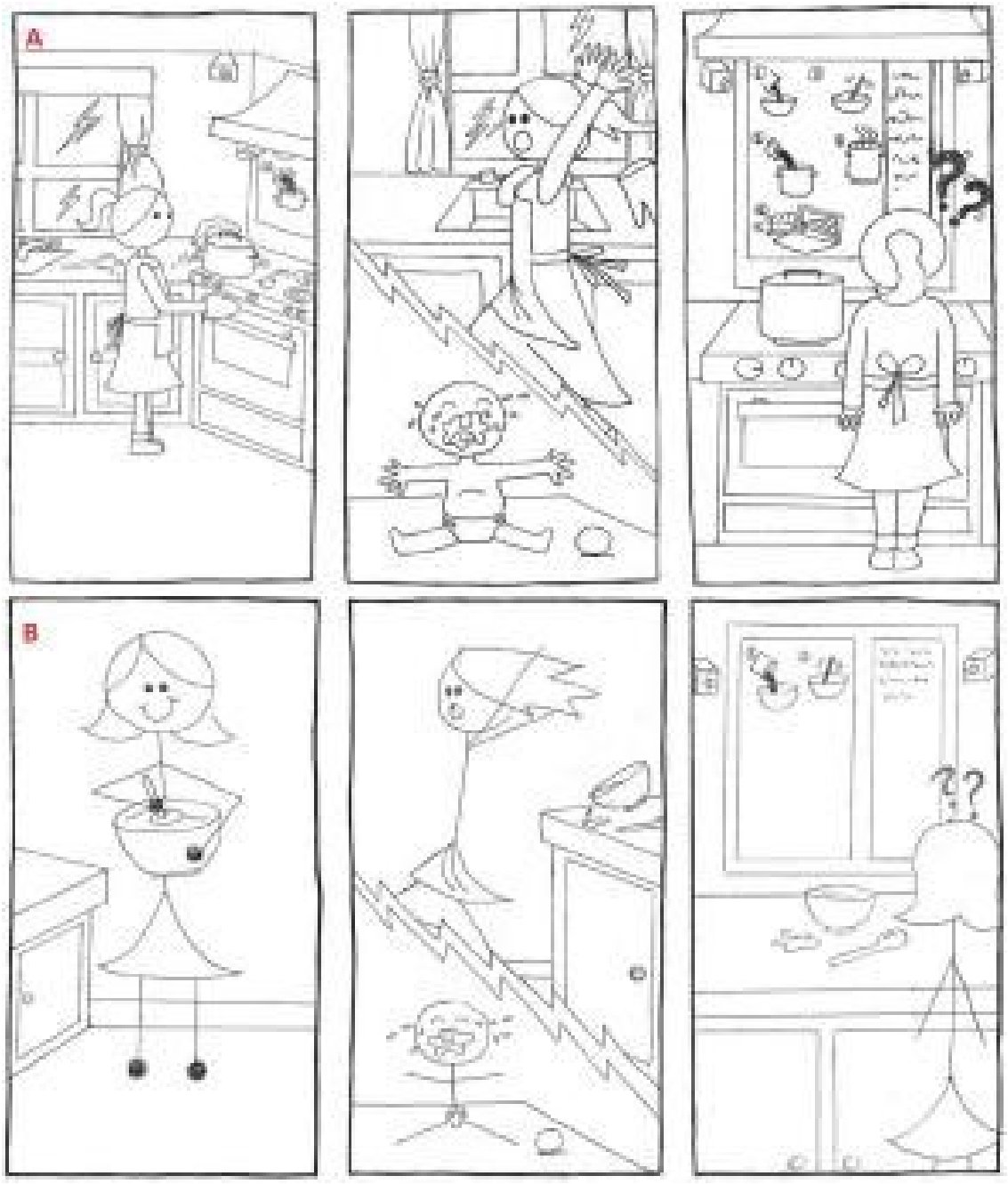

Figure 2.3: illustrates the comparison of two contrasting levels of detail: Image A with a high level of detail and therefore a high level of distraction, and Image B with a low level of detail and thus a high level of attention on the stroy [12].

Inclusion of text Text may be represented in storyboards in a variety of ways. The text below the frame and speech bubbles or text markers within a frame are all common. Truong et al. [12] findings show that the text is one of the most critical indications of whether the viewer understands the storyboard's content. At the same time, the text's length is crucial for interpretation. The use of short text sections is

helpful in this case. Due to this reason, determining the extent to which text may simplify or even replace visuals without affecting understanding or overtaxing the frame with text is necessary.

Inclusion of people and emotions Representations of human users interacting with an interface can be included in storyboards. Designers may also utilize these characters to create empathy for potential users, demonstrate motivation, or represent other intangible aspects of the program, such as how it impacts the user. Designers can also create empathy by eliminating humans from the scene and depicting the interaction as the reader is the actor. This is crucial in encouraging a viewer to sympathize with the storyboard [12].

number of frames A single storyboard can have anything from one to more than 20 separate panels, but most of the storyboards collected by Truong had between three and six frames, which experts consider to be the ideal amount for describing a particular feature or action. Numerous storyboards were often used to depict multiple elements and activities. Truong et al. [12] conducted research and found that the intelligibility of storyboards falls with fewer than three frames and increases with more than five frames. It does not matter if the technology or product exhibited was familiar to the audience. As a result, Truong et al. [12] recommend a frame size of three to five frames. Figure 2.4 illustrates how many frames (A) lead to obstructing storyboard reader's understanding.

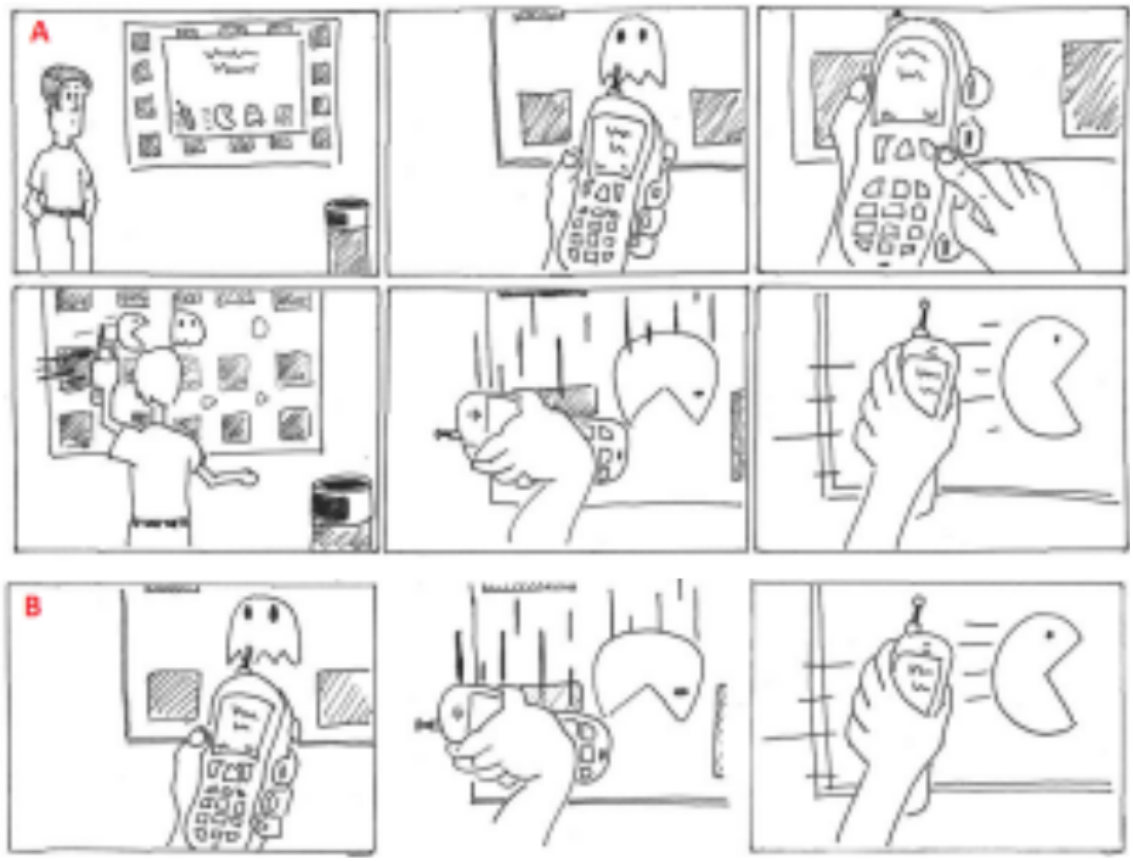

Figure 2.4: shows comparison of two storyboards by using various frame counts [12].

number of frames In storyboards, time is represented either explicitly or implicitly. For example, clocks and calendars, as well as times of day and seasons, are explicit representations of time. On the other hand, implicit representations are noticeable changes that occur over time, such as plant growth or a person's aging. However, time should only be shown if it is crucial for the story [12].

2.3.3 Stages of Storyboarding

Truong et al.[12] developed recommendations and derived phases for creating storyboards based on the empirical study findings. These may be used with established HCI design principles and guidelines to produce storyboards that are easier to understand and also higher in quality.

Understand the consumers of the storyboard When designing prototypes, it is widely understood that designers should consider the backgrounds and experiences

of their intended users. However, in the case of storyboard prototypes, this external information might be much more critical, especially when it comes to understanding new systems and applications. As a result, the first phase in creating a storyboard is to have a strong knowledge of the users and their backgrounds, as well as the system and its functionalities. Designers should think about the computing systems, with storyboard viewers are likely to be familiar, as well as the symbols and words they use. A good understanding of end-users, the system, and its operations are critical for a well-designed and clear storyboard in software design [12].

Get Creative in the Story The second phase starts with a brainstorming session in which all the project designers generate ideas in a group as creatively and freely as possible. A group should experiment with diverse spatial surroundings and make use of the creative possibilities that each venue offers. The design of a storyboard may start if everybody involved agrees on the story to be presented, as well as understanding about the user and system [12].

Create the Artifacts Breaking each story into smaller distinct chunks is the first step in constructing the storyboard artifacts. In most circumstances, three to five sections are ideal. According to experts, An application that requires more than five parts to express functionality, should be divided into numerous storyboards, each concentrating on a different feature. Each separate section should be described in a single short sentence. Drawing pictures that correlate to each of these short phrases is the first step in the final phases [12].

Test and Iterate on the Storyboard Individual designers should seek input from the group and iterate on their work. Every storyboard should be tested with participants who are identical to the desired end-user group, as this is the standard procedure for any prototype being evaluated [12].

2.3.4 Collaboration during the Storyboarding Process

Truong et al. [12] and Wahid et al. [13] investigated the process of storyboarding in a group in their studies. Truong et al. [12] observations and interviews revealed

that the collaboration technique presented in his research is also used in professional designers' storyboarding process and HCI (human computer interaction) Environment. They gather initial ideas in a private brainstorming phase and produce initial sketches with paper and pencil, and then they gather as a group to present and discuss the ideas they have developed. This typically occurs in front of a whiteboard or other vertical surface where ideas can be collected. Designers can create a shared understanding of the applications and context of use by discussing the artifact early. The designers can sketch on their own after the initial group meeting. After some time, the group met again and again and discussed the work regularly until the storyboard was completed. As the study evaluation progressed, Truong et al.[12] found that collaboration allowed designers to quickly and easily share artifacts for feedback. As a result, they often met to improve artifacts instead of storyboarding. Another advantage of this type of collaboration is borrowing and reusing artifacts from colleagues.

Wahid et al. [13] came to a similar conclusion with their study on collaborative storyboarding. They developed a procedural model of how a design group can ideally create a storyboard. They worked with prefabricated artifacts consisting of images and text but conceded that there might be an initial brainstorming phase in which ideas are collected, discussed, and then artifacts are created. The next phase is described as exploration, in which designers get an overview of existing artifacts and become familiar with them. Subsequently, everything is grouped and sorted in differentiation. The last phase, construction, is used to create the storyboard. Wahid et al. [13] found that extensive communication opportunities characterize the collaborative storyboarding process. In addition, they observed communication mechanisms such as utterances, gestures, and explanations between people that take place in each phase of the storyboarding process [13].

2.3.5 Storyboarding Creation Techniques

Saul Greenberg et al. [16] described the two different ways of creating storyboards. One is sketching by hand, and the second is using the photo as source material.

2.3.5.1 Sketching Storyboards

In this technique, hand-drawn sketches are used to create the storyboard.

Outline Storyboard Frames On a piece of blank paper, draw a grid of 5 rectangles. Our storyboard will be built around these frames. Depending on the type of storyboard you want to make and how complicated the interactions are, you might need more than five boxes to draw all your scenes. Using only five sketches for the storyboard, on the other hand, has the benefit of showing only one type of interaction. If further storyboards are needed, they can either be variants of the initial one or storyboards depicting a different type of interaction with the system [16].

Develop the storyline Before you start drawing scenes, you need to plan out the story you want to tell with your storyboard. Some things to remember when describing a storyline are:

- Where does the interaction takes place?
- What is the problem?
- What is the task that people are trying to do?
- Which people are present and what are their actions?
- What is the possible input and output for each digital system?
- How do the actions of people and/or devices solve the problem?

Throughout your five frames, you will create this storyline. The first frame of your story is where you introduce it to the audience. This is called the "establishing shot." The successive frames add to the story and lead up to the climax, where the problem is solved. The last end frame is the last part of the story. It usually shows a scene that shows that the interaction shown in the storyboard is over (e.g., a person walking away).

Sketch establishing shot The initial storyboard sketch (the establishing shot) will serve to set the stage for the storyboard, and the extreme long shot provides

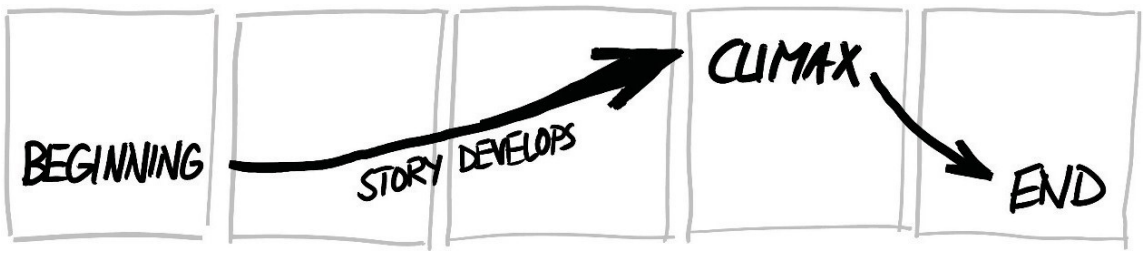

Figure 2.5: Illustrates the various stages of storyboard [16].

an overview of the space where the conversation occurs and depicts the participants. Keep the elements you are sketching (people and environmental aspects) to a minimum level [16].

Continue the storyline sketches with appropriate camera shots Saul Greenberg et al. [16] used stick figures to depict people's postures and orientation or trace photographs to create simple silhouettes of people and objects. Their five designs of a particular storyboard are displayed below [16].

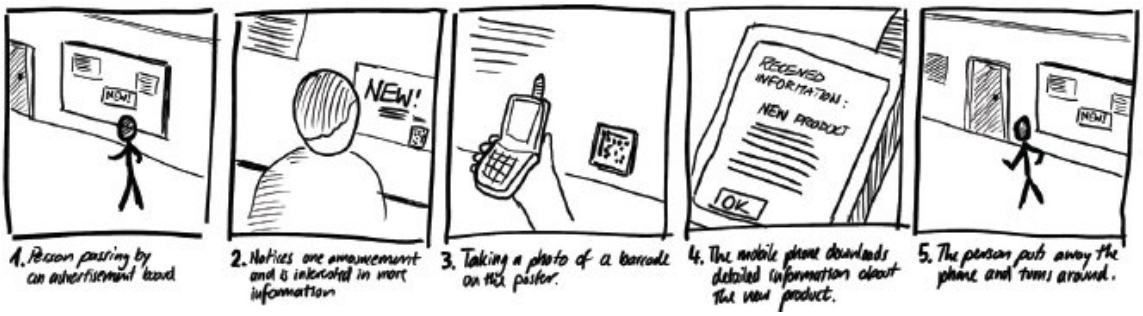

Figure 2.6: shows the various shots of storyboard [16].

Emphasize actions and motions we can annotate the sketches visually. Annotations are an excellent method of indicating and highlighting significant moves or actions that would be difficult to depict in a static image [16].

Demonstrate to others and iterate Show your developed storyboard to others and get feedback from them. Check whether this storyboard is effective or not [16].

2.3.5.2 Photo-Based Storyboards

In this technique, photos are used to create the storyboard.

Figure 2.7: shows the various annotations and motions in storyboard [16].

