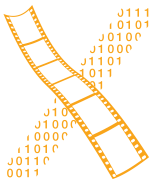

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Investigating New Interactions For Improved DIY Tutorial Videos on Mobile Devices

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Abstract

The growth of the do-it-yourself (DIY) culture has been influenced by the improved accessibility via online tutorial platforms in recent years. However, it is difficult for users to gain immersive and personalized learning experiences from these tutorials due to conventional linear structures. Moreover, conventional tutorials commonly focus on text-based or video-based formats, and are mainly designed for desktop platforms, leading to a lack of content flexibility and incompatibility on portable platforms.

This study addresses these limitations of conventional platforms by proposing guidelines for designing DIY tutorials optimized for mobile platforms. By adding interactive elements and combining text-based and video-based content formats, we aim to improve content flexibility and user experience.

The research began with the prototype design based on previously proposed guidelines and ideas from well-developed mobile applications, which were adapted into our design, and a high-fidelity prototype on Figma was developed. Video contents in the prototype were specifically tailored for mobile platforms.

Combined with semi-structured interviews and analysis of users' action patterns, the interactive tutorial prototype was validated through qualitative coding. Findings from the evaluation phase highlight critical factors in designing elements, that impact the user experience. Additionally, insights gained from users' feedback show the necessity of integrating interactive elements and their interest in transforming them into a mobile-friendly interface, provide recommendations for further development.

Findings in this research demonstrate comprehensive guidelines for further development of interactive DIY video tutorials on mobile platforms, as well as practical recommendations enlightening content creators to integrate interactivity into their tutorial materials.

Überblick

Das Wachstum der Do-it-yourself (DIY)-Kultur wurde in den letzten Jahren durch die verbesserte Zugänglichkeit von Online-Tutorial-Plattformen beeinflusst. Allerdings beeinträchtigen die traditionellen linearen Strukturen dieser Tutorials das immersive Lernerlebnis und die Möglichkeit der Personalisierung. Darüber hinaus konzentrieren sich herkömmliche Tutorials häufig entweder auf textbasierte Anleitungen oder auf Videoformate und werden hauptsächlich für Desktop-Plattformen entwickelt, was zu einem Mangel an Flexibilität für die Inhalte und Inkompatibilität mit mobilen Plattformen führt.

Diese Arbeit befasst sich mit diesen Einschränkungen, indem sie Richtlinien für das Design von DIY-Tutorials vorschlägt, die für mobile Plattformen optimiert sind. Durch die Integration interaktiver Elemente und die Kombination von textbasierten und Videoformaten soll die Flexibilität des Inhalts und die Benutzererfahrung verbessert werden.

Die Arbeit beginnt mit dem Entwurf eines Prototypen auf der Grundlage von Ideen aus exemplarishen Anwendungen, die Anpassung dieser Beispiele an ein mobiles Format und die Weiterentwicklung zu einem Software-Prototypen. Videomaterial wird für mobile Plattformen angepasst.

Semi-strukturierte Interviews und die Analyse von Benutzer Interaktionsmustern validieren den interaktiven Tutorial-Prototypen durch qualitative Codierung. Ergebnisse aus der Evaluierungsphase heben die kritischen Faktoren der Designelemente hervor, die sich auf die Benutzererfahrung auswirken. Darüber hinaus zeigen Erkenntnisse aus dem Nutzerfeedback die Notwendigkeit interaktiver Elemente und einer benutzerfreundlichen mobilen Schnittstelle.

Diese Arbeit präsentiert Richtlinien für die weitere Entwicklung interaktiver DIY-Video-Tutorials sowie praktische Empfehlungen für Content-Ersteller, um Interaktivität in ihre Lernmaterialien zu integrieren.

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All participants and staff members have provided me with invaluable assistance, without them, I could not finish my master's thesis successfully.

Conventions

Throughout this thesis we use the following conventions.

Text conventions

Definitions of technical terms or short excursus are set off in coloured boxes.

EXCURSUS:
Excursus are detailed discussions of a particular point in a book, usually in an appendix, or digressions in a written text.

Definition:
Excursus

Source code and implementation symbols are written in typewriter-style text.