Take photo snapshots We take multiple photographs of a person in front of a public notice board to create this version of the storyboard. Vary the camera angles: long shots for overviews, over-the-shoulder and point-of-view shots for people's actions, and close-ups for interface elements or specific movements. Select five photographs as your storyboard's sources. Again, begin the storyboard with a long shot describing the environment, followed by three shots demonstrating the interaction, and concluding with a single snapshot [16].

Add annotations We can indicate a person's movements by adding annotations to our storyboard. To make these annotations visible in the photo below, use a strong marker and a variety of colors [16].

Add storyline text and comments Write the storyline text underneath the photo printout. This makes it easy for others to follow the story you are conveying when they read your storyboard. [16].

2.3.6 Storyboard Variants

Storyboarding is a creative approach that lacks specific rules, which is why it has undergone numerous changes throughout the years. We described some variants below.

2.3.6.1 Context storyboards

The utilization context of new technology is the main emphasis of context storyboards. More and more technologies are being created today that can no longer be

used to operate a computer traditionally, using a mouse and keyboard at home or work. Instead, technology is advancing and giving rise to new forms of interaction. When a user is mobile, the context and how it is perceived are constantly changing. context storyboards depict the use, location, and environment of a technological application and try to visualize the context of use and its impact on the use of that technology [17].

Figure 2.8: shows representation of a scenario in its usage context by sketching and photographic with colored annotation [16].

2.3.6.2 User interface storyboards

Interface storyboards display the user interface of an application. They illustrate the operation of the application and how it responds to user input using representations of the user interface [18]. State diagrams, which also allow the display of state transitions and branching alternatives, are frequently integrated with user interface storyboards [16]. Before they are implemented at great expenditure, a surface and its interaction concept can be played through and reviewed for flaws with the aid of user interface storyboards. Additionally, they work well as a foundation for software requirements and paper prototypes [19]. Because user interface storyboards are primarily concerned with the user interface, there is a chance that the application's context of usage and other crucial concepts will be overlooked [19].

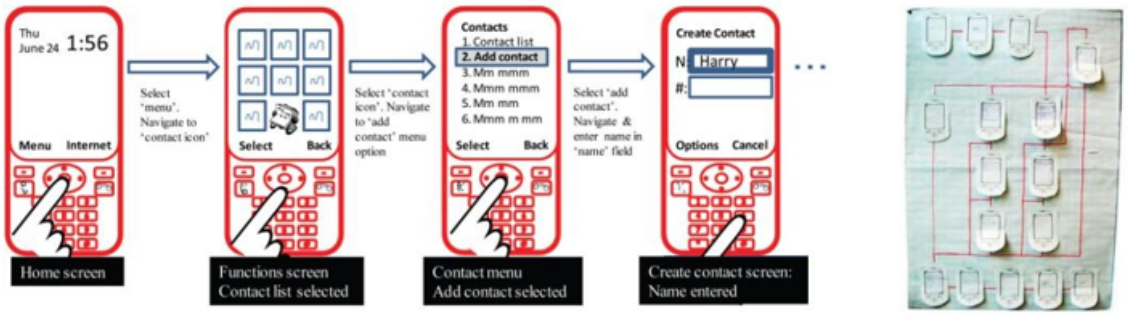

Figure 2.9: shows UI storyboards and state diagrams are frequently combined [16].

2.3.6.3 Schematic storyboards

Several scene segments are combined into one visualization in schematic storyboards. This is accomplished by annotating the picture with elements that can convey continuity and movement, such as arrows, borders, and text. Schematic storyboards are especially useful for video editing since they give a quick glimpse of a video without having to watch it [20].

Figure 2.10: Schematic Storyboards [20].

2.3.6.4 Claim storyboards

Wahid et al. [21] used reusing artifacts in claim storyboards to construct storyboards rather than developing storyboards from scratch each time. Designers are given cards

for this reason, which have a side-by-side captioned image of an item and the benefits and downsides of the so-called claims printed on the back. This can both motivate designers and familiarize them with a problem's design trade-offs. Developing claim storyboards involves naming each card and arranging the available ones to tell the desired story.

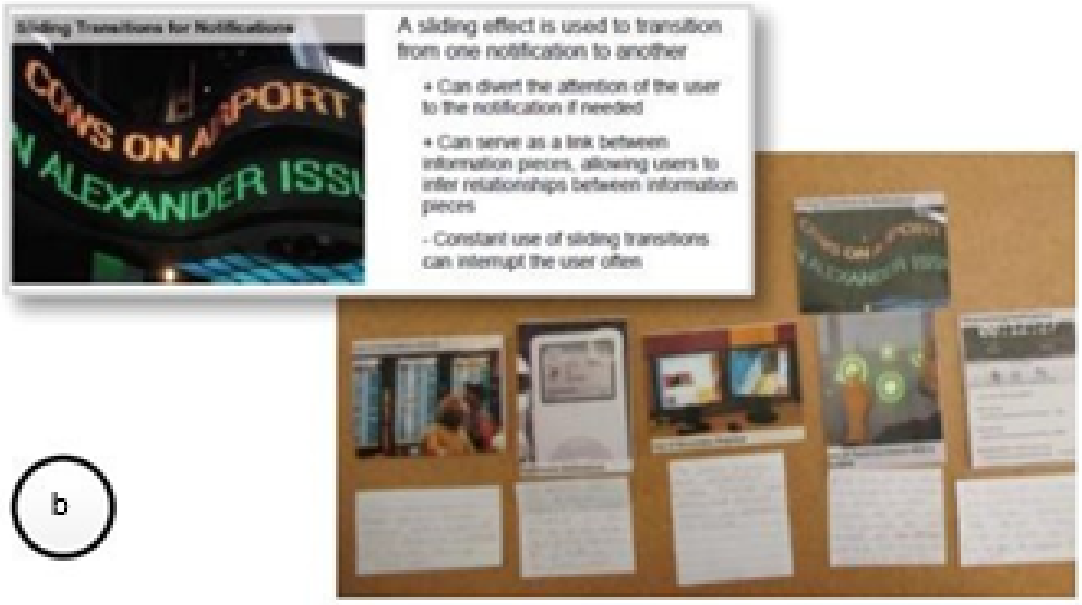

Figure 2.11: Claim Storyboards [21].

2.3.7 Tool Support for Storyboards

We described some tools that are mostly used to develop storyboards. Some tools are used for academic purposes and others are used as professional tools.

2.3.7.1 SILK

Landay and Myers developed SILK (Sketching Interfaces like Krazy) in 2001. Before SILK, there were no tools available for creating informal user interface designs. Because the available software focused too much on a button's color or text, most designers avoided utilizing them in the early stages of design. SILk is a tool that enables quick development and drawing of a user interface using a digital stylus. The sketches are interpreted by SILK. The sketches are translated by SILK, which

also recognizes Buttons and Gestures. The buttons can be connected by sketching arrows in a storyboard view, which displays all sketches in a comprehensive overview. However, as can be shown in Figure 2.12, these arrows can easily cause misunderstanding in sophisticated applications. Because of this, SILK can simulate how a user interface behaves and even create a usable user interface from the sketches [23].

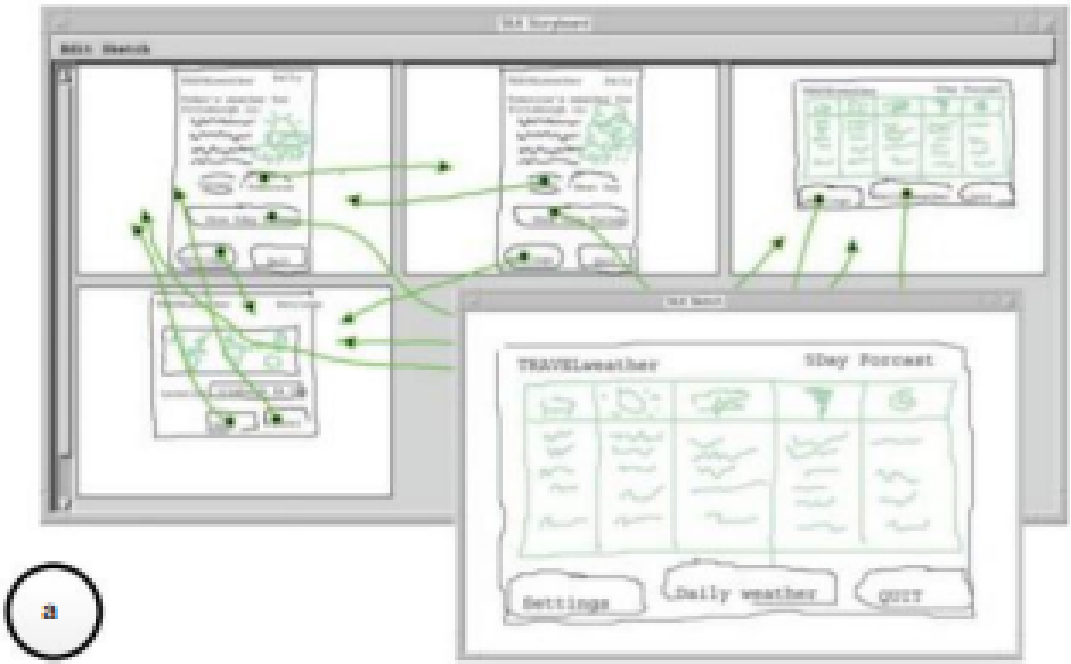

Figure 2.12: SILK Storyboard view [23].

2.3.7.2 DENIM

Design Environment for Navigation and Information Models supports web designers throughout the design process. It supports the conventional approach taken by web designers, who first create the basic framework of a website before adding specifics like texts and pictures. For this, DENIM provides many website views, including a sitemap, the individual pages themselves, or a storyboard, which are all linked to one another through a semantic zoom. This implies that a varying number of details are shown depending on the zoom level. Content is drawn using a stylus similarly to SILK. Arrows can still be used to connect pages, but since DENIM interprets the drawn text less, drawing is more liberated. Once a website's basic framework has

been established, placeholders can be filled up with actual content, allowing for an iterative design process [24].

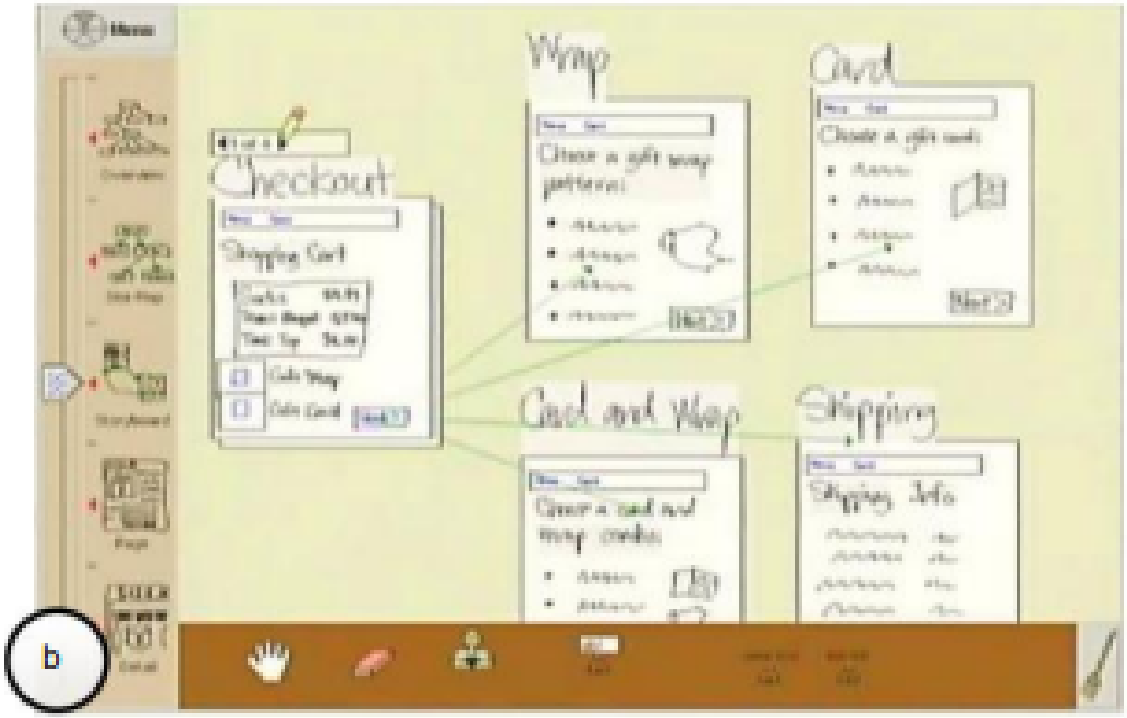

Figure 2.13: DENIM Storyboard view [24].

2.3.7.3 Toon Boom Storyboard Pro

Toon Boom Storyboard Pro is a specialized tool for making storyboards. It enables the development of self-drawn storyboards: The currently chosen frame is the application's main focus. Various tools, including some recognized from Adobe Photoshop, are located above and to the right of it. The program supports several colors, brushes, a layering system, and vector drawing creation. The individual photographs, which are also on a white background and can be seen clearly displayed and arranged in a higher view. Animation of storyboards in terms of camera angles and animatics is possible with Storyboard Pro [25].

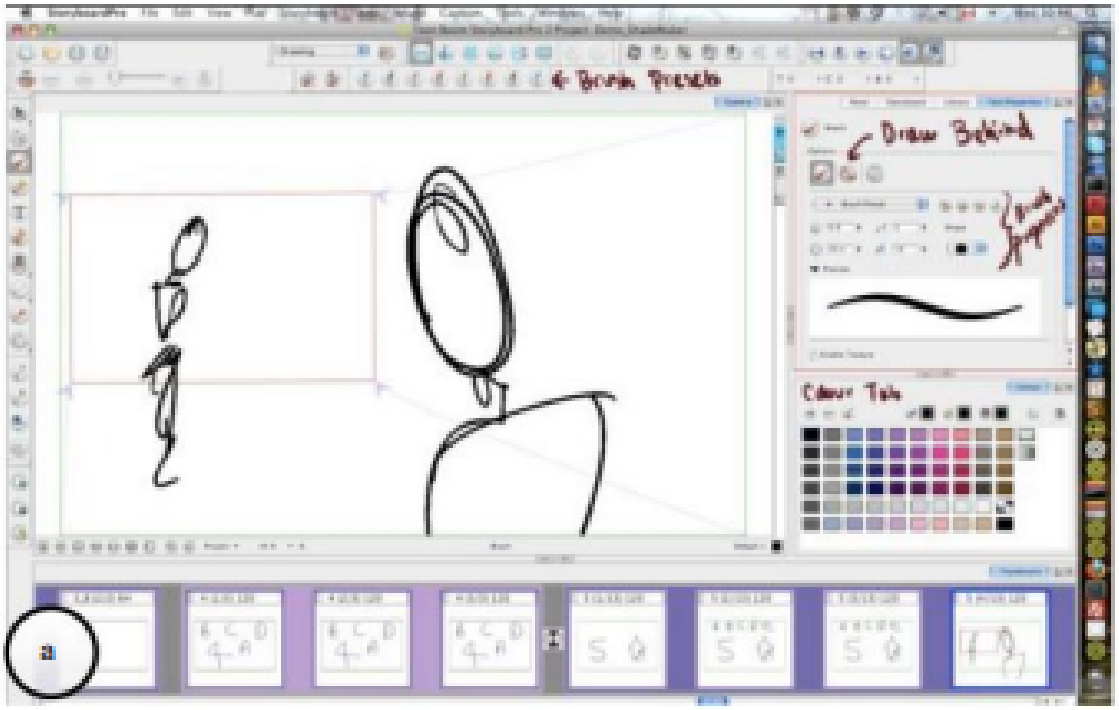

Figure 2.14: Toon Boom Storyboard Pro view [25].

2.3.7.4 Storyboard Artist

Another great tool for creating storyboards from image archives is called Storyboard Artist. Due to the inserted individuals' limited facial expression range, a limited range of emotions may be expressed. However, creating photos or 3D models is produced and imported into other programs. Therefore, the program is appropriate for those who have less obvious drawing abilities. Adding text to Storyboard Artist is also possible. The storyboard's individual images can be placed directly on a timeline, where the timing of the images can be set and transitions can be applied. Storyboard Artist also allows for the movement of the camera and the addition of sound effects. It allows for the creation of both low-fidelity and high-fidelity storyboards because it supports a variety of artistic techniques [26].

Figure 2.15: Storyboard Artist view [26].

2.4 Online Collaboration Tools

Commercial real-time distributed groupware is now available because of better hardware, more connectivity on the Internet, and the needs of more and more distributed businesses. The use of Information and Communications Technology (ICT) is an essential part of education [28]. In fact, online collaboration tools are very important in the classroom. Online Collaboration Tools are a piece of technology that can be used to help people work together and share information online so that they can all work toward the same goal [29]. Some tools only let you share files, but others have extra features like document management, document collaboration, shared calendars, task management, and surveys [30].

Most of the literature and studies that were reviewed say that online collaboration tools make it easier for the learning community to get involved in activities without having to be in the same place or at the same time. This leads to more productiv-

ity. Researchers said that online collaboration tools could be used for teaching and learning [31].

2.4.1 Groupware Systems Evaluation Challenges

In the field of Computer-Supported Cooperative Work, there is still a lot of work to be done when it comes to evaluating collaborative systems. It does not matter if evaluations are done or not. Many collaborative systems are set up on an as-needed basis, depending on what the researchers want or what works best in a given situation [32].

Several possible reasons could be behind the lack of groupware evaluation. First, methods that work well for single-user systems may not work well for groupware because the outcome depends on the group members' backgrounds, the culture of the organization, and the dynamics of the group. Second, it may cost a lot to evaluate, and the resources you need may not be available. Third, the benefits of a groupware system may last for a long time, so you should watch your group for a long time. Finally, it is not easy for an evaluator to figure out which methods to use in a certain situation [32].

While computer-supported cooperative work (CSCW) is related to HCI, the standard HCI methodologies have issues when used to evaluate groupware, as summarized below.

- Evaluators observe how one person uses the system in an area that is not entirely under their control. A person who studies how single person uses groupware now looks at how groups use the system. The problem is that observing groups requires a lot of people: finding them and setting up meetings can be challenging. Groups also vary a lot in composition and how they interact with each other, which makes it hard to generalize from single user observations when comparing them to group observations. They usually last a long time to observe, because group work requires people to build up friendships and communication styles before working together. For groupware, user observations can also be too smooth, because they do not consider things like how the

group will use the system and how it will affect them socially, politically, and psychologically [17].

- Field studies are done by people who want to know how people interact in their daily lives. These can provide the context missing from observational techniques. However, they take a lot of time, logistics, and analysis to set up and use. Evaluators need a lot of experience and a lot of time to do the evaluation. In addition, it can be hard to keep track of so many people at each site. Work well at the start and end of a project, but not when you are making changes to the design [17].

- Using inspection methods, evaluators inspect an interface for usability problems based on a set of criteria. These criteria are usually how people see and do a task. To be useful, groupware must be able to help people with their work. It must also be able to help with teamwork. There are only so many ways to use inspecting methods if you use them the way they are. Because they do not consider how groups work together, they do not know how to rate the groupware. However, it does not say anything about the groupware usability flaws that Nielsen [34] lists in his heuristics. There was the same thing with the cognitive walkthrough that was used to look at groupware, It had mixed results, and now other researchers have come up with a framework for typical groupware scenarios that can be used to show people how things work [17].

2.4.2 Awareness Support In Groupware Systems

In computer science, the word awareness is used to describe the information that a system gives to a user to make them more aware of a situation. There are different ways to explain what awareness means in the context of collaborative systems. Even though there are different definitions, many use the one defined by P. Dourish and V. Bellotti as a starting point. They say that awareness is "the understanding of the activities of others, which gives your activity a context" [33].
People naturally stay aware in physical workspaces by using their senses. However, awareness information from a GS is more than just being aware of individual pieces

of information, it also requires a complex level of understanding of the situation. Gutwin says about awareness: "It should include more than just knowing how others interact with the workspace. It should also include knowing the state of the workspace and its artifacts, as well as your own actions in the context." So, users would not be able to do their jobs well if they did consider information about the state of the system, their own actions, and the context of their collaborators [33].

individual awareness is shown in the form of feedback about the state of the system or the current state of the user's interactions. In terms of being aware of the other people in the workspace, it includes information about who they are, what they are doing, and how they are doing it. Knowing how people are connected gives information about how users interact with each other. For example, emoticons or "Like" tags tell you what a person thinks or feels. This information might or might not have anything to do with working as a team, but it is important to how you talk to that person [33].

Even though there are many kinds of awareness, they all have the same three main parts: perception, understanding, and projection. Perception is the first step in becoming aware. Perception is the use of senses to create a state of knowledge that is fed by the environment's perception. Understanding means making new knowledge out of what you already know, while projection means being able to guess or estimate the values of things in the near future [33].

Given the variety of principles and heuristics in HCI for supporting individual activities and in CSCW for supporting collaborative activities, Cepero García et al. [33] developed a comprehensive set of heuristics for evaluating awareness support. The heuristics combine HCI and CSCW principles to assist GS designers in meeting the requirements of awareness of other people's actions, the condition of the workspace and its components, and understanding the user's behavior within the collaborative environment. In their work, expert judgment was used to design and validate the proposed heuristics using the Delphi method and the methodology of Ouariachi, Gutiérrez-Pérez, and Olvera-Lobo.

Using a case study, they evaluated the effectiveness of the given heuristics (For a more detailed heuristic study, see [33].) for evaluating awareness support. Two com-

mercially available collaborative systems (Trello and Canva) exhibited inadequate support for communication and teamwork coordination, as well as inadequacies in their support for awareness. However, it may be necessary to apply the heuristics with a greater number of experts in additional tools in order to determine the heuristics' effectiveness in identifying improvement opportunities in diverse collaborative systems [33].

Awareness assistance helps to compensate for inefficiencies in communication, coordination, and collaboration in computer-mediated collaborative activities by giving information about the collaborative environment situation. Multiple types of awareness have been defined to support the needs of the teams within the systems, as each task has distinct requirements [33].

CHAPTER 3: THE STUDY

The design of the experiment will be thoroughly addressed in this chapter. This chapter also explains the experimental findings and data collection methods.

3.1 Objective

We designed and conducted an experimental study to investigate the effects of storyboard use in participatory redesign activities for collaborative online tools. We developed two storyboards about two scenarios and also described these scenarios' situations in a more abstract textual form. The goal of this study was to see how storyboards and brief textual descriptions affected the participants' ability to redesign groupware, specifically Zoom.

Prior work on storyboards presents case studies investigating the effectiveness of storyboarding in the film industry. However, this work is about investigating whether storyboarding helps users to generate re-design ideas of groupware (Zoom). In this thesis, we investigate whether the users would be able to generate more design ideas when they are presented with storyboards, as compared to when they are presented with storyboard situations in textual form. We also want to investigate whether participants design ideas support other perspectives more when they are presented with storyboards as compared to when they are presented with the described situations in a more abstract textual form.

Based on the above-mentioned factors, we hypothesized the following:

- **Hypothesis 1**: When users are presented with storyboards generate more redesign ideas as compared to when they are presented with described situations in more abstract textual form.

- **Hypothesis 2**: When users are presented with storyboards generate more re-design ideas that support other perspectives as compared to their own perspectives.

3.2 Methods and Participants

A controlled experiment was performed for this study, in which participants were presented with storyboards and described situations in more abstract textual form and asked to make suggestions for changes or additions to the design of the zoom groupware. We have created two different versions of our storyboards based on two scenarios to test our hypothesis. We have two different conditions (i) Re-design zoom groupware by using storyboard (ii) Re-design zoom groupware by using an abstract textual form. We divided participants into five groups. The participants of three groups (OS1, OS2, OS3) were presented with storyboards, and the participants of two groups (OT4, OT5) were presented with described situations in a more abstract textual form.

1. OS: Participants of this group were given the storyboards based on two scenarios (classroom, break-out room)

2. OT: Participants of this group were given the described situations in more abstract textual form.

Participants of three groups were encouraged to explore both storyboards while participants of the two group were encouraged to explore described situations in abstract textual form and think about what improvements (in features and design) would they like if they were users of the zoom groupware.

Every usage scenario of zoom groupware was not developed by using storyboarding because we wanted the participants to focus only on collaborative zoom groupware features to restrict the research complexity of the experiment. If each scenario of zoom groupware was developed by using storyboarding, it would have taken more time to explore storyboarding during the experiment, which could make the participants feel exhausted.

Storyboards and described situations in more abstract textual form served as the independent variable in the experiment, while the number of new or improved design ideas offered by the participants, suggestions about new features, or modifications of the current features were the dependent variables.

We created two storyboards, which depict two scenarios of collaborative studies in classroom and breakout room. The experiment had a total of 16 participants.

Based on the two different conditions, five different groups of participants were formed. The number of participants who participated and presented with storyboards in second iteration were 10 and those who participated and presented with described situations in more abstract textual form were 6.

Table 3.1: shows number of participants in different groups.

Group names	Participants	Conditions
OS1	4	OS
OS2	3	OS
OS3	3	OS
OT4	3	OT
OT5	3	OT

3.3 Storyboards in use

I considered zoom groupware for this study. The domain of groupware was chosen to keep in mind the diversity of the participants. The large number of people who are, at least to a certain extent, familiar with this domain to analyze and give useful feedback. Also, we thought it would be interesting to present storyboards related to that groupware that everybody uses in an education domain like Zoom because many people due to the Covid-19 pandemic are stuck in their homes and taking classes online using different groupware.

We also wanted the domain to be attractive to the majority of participants so that they were motivated to do the task and also most of them were familiar with the

groupware. The storyboards were created in a way that closely resembled a realistic situation while still being kept simple enough to allow the experiment to be finished in a reasonable amount of time.

Participants were encouraged to explore both storyboards of the zoom groupware and try to think about what improvements would they like if they were the users of the zoom groupware.

3.3.1 Design Of The Storyboards

There are two iterations in the design process of the storyboards. They are described as follows.

3.3.1.1 First Iteration

After selecting the educational domain of our groupware for this study, the next challenge was to decide the scenarios which we want to depict in the storyboards. For this, we chose two scenarios, one is the zoom classroom scenario and the second is the zoom breakout room scenario. We used Storyboard That tool to design these two scenario-based storyboards. Storyboard That[1] is cheaper and easy to use as a tool for creating both versions of storyboards. Figure 3.1 and Figure 3.2 show two different early version storyboards for the zoom class scenario and the zoom breakout room scenario, which we internally discussed with respect to the goals of our experiment.

[1] https://www.storyboardthat.com

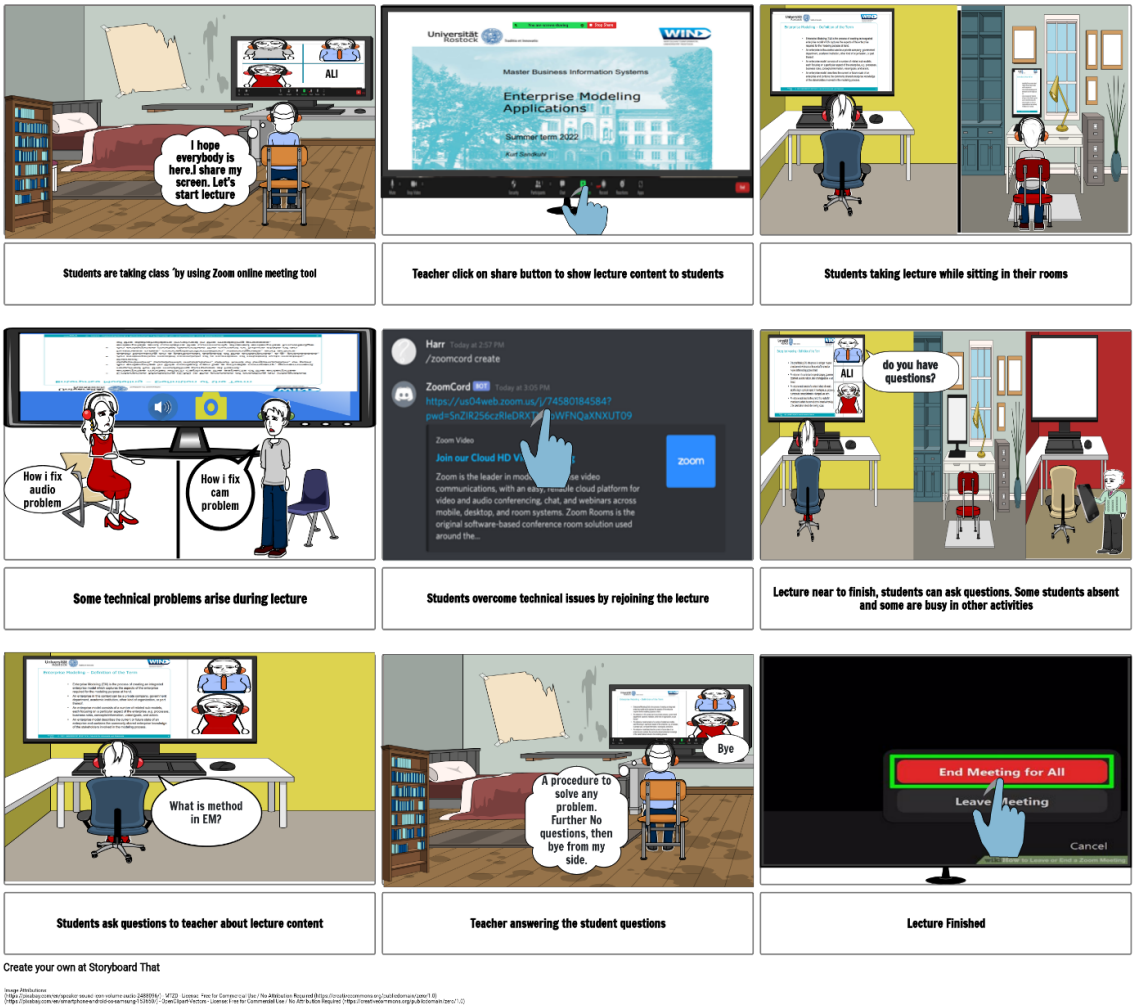

Figure 3.1: Zoom classroom scenario storyboard.

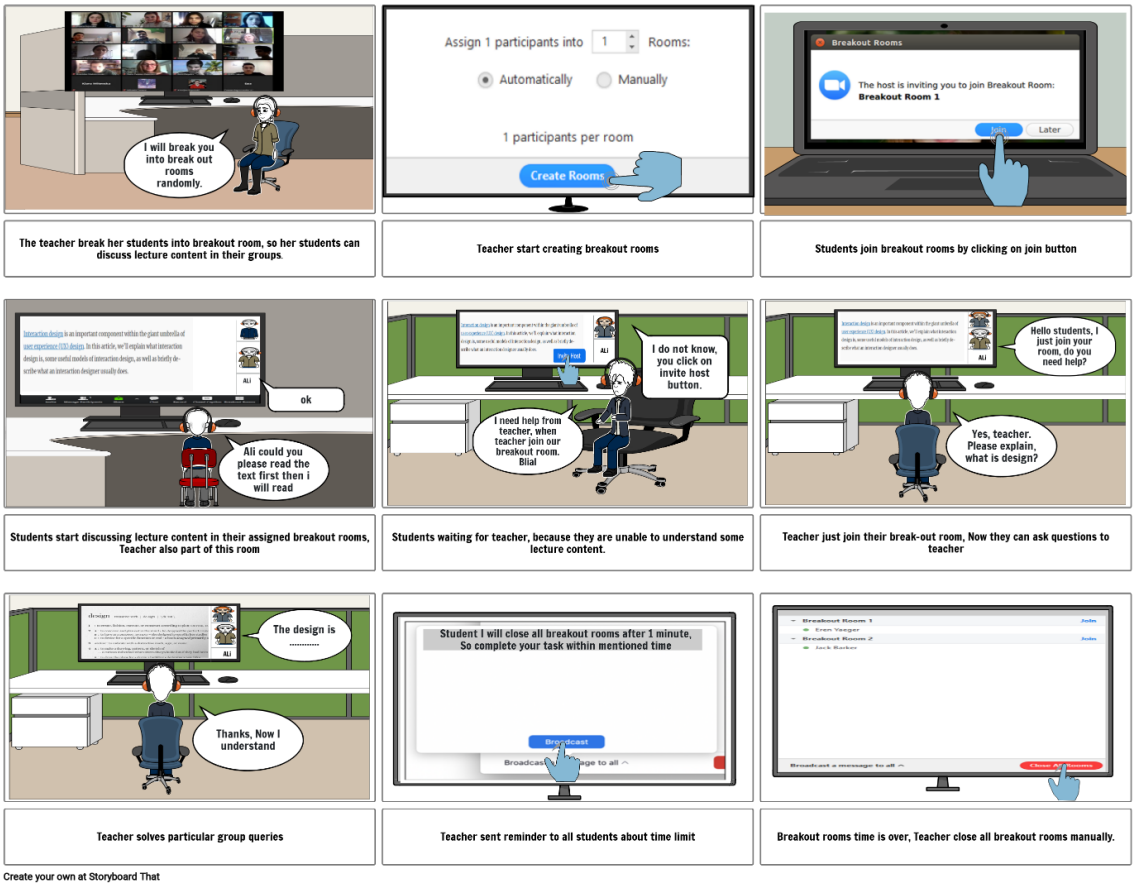

Figure 3.2: Breakout room scenario storyboard.