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The whole thesis is written in American English.

Download links are set off in coloured boxes.

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[a] http://hci.rwth-aachen.de/public/folder/file_number.file

Chapter 1

Introduction

As the market shifts from a goods-centered logic to a more service-centered logic, the concept of DIY activities has risen as prosumption activities

Consumer involvement in the co-creation of value is playing a critical role in marketing as a shift from a goods-centered logic to a more service-centered logic found by marketers [Vargo and Lusch, 2004]. Even though the practice of learning from previous experiences of others and applying that knowledge with one's understanding has a rich historical record, consumers have been regarded as passive buyers and users of goods or services [Xie et al., 2008]. In other words, people tend to directly consume products instead of playing a fundamental role in the invention, creation, and production of goods or services. However, some researchers argued that consumers would emerge from the socio-cultural environment of modern society and produce products for their consumption, so-called prosumption activities [Lusch and Vargo, 2006]. Furthermore, previous studies have proposed a specific form of prosumption activities, so-called Do-it-yourself (DIY), as behaviors in which individuals tend to utilize raw materials or parts to produce, transform, or reconstruct material possessions, including items from the natural environment [Wolf and McQuitty, 2011].

A brief historical introduction to the DIY activity

The term DIY has been associated with consumers since the early twentieth century. One of the modern DIY communities can be traced back to the 1920s when a group of radio hobbyists used self-recorded handbooks and collaborative group discussions to complete their projects [Har-

ing, 2007]. In the 1950s, the concept of DIY had been commonly applied in more fields as a trend of people undertaking home improvement and small crafting projects for cost-saving and creative recreation [McKellar and Sparke, 2004].

In the 1990s, the hacker culture was formed alongside with the explosion of technology and the growing interest people began to show in computers. Computer hobbyists created forums and organizations to share ideas, solve problems, and advance their knowledge [McKay, 1998]. Nowadays, DIY culture is regarded as a symbol of innovation, creativity, and anti-consumerism as people can create what they want by themselves.

Background of the study

Even though the DIY culture is playing a critical role in the industry, DIY activities on mobile platforms have not been extensively and systematically prompted and investigated in academic research. Early academic research investigated the relationship between DIY and conventional non-DIY segments, while recent research paid more attention to motivations and outcomes for DIY activities, and benefits of these behaviors on the growth of relevant industries [Bush et al., 1987][Swartzlander and Bowers, 1989]. With the help of modern digital technologies like the Internet, the effort required to share and get knowledge is significantly reduced, as a previous study indicated that DIY activities were enabled but limited by ecosystems of industrial actors and individuals [Mellis and Buechley, 2014]. Websites like Instructables[1] focusing on text-based DIY tutorials have been established, modern video platforms like YouTube[2] also provide tutorial authors chances to publish their video-based tutorials and increase the opportunity to let people get in touch with the concept of DIY. In this case, interests in DIY activities have been triggered in the past years. During the COVID-19 pandemic, worldwide quarantine measures resulted in a peak of DIY-related searches. After the pandemic, the search volume is still at a high level. Figure 1.1 visualizes the trend of DIY interest on the internet over the past decades.

[1] https://www.instructables.com
[2] https://www.youtube.com

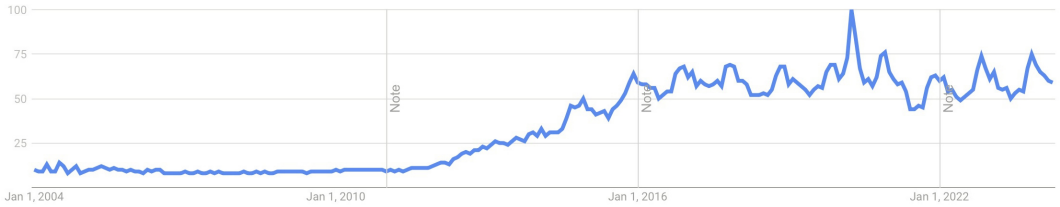

Figure 1.1: The count of searches of the keyword "DIY" in Google Trend Germany from 01/01/2004 to 04/22/2024 [a]. From 2004 to 2011 the amount of searches fluctuated between 10% to 20% compared to the peak in April 2020, then reduced to around 55%.