These storyboards are not part of the experiment, but it helps me to redesign storyboards. Some modifications are done to these storyboards after internal discussion.

3.3.1.2 Second Iteration

Our intention was to develop storyboards that are focused on one scenario/problem. Also, we have added enough frames in both versions of the storyboards so that it would not be too simple for the experiment. To explain this concept, two final version storyboards are presented which are much more focused on one specific scenario/problem, textual comments were also removed from both final version storyboards and the number of frames were also reduced to 6 and 8 respectively. (See Figures 3.2,3.3).

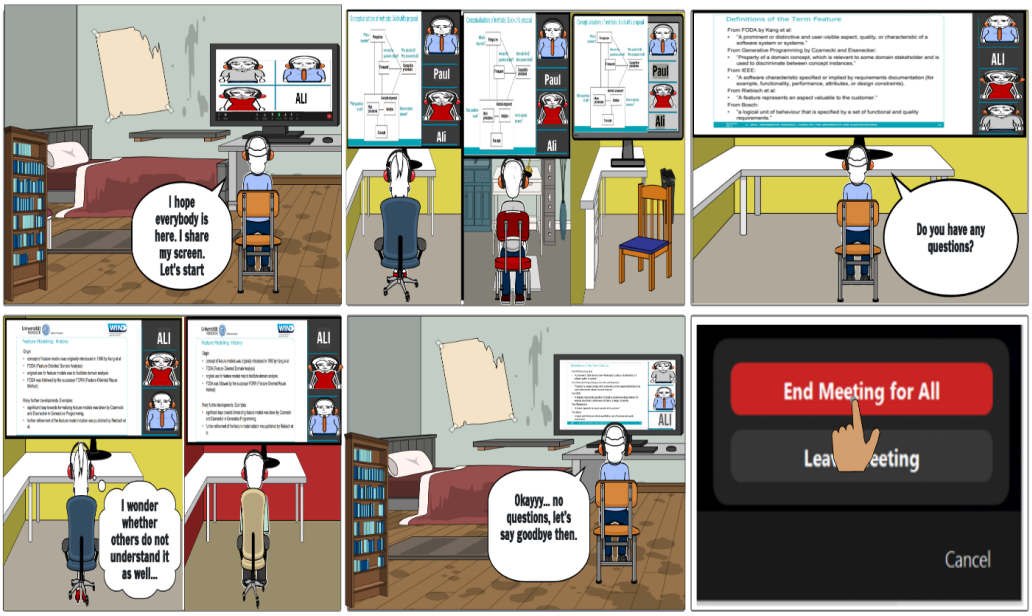

Figure 3.3: Final version zoom classroom scenario storyboard.

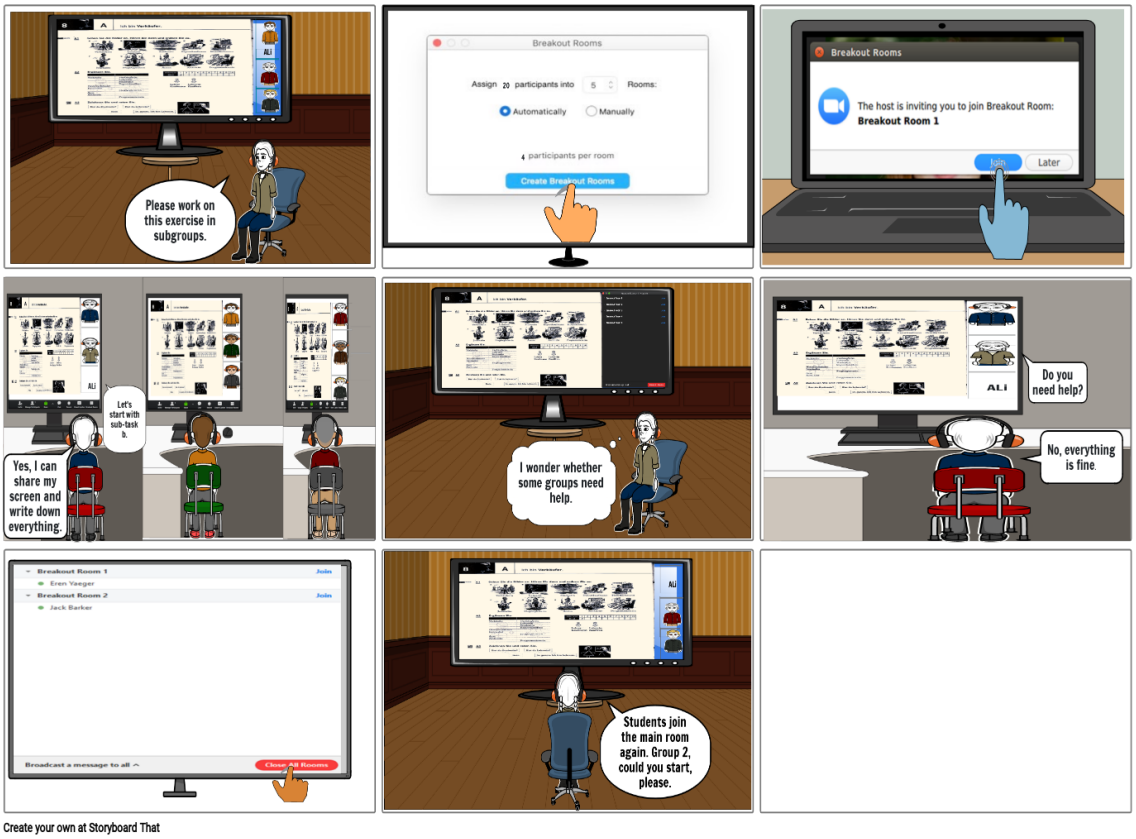

Figure 3.4: Final version breakout room scenario storyboard.

The next section explains both the first and final version storyboard modifications by comparing them frame by frame.

Initial version storyboard - First iteration storyboard, **Final version storyboard** - Second iteration storyboard.

3.3.1.3 Zoom classroom scenario storyboards frames comparison:

The context of groupware zoom use is shown in both storyboard frames from the perspective of the teacher. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The speech bubble shape and text were changed in a final version storyboard frame because the wrong speech bubble was used in the initial storyboard frame. (See Figure 3.5).

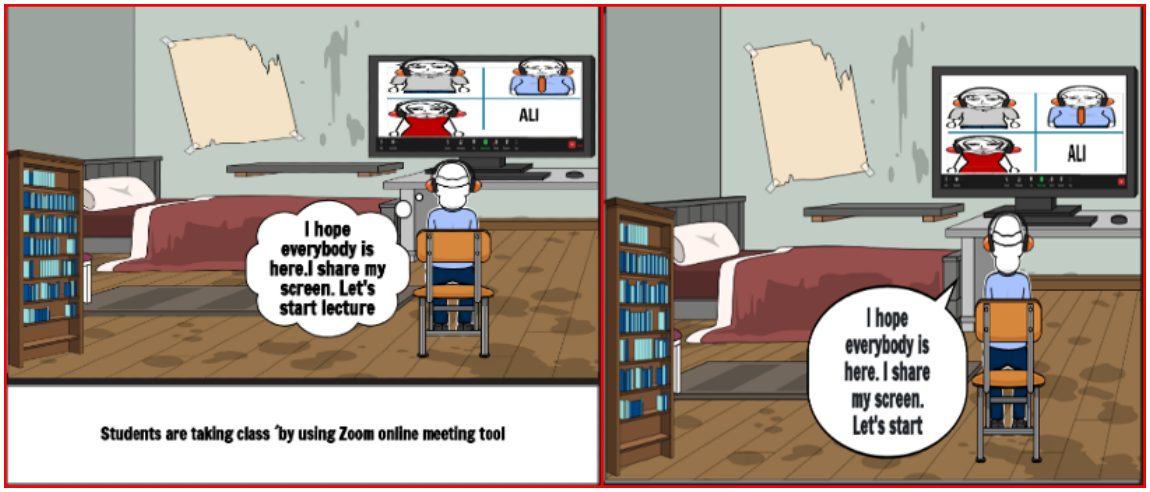

Figure 3.5: Shows frame comparison between both storyboards.

The context of groupware zoom use is shown in the initial storyboard frame from the viewpoint/perspective of the students, but in the final version storyboard shows from the teacher's perspective. While the initial version storyboard frame includes the comment description to support the context of groupware zoom use is shown in both storyboard frames from the perspective of the students. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The final version storyboard frame shows that two students are taking an online class, but one student currently is not participating in

class. The final version storyboard shows participants joining meeting mode as well. Some students joined the meeting by switching on their cameras and some students switch off their cameras, We thought this situation is fascinating for storyboard readers. The situations and use contexts are not well depicted in the initial version storyboard frame, and the initial version storyboard frame shows that only two students are taking a class using an online collaborative tool (Zoom). Due to the above-mentioned reasons, we decided to modify it. (See Figure 3.6).

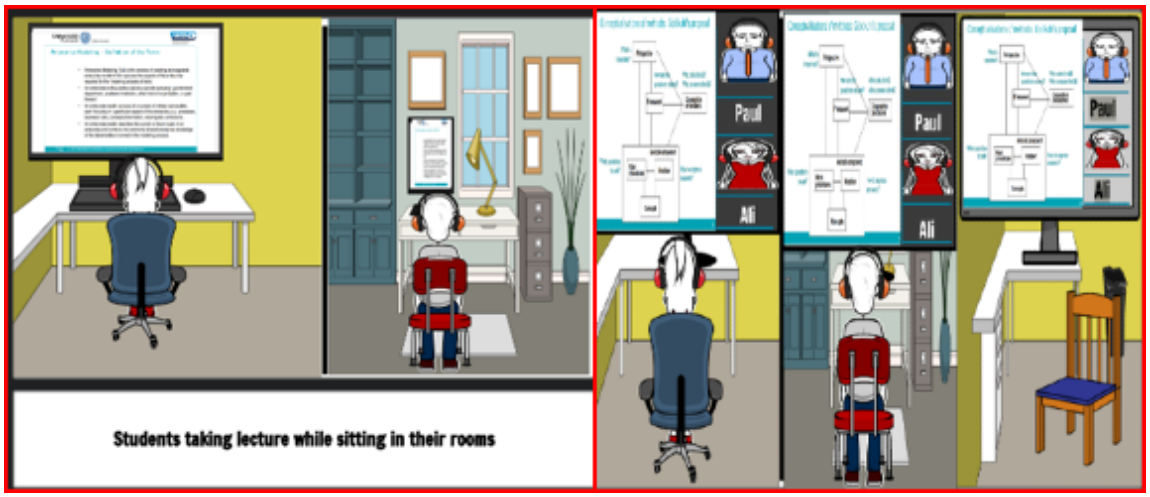

Figure 3.6: Shows frame comparison between both storyboards.

The context of groupware zoom use is shown in the initial storyboard frame from the viewpoint/perspective of the students, but in the final version, the storyboard shows the teacher's perspective. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard, we removed the comment description from the final version storyboard frame because we want to show that images/characters and text bubbles are sufficient for participants to understand the storyboard. The initial version storyboard shows that three students are taking an online class, but the final version storyboard shows that only the teacher is delivering the lecture by using an online collaborative tool Zoom. During the pilot study, one student told me that teacher is asking questions to the student and Ali is the teacher's name, and he said why do you show two screens empty in a frame. After that, I decided to modify this frame. I separated the meeting par-

ticipants by using a border around them and changed the frame perspective from students to teacher. (See figure 3.7)

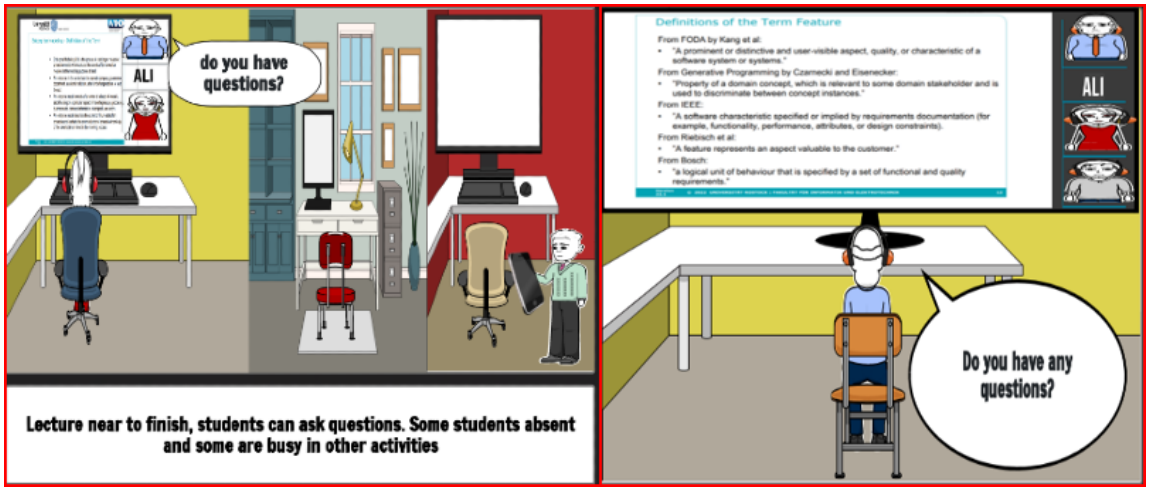

Figure 3.7: Shows frame comparison between both storyboards.

The context of groupware zoom use is shown in both storyboard frames from the perspective of the students. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The final version storyboard frame shows that students sometimes hesitate to ask questions during an online lecture environment. The final version storyboard frame shows that the Zoom interface contains students in both situations with the camera on and off, and students are also separated by a small border to maintain readability in the final version storyboard. See Figure 3.8

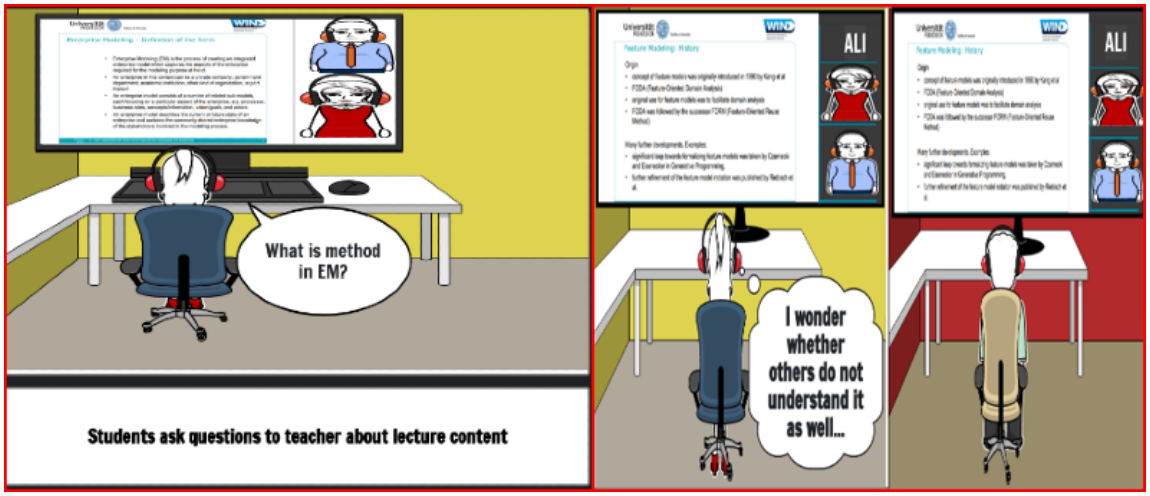

Figure 3.8: Shows frame comparison between both storyboards.

We removed some frames from the initial version storyboard because these frames distract the users from the real scenario and also these frames mismatch with our one storyboard for one problem goal. See Figure 3.9

Figure 3.9: Shows removed frames from initial version storyboard.

3.3.1.4 Breakout room scenario storyboards frames comparison:

The context of the online collaboration tool zoom use is shown in both storyboard frames from the viewpoint of the students. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The final version storyboard frame shows that three students are sitting in their rooms and taking part in the breakout room, but the initial storyboard frame shows that only one student is sitting in his room and taking part in the break-out room by using an online collaborative tool (Zoom). We modified the first version of the storyboard because we wanted to illustrate how different students participate in break-out rooms and communicate with each other. (See Figure 3.10).