[a]https://trends.google.com/trends/explore?date=all&geo=DE&q=diy&hl=en Accessed on 04/22/2024

Previous studies showed the potential to improve the quality of learning outcomes with multimedia platforms

The use of multimedia tools to support learning provides positive impacts and unique benefits on work practices, changing the way that individuals create, perform, present, and share their works [Fauchart et al., 2022]. According to the cognitive theory of multimedia learning [Mayer, 2005], multimedia learning stimulates continuously through both visual and auditory senses which improves users' motivation and satisfaction with the learning experience. Besides, recent studies have indicated that the development of digital technologies, as well as multimedia tools, strongly affects creative work in fields of design and arts [Orlikowski, 2000]. Furthermore, studies in the field of education have demonstrated that video-based tutorials can outperform face-to-face learning in certain situations [Noetel et al., 2021]. The potential reasons for outperforming are that users can manage the content at their own pace using pausing and rewinding as well as the author's ability to edit content to optimize the cognitive workload of users.

The lack of optimization for mobile platforms

However, the relationship between mobile multimedia tools and DIY has not been fundamentally investigated in previous studies. Meanwhile, platforms like Instagram[3] and TikTok[4] are consuming a significant portion of our daily time [Southern et al., 2021], revealing the fact that it is necessary to investigate how multimedia tools modulate the DIY experience, especially with the combination of mo-

[3]https://www.instagram.com
[4]https://www.tiktok.com

bile platforms.

Mainstream media platforms attempt to adapt to more mobile-friendly interfaces. When it comes to DIY tutorials, few platforms focus specifically on this concept, and they rarely take advantages of the cognitive theory and interactive elements. Instead, these platforms simply adapt the content from their web version for mobile use.

Currently, most DIY tutorials, whether video-based or text-based, are presented in a linear form, which may not always have a positive effect on learning. While adding interactive elements, can potentially achieve better outcomes and enhance user experience [Zhang et al., 2006].

The purpose of the study

In this thesis, we explored how to integrate interactive elements within a mobile-friendly interface for DIY tutorials. We aimed to achieve this by reviewing previous works on DIY tutorial design and guidelines for integrating interactive features. Getting insights from these reviews, we proceeded to develop a prototype that embodies the proposed approach.

The goals of this study are twofold: firstly, to get a deeper understanding of users' action patterns within the newly developed mobile interface; and secondly, to gain feedback from users regarding the usability and effectiveness of the prototype. By evaluating these insights, we aimed to provide robust guidelines for further development and contribute to improving the quality of interactive DIY tutorials.

Chapter 2

Related work

As discussed in the first chapter, DIY activity has a rich history and a variety of studies have been done in this field. In this section, we dived into three key aspects relevant to our study: the impact of multimedia tools in education, methods of crafting DIY tutorials, and the integration of interactive elements into tutorials. These aspects provide essential background and theoretical support for understanding how to design and develop DIY tutorials on mobile platforms.

By comprehensively presenting these three key aspects, we aimed to provide theoretical foundations and basic background knowledge required for the subsequent chapters of our research.

2.1 Use of Multimedia Platforms

2.1.1 Use and Gratification Theory

Use and gratification theory as theoretical background for using multimedia platforms

In terms of the theoretical background of using mobile multimedia platforms, a theory has been proposed to explain diverse media use practices, so-called the use and gratification theory [Katz and Foulkes, 1962], guiding the assessment of motivations of using multimedia [Stafford et al.,

2004]. In detail, this theory is based on social and psychological origins of needs, which inspire expectations of the media, leading to corresponding media exposure, which results in need gratifications. It also focuses on the mechanism of need satisfaction and gratification while using media [Katz et al., 1973]. This theory highlights that people tend to use varied media sources to satisfy particular needs and personal aspirations. The use and gratification theory has been extensively used to analyze motives and ways people use multimedia platforms [Phua et al., 2017].