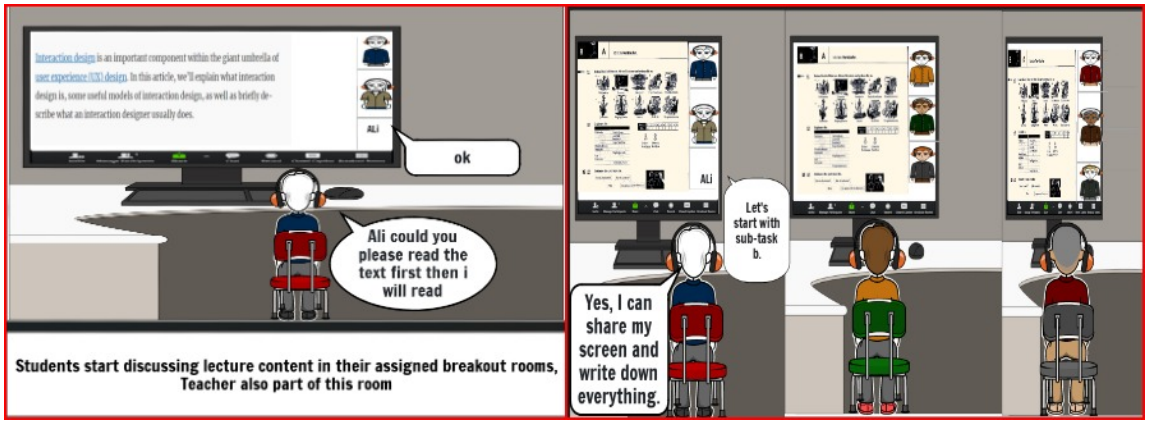

Figure 3.10: Shows removed frames from initial version storyboard.

The context of groupware zoom use is shown in the initial storyboard frame from the perspective of the students, but in the final version storyboard frame shows from the teacher perspective. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The initial version storyboard frame shows that two students are communicating with each other, but the final version storyboard shows that only the teacher is thinking about break-out rooms. We modified the initial version storyboard frame because it distorted the sequence flow between storyboard frames. (See Figure 3.11).

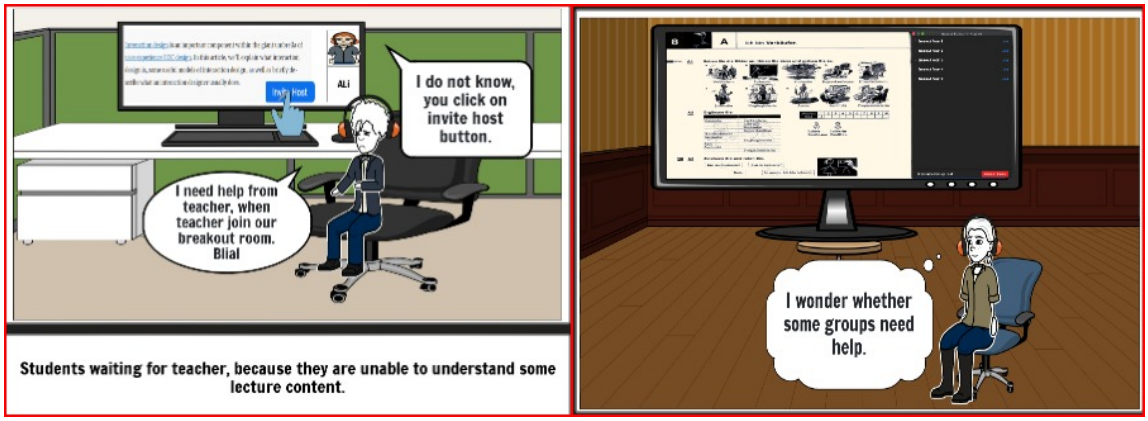

Figure 3.11: Shows frame comparison between both storyboards.

The context of the online collaboration tool zoom use is shown in both storyboard frames from the viewpoint of the teacher. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The initial version storyboard frame shows that a reminder is sent by teacher to students to inform them about the time limit. After internal discussion, we agreed that it must change with the main room discussion situation, so students can share their ideas with the teacher and other students, and this situation is more realistic to a real-world scenario as well. (See Figure 3.12).

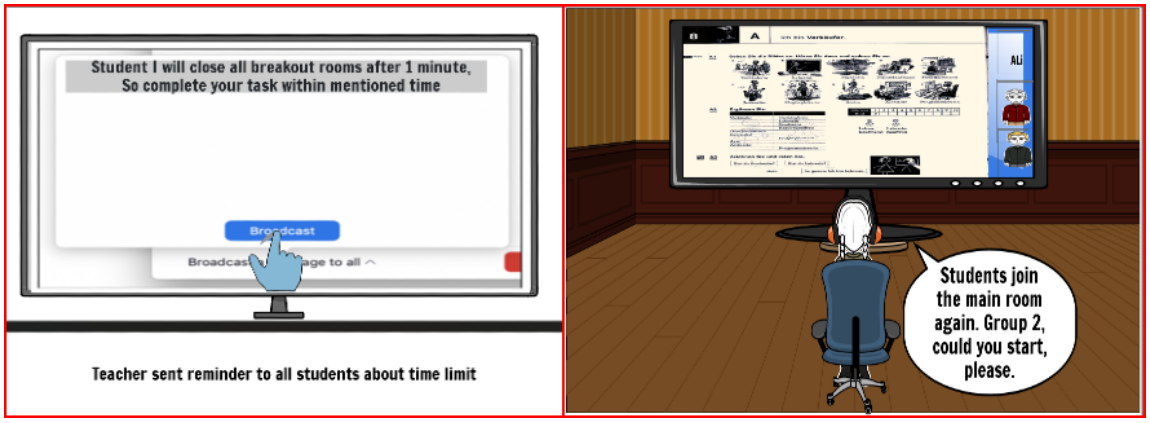

Figure 3.12: Shows frame comparison between both storyboards.

The context of online collaboration tool zoom use is shown in both storyboard frames from the viewpoint of the teacher. While the initial version storyboard frame includes the comment description to support participants in analyzing the storyboard. The initial version storyboard shows only one participant per subgroups which does not make sense in our scenario, thus we decided to change it in the final version storyboard. (See Figure 3.13).

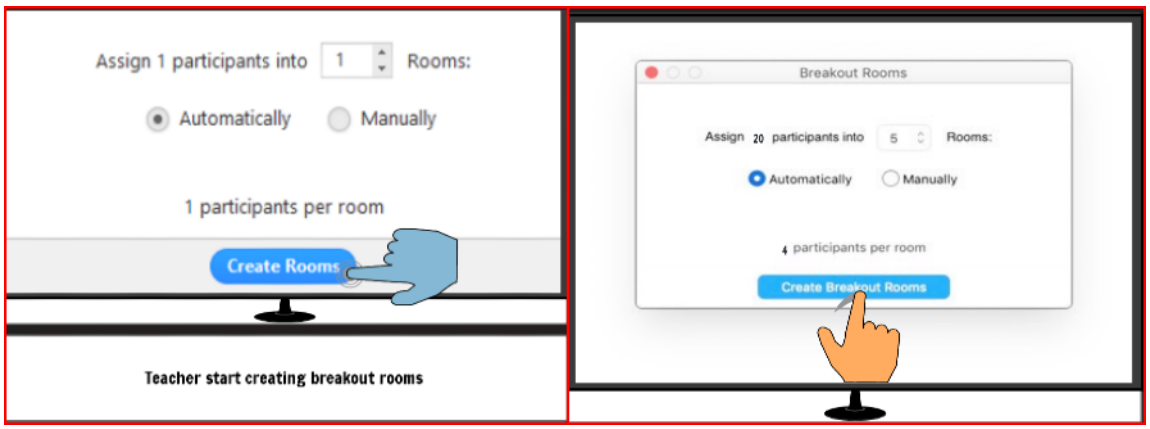

Figure 3.13: Shows frame comparison between both storyboards.

3.4 Mode of the Experiment and Procedure

Experimentation was a critical element in this study process in order to draw conclusions regarding our use cases. We utilized the following method to carry out the experiments and collect data for the experiment::

1. Group Discussion

The group discussion session was held at the University of Rostock. The group discussion lasted for about 90 minutes in total. A short presentation was given to the participants about the goal of the group discussion session, and task descriptions were handed over to the participants as printouts. Participants were divided into three subgroups, and separate rooms were allocated to every group. Storyboards were presented to two groups of participants in various ways, such as print-outs or digitally by using laptops, and one group was presented with described situations in a more abstract textual form. Participants were allowed to use laptops, beamers, microboards, and paper. The use of the classroom whiteboard was not prohibited during the group discussion session.

The second group discussion was held in the student dormitory. The experiment procedure was the same as the above-mentioned. The participants were divided into two subgroups. One group was presented with storyboards and the second was presented with described situations in a more abstract textual form. The second group discussion duration was also 90 minutes.

We encourage participants to explore both storyboards, but it did not compulsory for participants. We wanted to remain flexible in the control experiment, so participants do not feel exhausted.

We also gathered data from groups discussions sessions. During discussions, as participants proposed re-design ideas, we wrote them down on paper or in a Word file. We wanted to use the audio tab to record all group discussions and re-design ideas. We did not implement this idea because it creates privacy problems for participants, and some participants may hesitate to record their voices.

The structure of the group's discussions is shown in Table 3.2.

Table 3.2: shows time distribution in groups discussions sessions.

Activities	Time distribution
Welcome, Presentation	15 minutes
Groups discussions	60 minutes
Farewell and reward	15 minutes

3.5 Observations during Experiments

We divided the participants into five groups. The three groups were presented with storyboards and two groups were presented with described situations in more abstract textual form. Participants observations are described below.

3.5.1 Groups Presented with Storyboards

Group OS1:

They read the storyboards, got the problem, and discussed the problem based on experience. Around 10 minutes later, the all students started to look into the storyboard again while thinking about solutions, and often they got an idea while doing that. I asked later, and one student said that the storyboards were helpful to imagine this situation, and many ideas popped up. Some participants sketched their ideas by using storyboards. Participants continued pointing at sketches while explaining their solutions, and some participants returned to the storyboard. They used both storyboards and sketches very well to describe their ideas. In the end, they pointed at the lecture room scenario storyboard, and they started to find the solution for students who are not participating in the lectures. It is fascinating, that they found that as a problem by reading the storyboards. They were also inspired by pictures used in storyboards.

Group OS2:

Every participant decided to start with the zoom classroom scenario storyboard, and then they analyzed the breakout room scenario storyboard. All participants said that they are already familiar with the situation you depicted in both storyboards. After that, some participants started the discussion with me about their earlier experiences with the online collaboration tool Zoom. Each participant looked into both storyboards again and again and generated new ideas after some time. Some participants took more time to develop new re-design ideas because they started sketching the ideas and relating their ideas with the storyboard depicted situation. Some participants analyzed the storyboard to find some problems in zoom design and started looking at the storyboard again and again to find the solution for these problems.

After 20 minutes, they started a discussion with each other. They looked into both storyboards again and again and explained their re-design ideas to other participants.

Group OS3:

One participant decided to start with the zoom classroom scenario storyboard. He started to analyze the zoom classroom scenario storyboard and after 2 minutes he told loudly a redesign idea to the group. After that, a student stood, picked a white-board marker, and start sketching on the whiteboard his redesign idea. He looked at the storyboard again and again and discussed his idea with colleagues and tried to verify whether this idea his already been implemented or not. After 20 minutes, all participants started sketching their ideas on paper. One participant told me that I faced a similar situation during Covid-19, which you depicted in your both storyboards. In nutshell, all participants agreed that storyboards help us a lot to understand both situations and generate new ideas. One participant of this group told other colleagues that: *"I mean, one thing that I liked about storyboards is that storyboards were focussed on one situation at a time. This helps me to generate re-design ideas."*

3.5.2 Groups Presented with described situations in more abstract textual form

Group OT4:

The participants decided to start with situation 2. One participant said that it is maybe a more effective situation in general, and one could even discard situation the 1. Most of the participant's ideas and suggestions were based on their own experiences, Which they got while using online collaboration tools during the Covid-19 situation. They also used a whiteboard during group discussions.

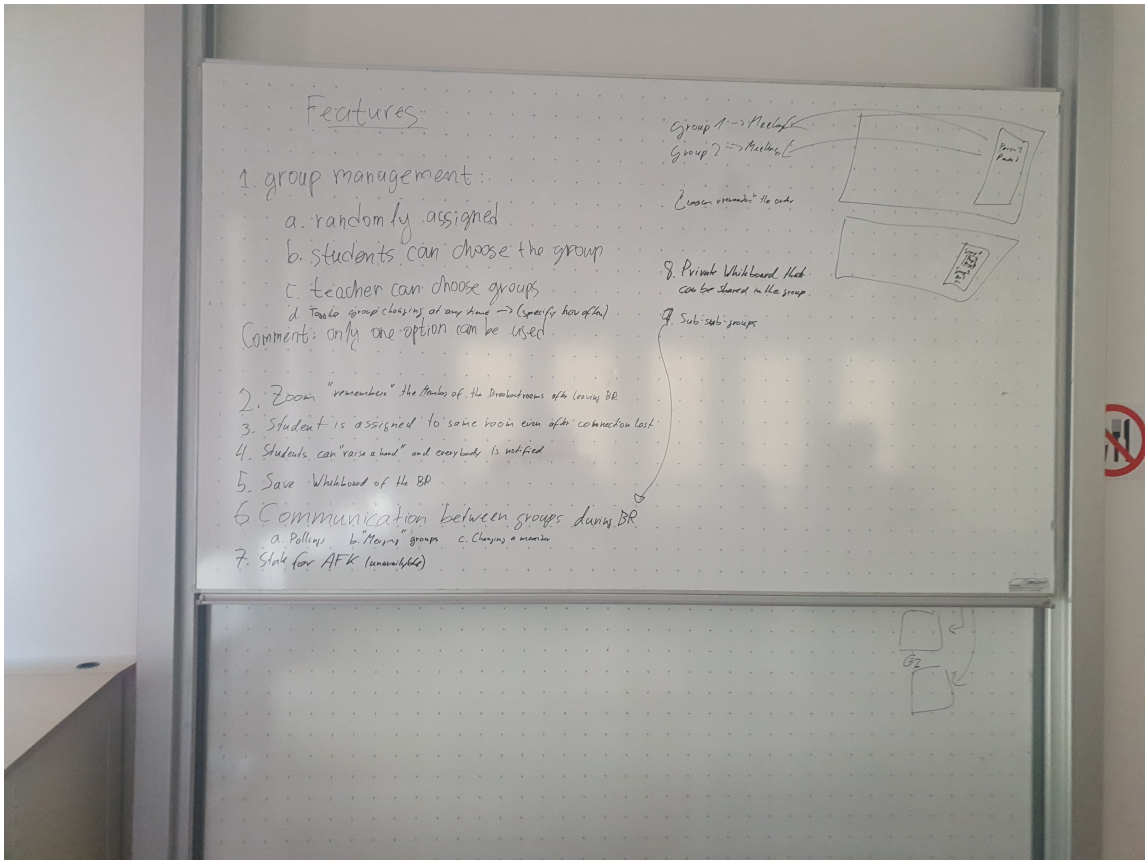

Figure 3.14: shows whiteboard used in group discussion

Group OT5:

The participants decided to start with both situations. They read both text descriptions and started thinking about both situations. One participant told me that I can't propose a redesign idea by just reading text. I explained both situations to him and asked him that are you familiar with similar situations. He replied yes, I am familiar with situations, then he started thinking about new design ideas. All participants used A4 papers or their note pads to explain their ideas to other participants.

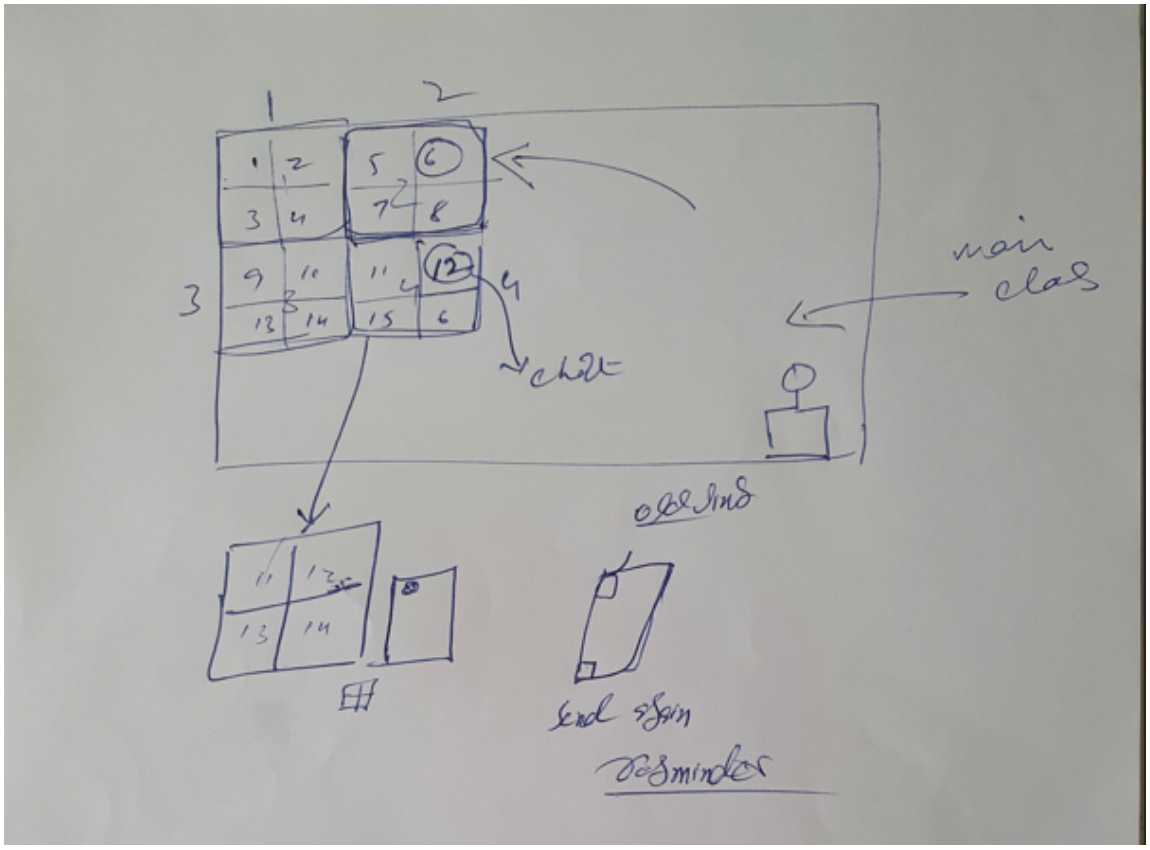

Figure 3.15: shows A4 paper used in group discussion

3.6 Result and Analysis

Participants remarks were divided into the following categories to verify our hypotheses.