2.1.2 Use of Mobile Multimedia Tools

The role of multimedia tools use has been investigated by previous studies with different purposes. Specifically, some researchers investigated reasons why people use multimedia [Best et al., 2014]. Some research explored the role of multimedia use in different views. For instance, Scott's team has applied person-oriented approaches to examine user profiles among different multimedia platforms [Scott et al., 2017].

Different purposes for using conventional and mobile media resources

Compared to conventional media resources, mobile media users prefer to be self-publishing consumers. Recent studies indicated that users' motivations, including self-expression, social interaction, and escapism, are significantly modulated by the use of online social media platforms [Omar and Dequan, 2020]. Furthermore, another study proposed several motives explaining reasons why Chinese users use TikTok, including trendiness, novelty, and socially rewarding self-presentation [Scherr and Wang, 2021].

Internal factors for using mobile media resources

Similar to properties of DIY behaviors, the use of multimedia is modulated by internal factors (e.g., age and gender), which have been revealed by previous studies [Swartzlander and Bowers, 1989]. For example, researchers indicated that female users had more frequent use of social media compared to male users, as well as more frequent use of Facebook observed among younger people than elderly people [McAndrew and Jeong, 2012]. Besides, a re-

cent study revealed that there was a gender difference for the addictive escapism [Scherr and Wang, 2021].

2.1.3 Multimedia Learning in Education

Advantages of using multimedia platforms to support study

The effectiveness of multimedia platforms in supporting learning has been validated by previous studies. Users get several benefits, including flexibility in time and location, collaborative environments, and unlimited access to learning materials. Moreover, tutorial authors also get unique advantages such as cost and time-saving, as well as the ability to update and maintain their content in a timely and efficient manner [Baloian et al., 2000] [Kumar et al., 2002] [Zhang et al., 2006].

Multimedia learning materials can activate more frameworks of our brain

According to the cognitive theory, various forms of multimedia learning materials, including video-based learning material, face-to-face sessions, and video conferences have been shown to activate our cognitive infrastructure. While it triggers both the auditory and visual framework of our brain, multimedia learning is more efficient compared to forms that only use one of these neurological frameworks [Mayer, 2005].

Online learning improves the study outcome of students

Besides, another study indicated that online remote learning platforms help students independently identify, access, evaluate, and use information resources for their self-directed learning [Ladell-Thomas, 2012], which is driven by self-reference, a psychological effect that people tend to show biases toward self-related information while cognitive processing, resulting in better performance in perception, attention, and decision making [Sui and Humphreys, 2015][Sui and Humphreys, 2017].

Benefits of video-based learning materials

Among these platforms, the video-based platform has shown its benefits by triggering students' motivation and satisfaction as it offers them opportunities to control their learning pace, resulting in several benefits [Schneider et al., 2018][Noetel et al., 2021]:

- Providing a sensory learning environment to help

users get more information and better memorization.

- Improving students' motivation and adjusting their cognitive load through perceived control.
- Improving students' autonomy and self-direction.
- Mitigating the perceived and real cognitive load via own content choice and control.

To be more specific, the video format offers interactive functionalities that enhance the learning experience. Users can pause at any point to make personal notes, utilize the playback function to rewind difficult sections, and skip through the content that they find relatively easy. This flexibility allows users to adjust the learning pace to their individual cognitive needs, improving the overall learning experience [Noetel et al., 2021].

Unique benefits of text-based learning materials

While video tutorials provide unique benefits, certain types of information may be more effectively conveyed by text. Research conducted by Breimer's team, for example, shows that to finish a specific task, the average completion time for users who only relied on video-based instruction took nearly twice as long compared to the duration of the text-based group. Moreover, the completion time was almost double compared to the instructional video content[Breimer et al., 2012]. The potential reason is that when tutorials show the exact process of how to complete a certain task, most users frequently pause and rewind which slows the progress. Their observation indicated a further fact that users often watch only a portion of the video before attempting the task themselves, then use the video afterward as a reference to verify their results.

Combining text-based and video-based content to improve study experience

Moreover, studies have shown that combining text and video content can enhance the effectiveness of multimedia learning. For example, using simple texts alongside video content to highlight important details or present the text as a supplement to video content at the same time can improve comprehension and retention [Zheng et al., 2023].

Therefore, in our prototype, the integration of text and video content was an important focus. We analyzed the

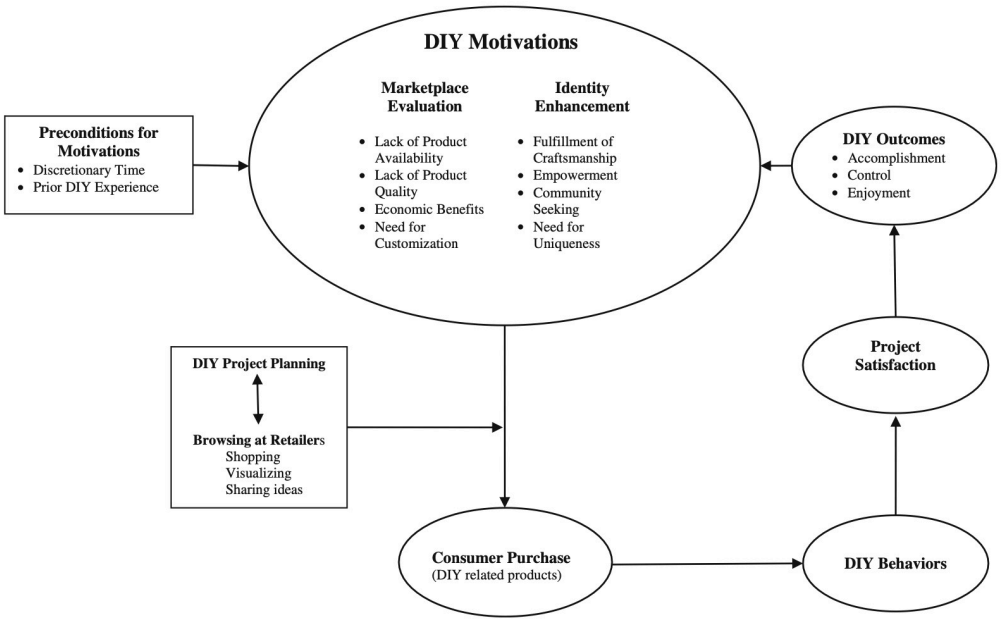

Figure 2.1: Chart visualizes the conceptual model of motivations and outcomes of DIY activities [Wolf and McQuitty, 2011].

feedback to determine which types of content are best suited for video-based design and which are more effectively presented in text-based design.

2.2 How to Make Proper DIY Tutorials?

Two aspects are further explored in this chapter. Firstly, the underlying reasons why people engage in DIY activities are discussed. Secondly, we drew upon the research findings of others to highlight key considerations when crafting DIY tutorials. Based on this discussion, we aimed to present the foundation for designing and producing high-quality DIY tutorials.

2.2.1 Motivations of DIY Crafting

To design an effective and comprehensive DIY tutorial, it

Motivations behind DIY activities

is important to understand motivations driving individuals to make DIY projects. Research conducted by Wolf's team explored general reasons about why consumers do DIY activities and benefits they can get from different aspects. Figure 2.1 illustrates the conceptual model describing motivations and outcomes of DIY behaviors. In their research, they identified two main categories of user motivation.

Explanation of "Marketplace evaluation"

The first one, called "Marketplace evaluation", suggests that the DIY behavior is influenced by four parameters [Wolf and McQuitty, 2011]:

- **Economic benefits**: Economic saving plays an important role in motivating people to do DIY activities. Many DIYers compare the cost of professional services and decide to do the craft by themselves to save money. Some DIYers use this saving to enhance their result or support their future DIY activities. Income's impact on DIY varies, with some studies demonstrating a positive correlation [Bogdon, 1996] while others show a negative one [Williams, 2004]. This suggests income does not determine the DIY motivation alone. People think wise spending, rather than the general income level, is the driving force behind their DIY activities.
- **Lack of product quality**: People may feel that the professional service they pay for does not meet their quality expectations.
- **Lack of product availability**: Product scarcity can occur during high-demand periods in the market, leading to a shortage of professional services. This can be problematic for individuals when they need assistance with small tasks, as professionals may prioritize larger and more profitable jobs.
- **Need for customization**: DIY activities provide a chance for individuals to satisfy their unique requirements through product personalization. By doing DIY activities, users gain control over the crafting process and can modify products to their personal needs without relying on third-party services.