- Feature addition ideas
- Feature modification ideas
- Generic ideas
- Already implemented ideas
- Technical issues
- Sketched ideas
- Students supportive ideas
- Teachers supportive ideas

- Both teachers and students supportive ideas
- Similar ideas between same groups (storyboard/textual description)
- Similar ideas between different groups (storyboard/textual description)

These classes were constructed by interpreting user comments. “Feature additions ideas" were the comments in which participants discussed additions in zoom features and perfectly matched with given situations. Participants from the OT4 group proposed a new re-design idea for the Zoom: *“If I remember it right, you come back into the whole group. The teacher cannot see anymore who was in the groups. It would be good if subgroup members are still visible for teachers, but also students.”* “Feature modification ideas" were the suggestions in which the participants suggested modifying a feature that is already present in Zoom and also perfectly matched with given situations. participants from group OS2 proposed a redesign idea for the zoom as follow: *“The Invite host button is modified in a such way that it looks more prominent without a popup new model, so we can minimize user interaction at one level.”* "Already implemented ideas" were the comments in which participants proposed redesign ideas that implementation already done in Zoom but some groups participants did not aware of it. For instance, participants from group OS1 suggested that:*“ adding a whiteboard feature in the zoom tool is very useful for students. when the student asks questions to the lecturer, it is difficult to explain the doubt in the presentation itself. It would be better if zoom provides a whiteboard option, in which doubt can be solved or any confusing topic can be explained on it. The white feature should also be flexible for the pictures/images to be uploaded freely. Also, we can export this whiteboard content as a PDF file so that it can be shared with the other students who have the same queries.”* “Generic ideas" that describe users’ behaviors, implementation of such ideas in groupware difficult than in real-world scenarios and these ideas did not match perfectly with given depicted situations. Group OT4 students suggested that: *“Survey and pooling can be used as a mode of communication between breakout room groups.”* “Technical issues" were the ideas that related to hardware and network. Members from OT5 group proposed that: *“I have been*

facing one problem again and again when my meeting duration is over 30 minutes, my screen start freezing."

The overall main categories results of the experiment are displayed in Figure 3.16. The participants of group OS3 generated more number of re-design ideas related to the "Feature addition ideas" category as compared to all other groups in this category. The number of generated ideas were 8. The members of the OS1 group generated re-design ideas related to "Feature addition ideas" were 6. The Students of the groups OS2, and OT4 proposed ideas were similar, 5, 5, respectively. The least number of re-design ideas were generated by the participants of the group OT5. The number of generated ideas were just 2. The members of the OS2 group gave the highest re-design ideas related to the "Feature modification ideas" category than the members of all other groups. The number of comment proposed by group OS2 members was 1.

All OS groups participants (OS1, OS2, OS3) generated more re-design related to "Feature addition ideas" and "Feature modification ideas" than the participants of the OT groups (OT4, OT5) suggested re-design ideas.

Participants in group OS1 proposed more re-design ideas related to the "Generic ideas" category than those in groups OS2 and OS3. The number of suggested ideas were 2. The students of both groups OT4 and OT5 generated re-design ideas were identical. Both groups generated 1, 1, ideas, respectively.

The members of groups OS1 and OT5 gave re-design ideas related to the "Already implemented ideas" category were similar and higher than all other groups in this category. The participants in group OT5 gave ideas related to "Technical issues" category. The number of the recommended ideas were 1

The students of the OS1 group proposed the total number of re-design ideas for all categories were 9 and the participants of the OS3 group generated a total number of re-design ideas for all classes were 8. The total number of re-design ideas for all categories suggested by participants of groups OS2 and OT3 were 6,6 respectively and 5 total re-design ideas were proposed by OT5 group members for all categories

The average number of ideas generated by all OS group (OS1, OS2, OS3) members were 7.7 and the average number of ideas proposed by all OT group participants (OT4, OT5) were 5.5.

Groups	Groups names	Feature addition ideas	Feature modification ideas	Generic ideas	Already implemented ideas	Technical issues	Total number of ideas	Avg. no of OS groups ideas	Avg. no of OT groups ideas
1	OS1	6	0	2	1	0	9		
2	OS2	5	1	0	0	0	6		
3	OS3	8	0	0	0	0	8		
4	OT4	5	0	1	0	0	6		
5	OT5	2	0	1	1	1	5	7.7	5.5

Figure 3.16: Main Categories Findings

The number of re-design ideas generated by the OS2 group members that support students' perspectives were 5 and highest among all other groups in the "Students supportive ideas" category. The groups OS1 and OT4 gave similar numbers of ideas that support students' point of view were 3,3 respectively. The number of redesign ideas that support the perspectives of students proposed by members of the OT5 group were 1.

The number of re-design ideas proposed by the OS3 group members that support teachers' perspectives were 6 and highest between all other groups in the "Teachers supportive ideas" category. The groups OS2 and OT5 proposed the similar numbers of ideas that support teachers' point of view were 1,1 respectively. The number of redesign ideas that support the perspectives of teachers suggested by members of the OS1 group were 2.

The participants of group OS1 generated re-design ideas that support the both perspectives of students and teachers. The number of proposed ideas were 1. The students of groups OS3 and OT4 suggested redesign ideas that support both points of view of students and teachers were similar, 2,2 respectively. The total number of ideas that support both students and teachers proposed by all OS groups (OS1, OS2, OS3) were 3 and the total number of ideas that support both points of view generated by all OT groups (OT4, OT5) were 2.

The number of ideas sketched by OS2 group students were 2. The groups OS1 and OT5 members sketched ideas were similar 1,1 respectively. The total number of ideas sketched by all OS group (OS1, OS2, OS3) participants were 3 and the total number of ideas sketched by all OT group (OT4, OT5) members were 1.

The average number of ideas that support teachers perspectives proposed by all OS group (OS1, OS2, OS3) participants were 3 and average number of ideas that support teachers point of view generated by all OT groups (OT4, OT5) were 0.5.

The average number of ideas that support students point of view suggested by all OS group (OS1, OS2, OS3) participants were 2.7 and the average number of ideas that support students perspectives generated by all OT groups (OT4, OT5) were 2. (See Figure 3.17)

Groups	Groups names	Students supportive ideas	Teachers supportive ideas	Both teachers and students supportive ideas	Sketched ideas	Total number of both students, teachers supportive ideas	Total number of sketched ideas	Avg. no of all OS groups students supportive ideas	Avg. no of all OS groups teachers supportive ideas	Avg. no of all OT groups students supportive ideas	Avg. no of all OT groups teachers supportive ideas
1	OS1	3	2	1	1						
2	OS2	5	1	0	2						
3	OS3	0	6	2	0	3	3				
4	OT4	3	0	2	0						
5	OT5	1	1	0	1	2	1	2.7	3	2	0.5

Figure 3.17: Ideas Support Categories

The total number of similar ideas in all OS groups (OS1, OS2, OS3) were 3 and the total number of similar ideas between both OS and OT groups (OT4, OT5) were 2. (See Figure 3.18)

Groups	Groups names	Total number of similar ideas between same groups	Total number of similar ideas between different groups
1	OS1	3	2
2	OS2		
3	OS3		
4	OT4	0	
5	OT5		

Figure 3.18: Ideas Comparison Between Groups

The various types of comments provided by the participants are listed and categorized in the subsequent sections.

3.6.1 Feature addition ideas

The participants of different groups gave new design ideas which can be implemented in the zoom online collaboration tool. Various group members identified problems in the Zoom meeting tool, which makes it difficult for students to ask questions to the teacher. Participants from two groups OS1, and OT5 proposed some new design ideas to solve these problems. These new design ideas are: *" Shy students hesitate to ask questions to teachers. Possibility of a hand design which is connected to specific slides, so that the teacher comes back to the slides and answers the student's questions."* , *" Zoom allows students to write on the slides anonymously, so teachers can answer the questions later when they have time."* and *" Students questions appear as a pop message first. The students can answer the questions, so no dump question reach the teacher if no a lot of problems answers then the question goes to the teachers."*

Some participants from different groups encountered significant difficulties when they wanted to interact with one another in Zoom. Participants from group OS1 proposed the following new chat features to address these issues. They suggested that: *" The*

existing chat is fine for us, but a new button must integrate, so we send anonymous messages to others as well." and *" It would be better if we have a private button in a chat, so if a student has any problems with breakout room colleagues, he can directly inform the teacher without notifying his/her group participants."*

Students from group OS2 suggested some features to make Zoom more interactive. For example, They recommended that:*" Zoom must integrate more interactive features like collaborative document editing, working together in lecture and breakout room situations, and when solving/working on different exercises. "*

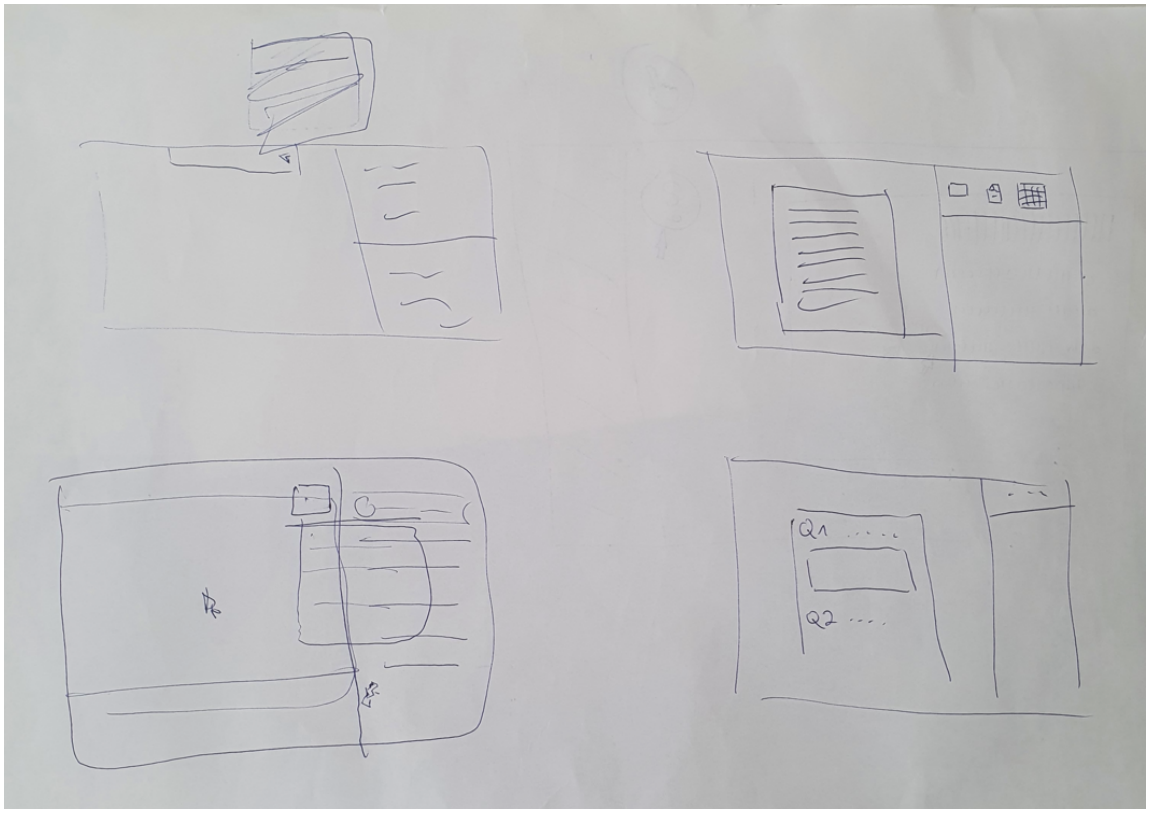

Figure 3.19: Sketch of integrate feature idea

3.6.2 Feature modification ideas

The participants of one group also proposed what must be improved in Zoom. participants of group OS2 suggested that:*"A more prominent invite host button display without popping up the model in breakout room situation."*

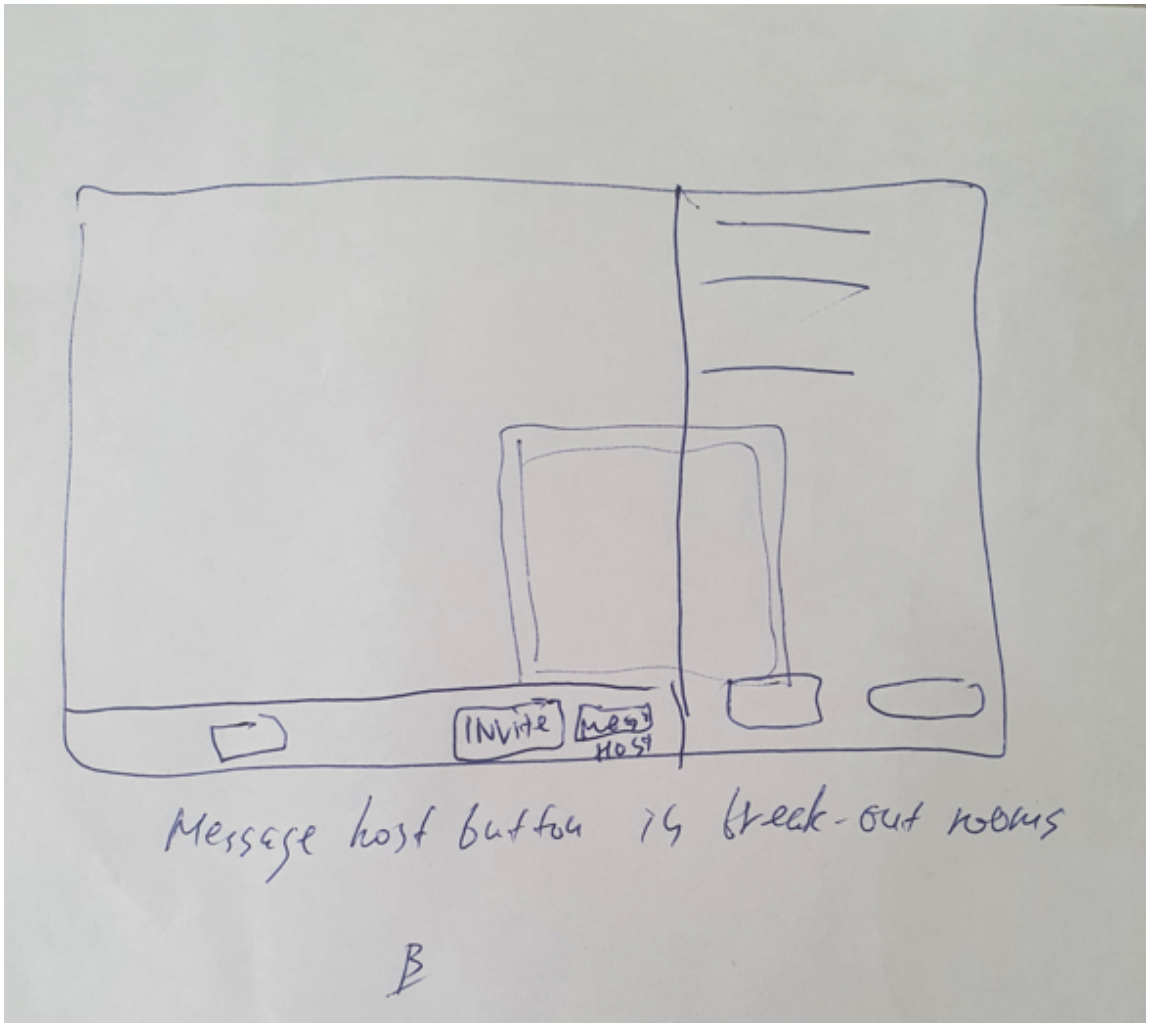

Figure 3.20: Sketch of Invite Host Button

3.6.3 Generic ideas

The participants of various groups proposed such comments, which are not related to the design and depicted situations. They just used their previous experience to suggest these ideas. Members of group OS1 stated that:" *"we have only one minute to move out of the breakout rooms. It would be fine if teachers allocate more move-out time, then better for students."* and: *"Raise a hand feature already exists and nothing additional is needed. They assumed that the problem is that the students can not answer directly to the teacher ."* Some other comments suggested by other groups participants are: *" Raise a hand feature already exist and nothing additional is needed. They assumed that the problem is that the students can not answer directly to the teacher "*, and *"It would be better if teachers send a reminder or notification before*

15 minutes of lecture. So nobody misses or forgets about class time and students join the class on time."

3.6.4 Sketched ideas

Some students of different groups sketched ideas to explain their ideas to other group members. Members of group OS2 proposed new re-design ideas with sketching. For example, *" A feature is known as a pointer. Host allows students to use this feature. This way, They can point out specific screen portions or help the teacher to point out specific slide parts about asking for further help."*

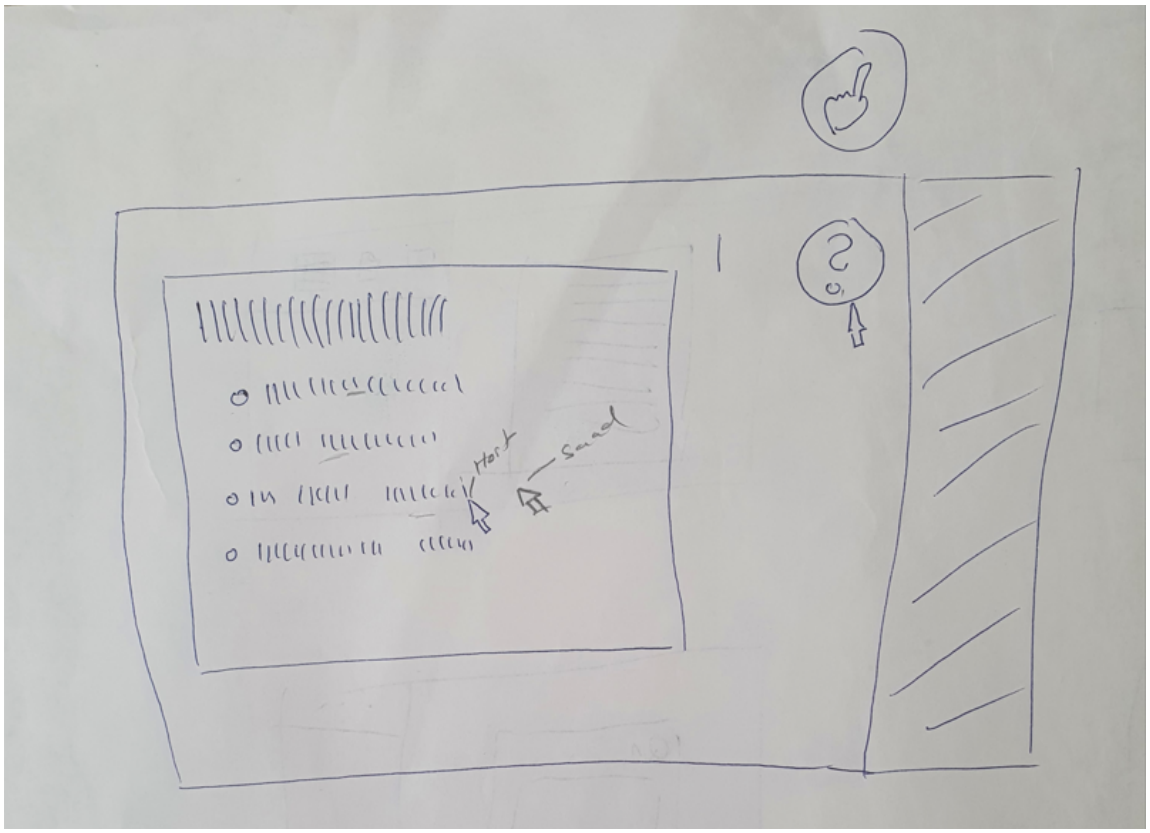

Figure 3.21: Sketch of pointer idea

3.6.5 Students supportive Ideas

Most of the ideas suggested by participants of the different groups support the student's point of view. For instance, *"It would be better that we save the break-out room whiteboard so that we can share our notes with other groups."*

3.6.6 Teachers supportive Ideas

Some ideas suggested by participants of various groups support the teacher's point of view. For example, *"If we have 9 breakout groups. The host can supervise every group at a time, not one by one. In the host control room, a host has a special button which he can use to listen to any specific group discussion without joining the group."*

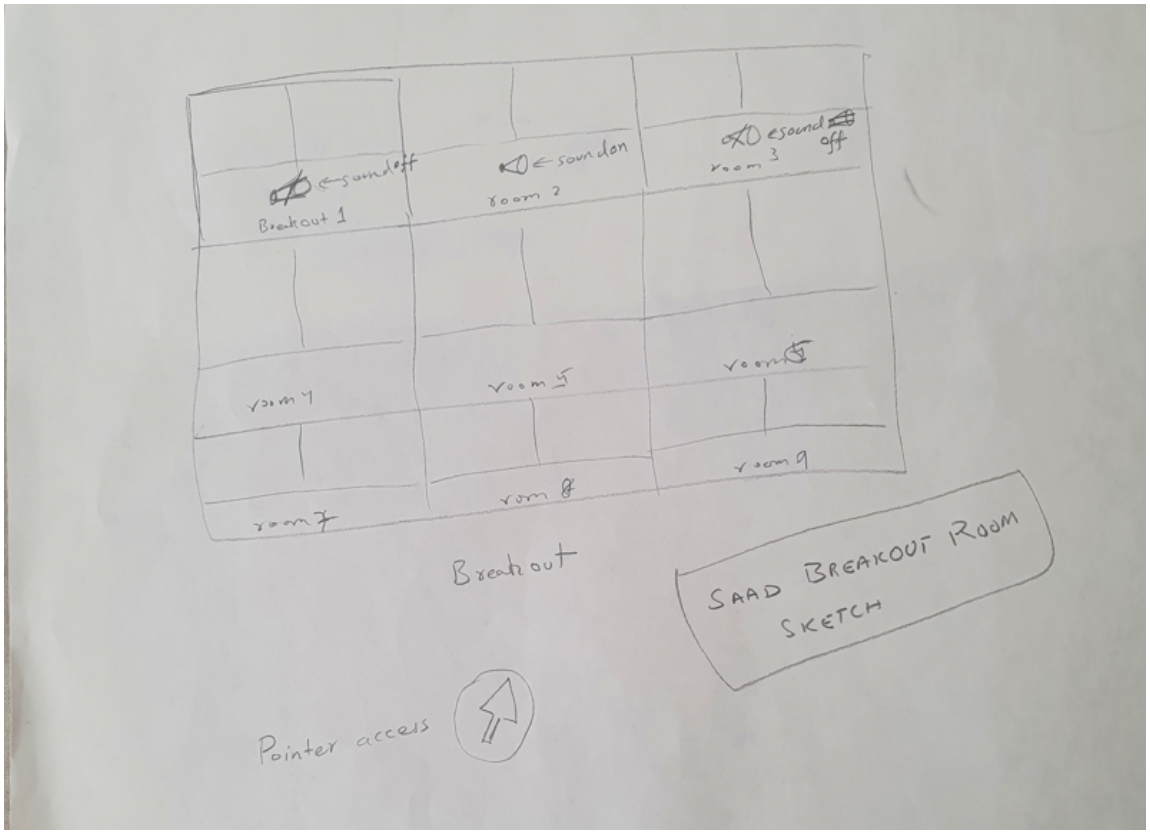

Figure 3.22: Sketch of control room

3.6.7 Both teachers and students supportive ideas

Some ideas proposed by participants of some groups support both students' and teachers' points of view. For example, *"Zoom allow students to write on the slides anonymously, so a teacher can answer the questions later when they have time."*

3.6.8 Similar ideas between same groups

Some ideas proposed by participants of the groups who presented with storyboards are similar. For example, *"Only speakers video and name available alongside screen option instead of all participants of the meeting/lecture."*

3.6.9 Similar ideas between different groups

Some ideas suggested by participants of the different groups who presented with storyboards and textual abstract descriptions are similar. For example, *"Control room feature is available for teacher to check all subgroups within one window."* and *"Shy students hesitate to ask questions to teachers. Possibility of a hand design which is connected to specific slides, so that the teacher comes back to the slides and answers the students' questions."*

CHAPTER 4: DISCUSSION

We performed an experimental study to evaluate the outcomes of providing users with two storyboards about two scenarios and described situations in more abstract textual form. We had two different conditions:

- Re-design zoom groupware by analyzing storyboard
- Re-design zoom groupware by using described situations in a more abstract textual form.

Our hypothesis was when users are presented with storyboards generate more re-design ideas as compared to when they are presented with described situations in more abstract textual form.

The findings show that when participants were given both storyboards, they suggested more design ideas than when they were given descriptions of scenarios in more abstract text form. This supports the statement in [27] *"Storyboarding truly stimulates creativity, facilitates the development of ideas and identifies opportunities for innovation. This could be due to the storyboard's use of external representations, which externalizes memory and decreases the processing load. This externalization frees up working memory space and inspires original thought. When drawing and narrating the events of the situation, it seems difficult for the teams to resist new idea's generation. When the story is broken into frames, a transition takes place between the frames, and a gap is found, as shown in Figure 4.1 by the arrows. Due to this plot point, new ideas can be developed which help to conclude the narration".* I think one reason cloud be for more idea generation is that participants understood both depicted situations in storyboards much better way as compared to descriptions of scenarios in more abstract text form and did not completely rely on their imaginations.

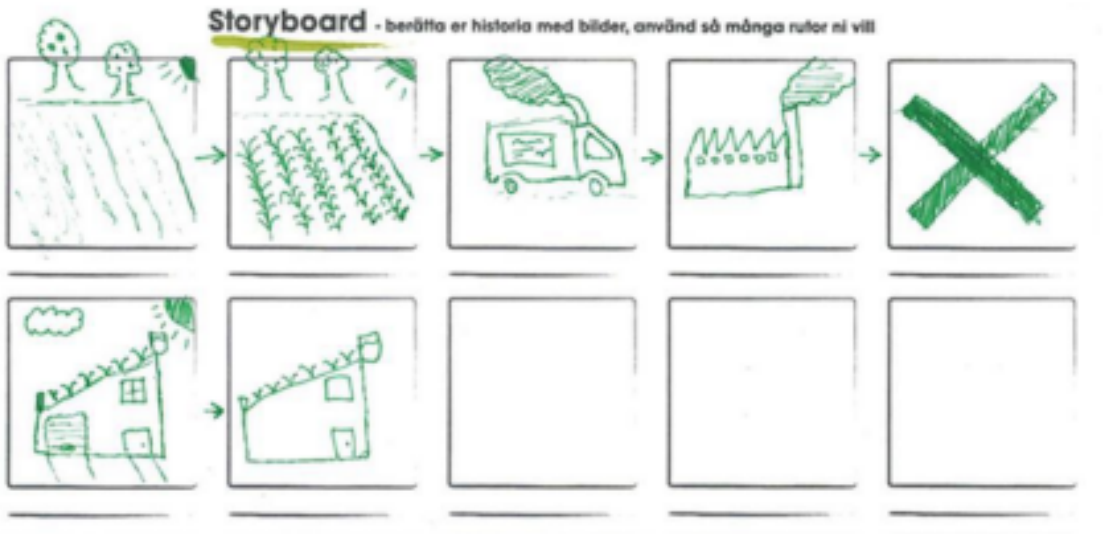

Figure 4.1: Idea Development By Using Storyboarding [27]

Our second hypothesis was when users are presented with storyboards generate more re-design ideas that support other perspectives as compared to their own perspectives.

This hypothesis is also supported by our experimental study. Participants of all OS (OS1, OS2, OS3) groups generated more total re-design Ideas, that support teachers' perspectives more as compared to students' perspectives. One reason might be that we showed both perspectives (students and teachers) in storyboards, which helped participants to consider others' perspectives and gave unbiased ideas. This supports the statement in [11] *" By withdrawing from the experience and viewing the unfolding event from the outside, the reader can reflect on the visualized interactions from his or her expertise. This unbiased viewpoint enables analysis, highlighting specific aspects of the interaction, and gaining a sense of time progression. This way, the storyboard visually represents numerous critical aspects of the context, serves as a reminder to the design team, and facilitates discussion by allowing team members to point to and annotate the visualized aspects.*

The participants of all OS groups (OS1, OS2, OS3) proposed more re-design ideas related to "Feature addition ideas" and "Feature modification ideas" categories as compared to OT groups (OT4, OT5) members suggested re-design ideas. The reasons

for such a high number of re-design ideas are: The participants of all OS groups (OS1, OS2, OS3) were presented with described scenarios in abstract textual form. One reason could be that storyboarding helped participants understand the situation and also helped them to focus on one specific situation. This statement also justifies that: *"The focus on a particular situation that we can see in the storyboard could result from human centeredness. Being forced to pick a story to tell, storyboarding places you as the narrator in the center of the story at the same time as it puts the situation in focus. [27]".*

The number of re-design ideas proposed by all OS (OS1, OS2, OS3) and OT (OT4, OT5) groups related to the "Generic ideas" category were similar. This is interesting for us because participants were presented with two different conditions (storyboards, described situations in textual form) during the experiment and generated the same number of ideas for the same category ("Generic ideas"). The reason might be that the students did not understand the depicted situations in storyboards and described the situation in textual form properly. They just used their previous experiences with the Zoom tool to suggest new re-design ideas, but further research is needed to establish how the previous experiences affect the ability of users to generate re-design ideas for the same tool.

The total number of re-design ideas related to the "Total number of similar ideas between same groups" category proposed by all OS groups (OS1, OS2, OS3) members were 3 and the total number of re-design ideas related to "Total number of similar ideas between different groups" category generated by all OS groups (OS1, OS2, OS2) and OT (OT4, OT5) members were 2.

The study has obvious limitations. First, the number of participating groups is very small so that other studies have to be conducted to confirm the results. Second, even though these experiments were conducted when the pandemic limitations were lifted, people were hesitant to offer us time since it needed them to stay at one place for 90 minutes and join the group to discuss the situations which were depicted in the storyboards. Some participants were want to give the re-design ideas individually, but this is not our experiment goal.

We must need group discussion to generate redesign ideas. For one session everything went well but in another session, we faced a lot of difficulties. When we contacted participants for group discussion, some participants were outdoors at the decided time. Multiple times, we postponed group sessions for one participant because he was busy at that time.

We limited the number of scenarios depicted in storyboards to only two in order to decrease the duration and complexity of the experiment. This way was very helpful in a way that people did not have to analyze too many storyboards. They just focused on two scenarios for generating the re-design idea instead of five or six.

In conclusion, most cases had the intended results, we discovered that both of our hypotheses when users are presented with storyboards generate more redesign ideas as compared to when they are presented with described situations in more abstract textual form and when users are presented with storyboards generate more re-design ideas that support other perspectives as compared to their own perspectives were true.

CHAPTER 5: CONCLUSION AND FUTURE WORK

The value of storyboards in the design process has already been the subject of extensive research. We discovered numerous concepts that have been addressed in prior studies when conducting the literature review for our thesis. While the researchers utilized many strategies to redesign any collaboration tool, one approach we used was to share storyboards with users in groups. The advantage of this strategy is that users understand the depicted situations more quickly, and different visualized user interactions with groupware help them to generate re-design ideas more efficiently. There is no research that can be considered complete. But this research could be expanded in the future in many ways. We will discuss the unresolved issues that emerged for us while we were working on this thesis that could benefit the community if resolved in the future.

The online collaboration tool we considered for this study is designed for the web. There were no restrictions on who could access the tool in terms of their origins, locations, or occupations. Almost all the participants in our study came from identical backgrounds. If there is enough time, it would be possible to use internet platforms to conduct cross-country group discussions, but hard to maintain the same working environment for all participants. This would be more beneficial in expanding the research's horizons, and many more gaps could appear that could need to be filled in the future.