Explanation of "Identity enhancement"

The second one is called "Identity enhancement", which implies the enhancement and maintenance of users' identities. This can be further categorized into four aspects [Wolf and McQuitty, 2011]:

- **Empowerment**: By completing a DIY project, users can experience a sense of empowerment and are motivated to finish further projects. The confidence is also enhanced as they finish more projects, especially among female DIYers.
- **Fulfillment of craftsmanship**: Unlike female DIYers, male DIYers prefer to treat their results as a reflection of their abilities as craftsmen.
- **Community seeking**: As users finish DIY projects, they feel more connected with other members of the DIY community. This can also provide them with more opportunities to build up social networks and share their ideas.
- **Need for uniqueness**: By crafting unique items through DIY activities, users can differentiate themselves and reduce the possibility of being similar to others.

After discussing motivations behind DIY activities, it is essential to take a closer look at specific reasons about why people search for DIY tutorials.

The utilization of tutorials by users

The research conducted by Tseng's team explored the utilization of tutorials by users. In their research, they discussed reasons why individuals check a tutorial. Their findings reveal that the majority of users search tutorials for inspiration and ideas for their projects, followed closely behind are those seeking to learn specific techniques and people looking for projects to recreate. Their results indicate that there is no significant difference in how users rank these three reasons based on internal factors such as their age or gender [Tseng and Resnick, 2014]. Figure 2.2 illustrates the result in detail.

Previous DIY experience influences the utilization of tutorials

However, previous experience with DIY tutorial creation

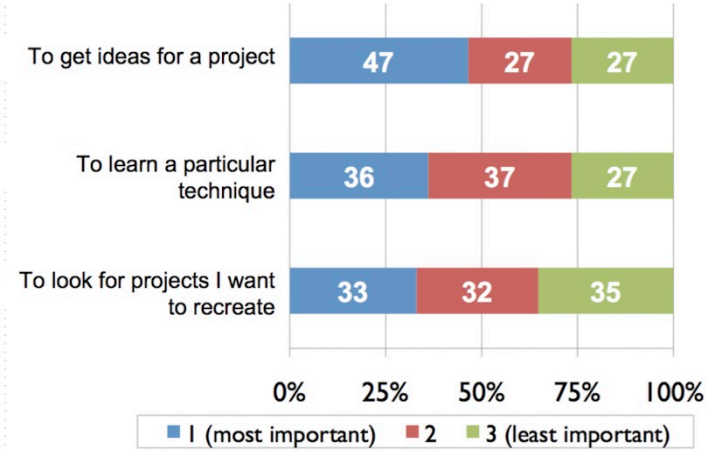

Figure 2.2: Results of asking people to rank the importance of reasons why they check a tutorial [Tseng and Resnick, 2014].

does influence the ranking of these reasons. Individuals with no prior experience place greater importance on learning new techniques, while those who have authored tutorials before consider this reason to be less significant. Additionally, individuals who view tutorials more frequently tend to prioritize the reason for seeking inspiration and ideas over those who have less frequency in reviewing tutoring resources online [Tseng and Resnick, 2014].

2.2.2 DIY Tutorial Design

For most tutorial authors, designing a tutorial and relevant documentation are separate and sometimes conflicting processes [Tseng and Resnick, 2014]. A tutorial serves not only to convey the necessary information for users to recreate but also requires authors to consider various aspects to create a more effective and clear content structure.

Wakkary's team conducted a review of ten online tutorials to examine their quality. They categorized the main problem of these tutorials into three aspects [Wakkary et al., 2015]:

The influence of competence, components, and tools on tutorial creation

Firstly, the competence, components, and tools required for a tutorial are interconnected. An unclear presentation of this information can lead to inconsistencies. For example, tools are only useful if the user has the skill to use them properly, which affects the integration of components. Meanwhile, predicting users' ability and their available tools can be challenging. Tutorials can solve this issue by providing explicit guidance on needed skills. Besides, the skill level of the user is also hard to estimate, some tutorials explicitly mention the expected skill level, while others assume this competence, leading to potential problems.