An additional way to proceed or add to this research is to focus on the people who are purely or strictly related to this domain of study. We considered only students

for our experiments. It will be great if we add teachers to the group of participants and experiments and increase the number of depicted scenarios in storyboards.

This research can be extended to other kinds of online collaboration tools, like collaborative tools in the form of mobile applications. These types of collaborative tools need different research approaches because the user interaction and experience change a lot as compared to web-based collaborative tools.

We believe that it would be more useful for future researchers to conduct their research if the constraints described in this thesis when undertaking this research were considered beforehand. If the pandemic entirely ends, they could save time by controlling their participants more effectively. They may use a more standardized and simplified approach to completing their work and getting re-design ideas through group discussions.

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APPENDIX A. Storyboards Frames

Classroom scenario storyboard frames are shown here because these are not include in the study chapter.

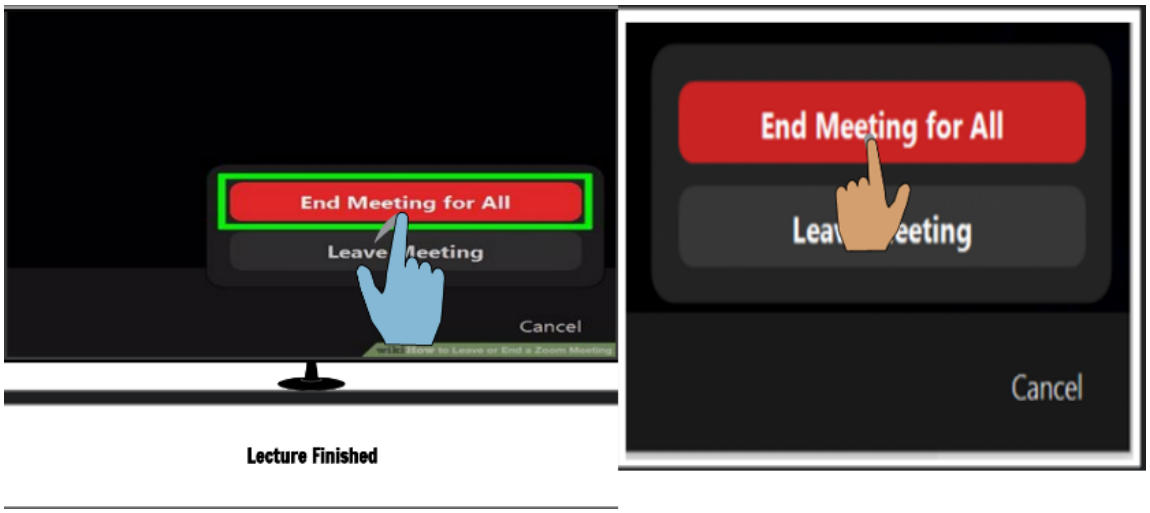


Figure 1: Classroom scenario storyboard frames comparison.

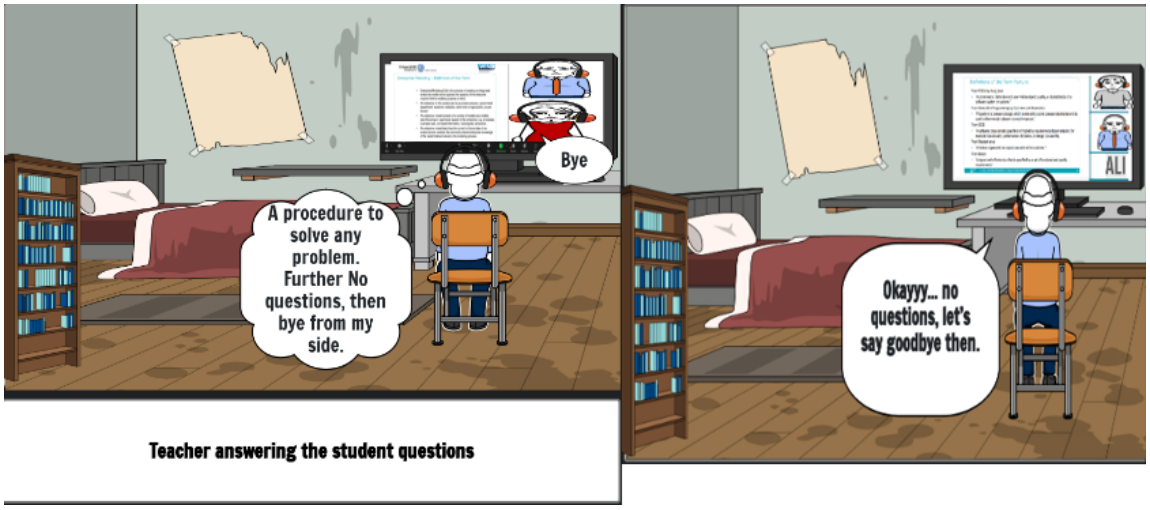


Figure 2: Classroom scenario storyboard frames comparison.

Breakout room scenario storyboard frames are shown here because these are not included in the study chapter.

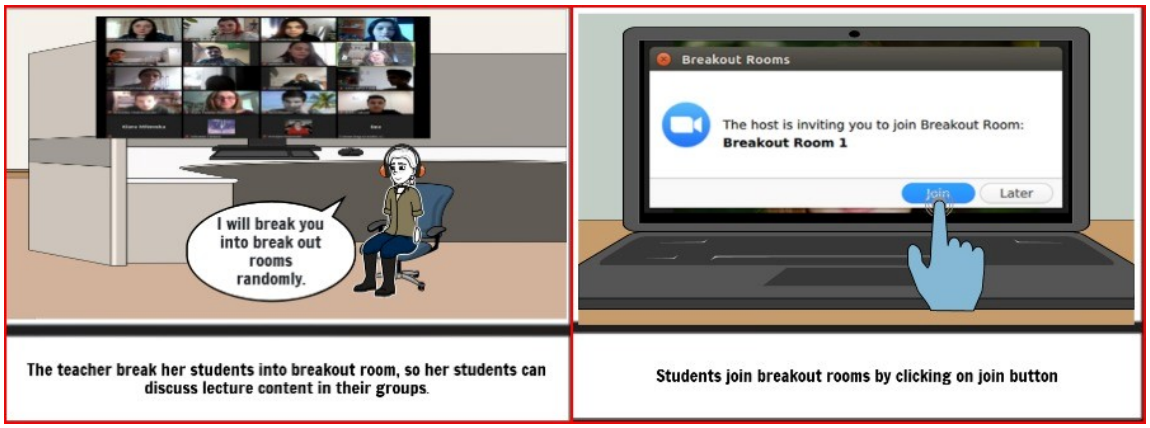


Figure 3: Classroom scenario storyboard frames comparison.

APPENDIX B. Zoom signup and sign-in scenarios depicted by using interface storyboard

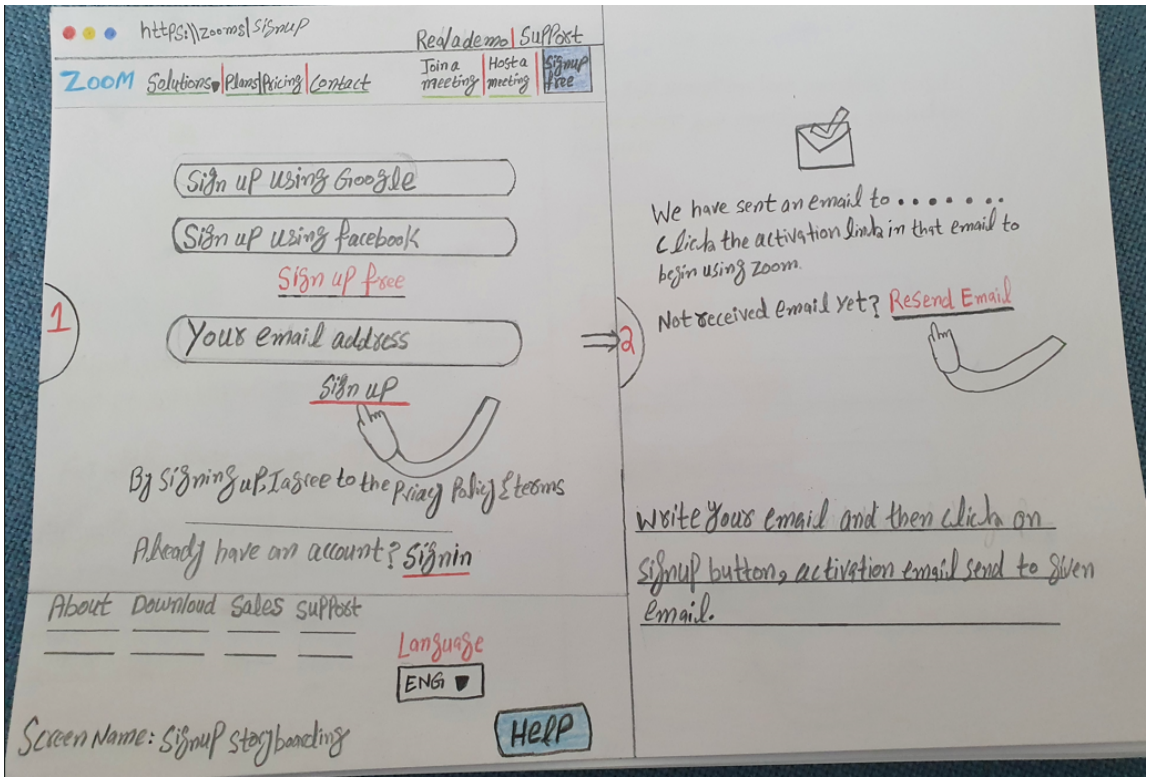


Figure 4: Signup sketch

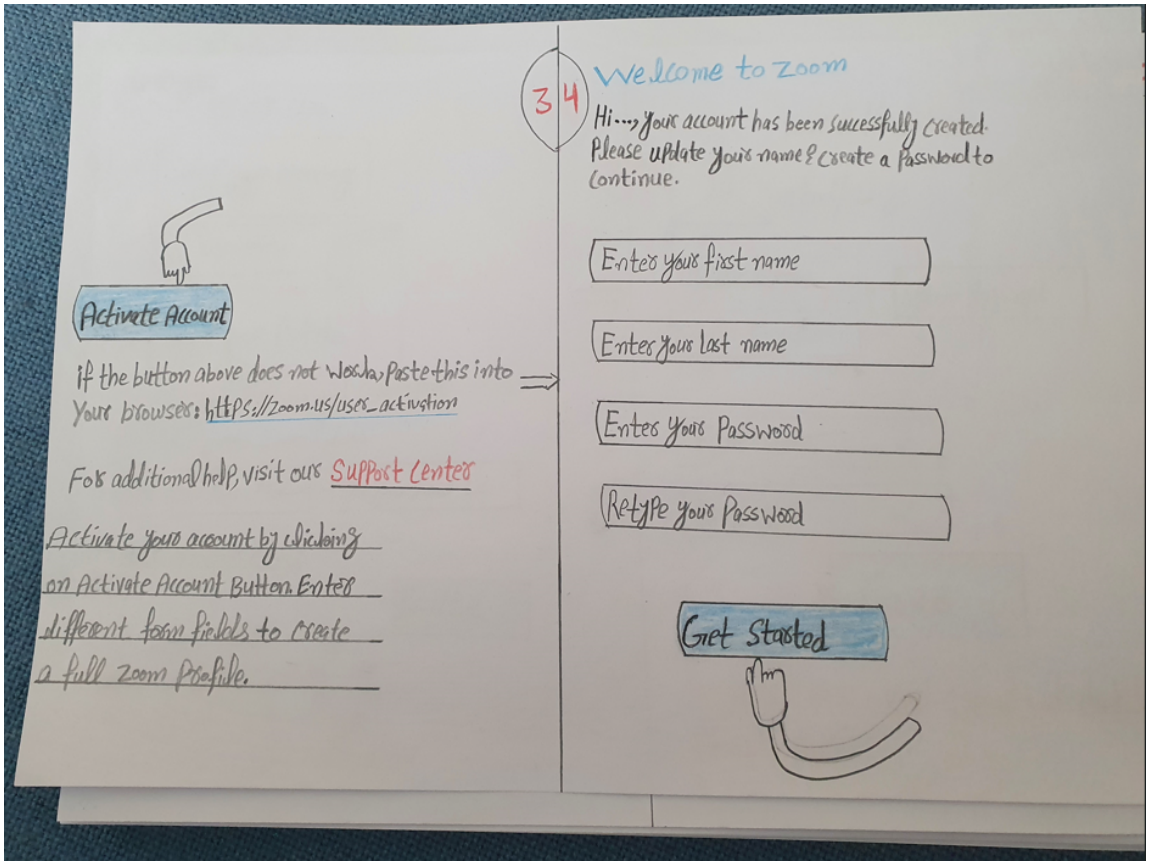


Figure 5: Account Register sketch

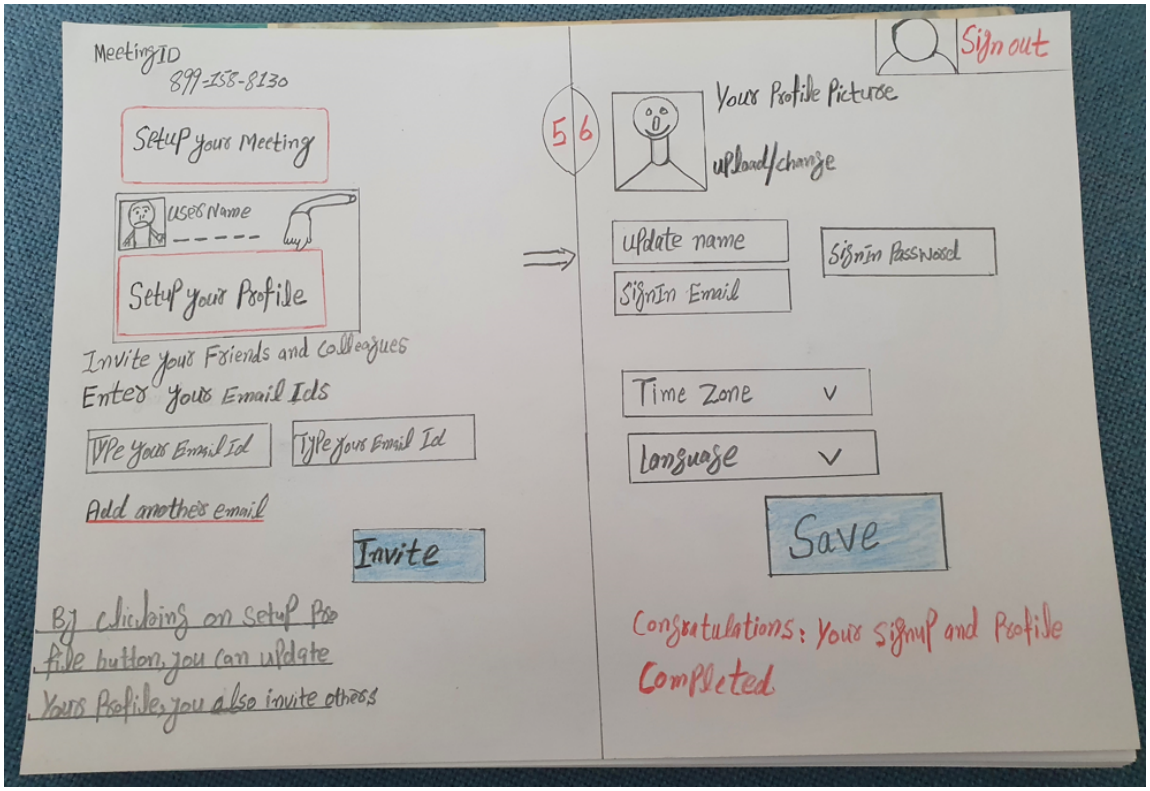


Figure 6: Account update sketch

APPENDIX C. Questionnaire

At the beginning of the experiment, participants were given the following questionnaire.

How could the persons be better supported in such situation ?

Develop and sketch down ideas how the zoom interface could be redesigned. What features could be added to or changed in the system?

APPENDIX D. Abstract textual description used in experiment for idea generation

Lecture room Scenario

Imagine you are in a Zoom-Meeting, listening to an online lecture. The lecturer talks about a certain topic and sometimes asks for questions.

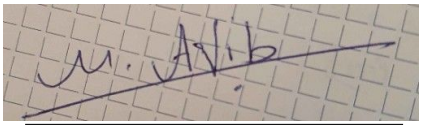
Breakout Scenario

Imagine you are in an online tutorial. The teacher asks students to work in small groups on a problem. Afterwards, they want to share the different solution. The teacher creates Zoom breakout-rooms for the group work...

DECLARATION

I herewith formally declare that I have written the submitted dissertation independently. I used no external support, except for the literature cited, and other sources mentioned in the document.

Rostock, 19-07-2022



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