The influence of sequencing of tutorial content on tutorial creation

Secondly, the sequencing of tutorial content holds significant importance. Authors need to organize sub-tasks in a correct order to describe their story clearly from the beginning to the end. Throughout their study, several issues were discovered. These include large gaps between subtasks, hindering clear progression. Additionally, containing overloaded information within a single sub-task can make the tutorial more difficult to follow. Furthermore, integrating additional materials with different styles, terminology, and context can lead to disruption to the consistency of the tutorial, creating a cumbersome experience for users.

The influence of effective communication on tutorial creation

Lastly, effective communication in tutorials plays an important role, this involves proper utilization of texts, images, and videos. Inconsistent presentation of videos can hinder user's comprehension, while tutorials relying only on text may lack visual aids necessary for spatial-orientated tasks. Poorly utilized images, such as inconsistent orientation and lack of annotations can also reduce understanding and make tutorials hard to follow. The sequence and alignment of images with textual descriptions are important for clarity as well. Applying formatting techniques such as column and row alignment can improve content clarity.

Three key aspects authors should pay attention to while creating tutorials

To address issues described above and enhance the quality of tutorials, Wakkary's team proposed guidelines which can be outlined into three aspects: accuracy for credibility, targeting competence and tools appropriately for the user, and improving communication through clear formatting [Wakkary et al., 2015].

Authors overlook while documenting tutorial, which results in recreations of the process

Tseng's study takes another look from the author's side when they document a tutorial. Their results show that while solving a problem, documentation can easily be overlooked due to the limited attention of the author. Some authors, realizing they forgot to document a certain step after completing their tutorials, would recreate their project only for documentation purposes. Though this reconstruction can increase the awareness of what needs to be documented, this approach is only practical for projects that could be easily rebuilt [Tseng and Resnick, 2014].

To distinguish between the product design and the documentation, the most efficient method is to recreate the project. Some authors edit out the extra information to make steps concise and omit mistakes they made during the design process. Others include mistakes and changes to draw a more realistic picture. Though revealing mistakes could risk damaging the author's reputation in the community, it will provide useful information for users to avoid the same mistakes [Tseng and Resnick, 2014].

2.3 Video Interaction Enhancement

Interactive materials improve the learning experience further

Adding interactive elements into tutorials offers several advantages. Various research has indicated that combined with interactive elements, users' motivation, satisfaction, and performance in learning are improved. By allowing users to act independently, adapt their cognitive load, and proceed at their own pace, interactive videos facilitate differentiated and personalized learning. Interactive materials enhance users' satisfaction with the educational process and transfer passive observers into active participants in their learning processes [Noetel et al., 2021] [Poquet et al., 2018].

Two types of learning interactivity

A previous study shows that there are two types of learning interactivity. The first one, functional interactivity, refers to users' actions. The second one is called cognitive interactivity, which triggers cognitive and meta-cognitive processes of users. Both interactivity layers have significant influences on study efficiency [Palaigeorgiou et al., 2019].

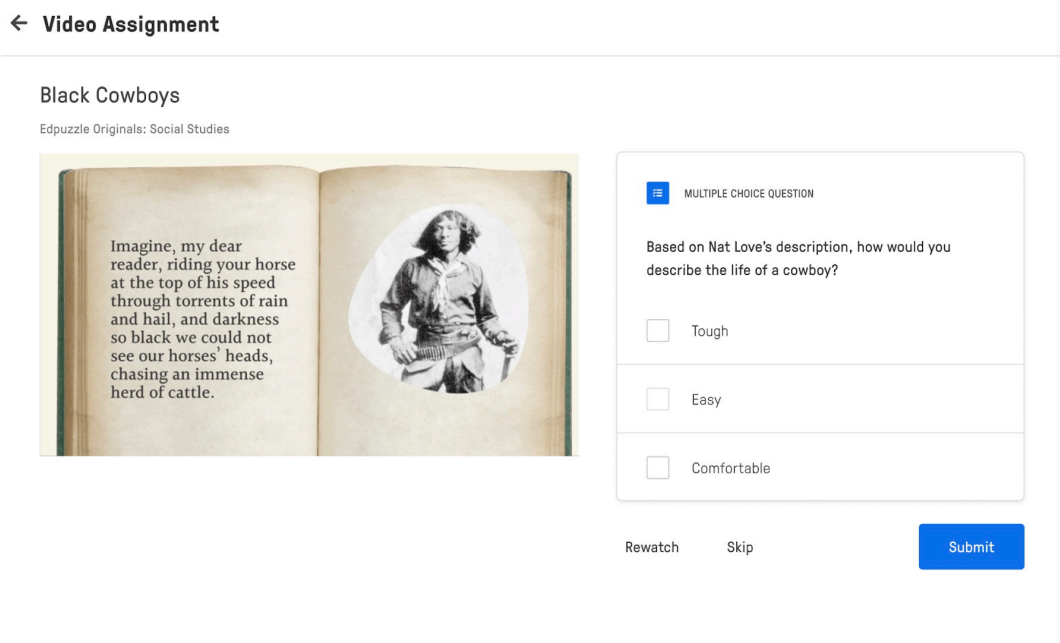

Figure 2.3: An example of integrating embedded question alongside with the video content [a]. Users can answer questions by selecting the choice on the right side while the video content paused.

[a] https://edpuzzle.com/ Accessed on 05/05/2024

Interactive elements can reduce the negative effect of limited attention of users

Moreover, one key assumption of the cognitive learning model is that users have limited and selective attention [Mayer, 2005]. With the availability of more interactive media, users will get a more flexible experience and the content can meet individual's needs better. Based on this, Zhang's study assumes that an instructional method that offers a wider variety of interactions and richer media should be more effective [Zhang et al., 2006].

Palaigeorgiou's team provided design guidelines for interactive videos in 2019. In their guidelines, eighteen studies with additional commercial video platforms were analyzed to classify interactive elements within the video into five categories [Palaigeorgiou et al., 2019]:

Author's annotations as interactive elements

The first category coming from the author's view is often seen as author's annotations. In interactive videos, authors use images or texts to facilitate user's understanding ef-

fort, these elements are usually synced with the video content. Adding these elements statically or dynamically can increase user's engagement with the content they perceive. Commonly used elements are [Palaigeorgiou et al., 2019]:

- **Element Overlay**: Elements that are added over videos (texts, images, hyperlinks, maps, and additional audio files), synchronized with specific frames. Compared with video content, they are relatively easier to edit and can be applied for different learning purposes [Giannakos et al., 2015][Meixner and Kosch, 2013].
- **Side Media**: Elements that are added side-by-side to synchronized video content. They can support content visualized through the video section without altering the layout of the original video [Onita et al., 2016].
- **Highlight**: By adding pointers or objects over the video to get users' attention directly, this kind of element lets users focus and encourages them to think about the highlighted information [Onita et al., 2016].
- **Captions**: Considering the diversity of users, providing captions can match their different cultural backgrounds. On the other hand, the use of captions has been reported as having no positive results on learning results when users are familiar with the language [Giannakos et al., 2015] [Poquet et al., 2018].
- **Embedded questions**: This is commonly used for educational interactive videos, forms deeper engagement for users, this can also assess the quality of learning outcomes. Figure 2.3 shows an example from Edpuzzle [Shroff et al., 2010].
- **Hotspots**: Clickable areas like extra buttons within a video frame can provide additional information, and direct users to different video sections or external links. This element can enable direct interactivity to the video content.

User's annotations as interactive elements

Different from author's annotations, user's annotations are

treated as a presentation of the ability to create a personalized experience. Elements such as personal notes, annotations, or personal marks can enhance the engagement of users [Bulterman, 2004].

Between-user interactions as interactive elements

In addition to user's annotations, synchronous and asynchronous between-user interactions can also enhance user engagement during video watching. These interactions can enhance users' sense of being part of a community and their confidence in helping each other for better success. Some videos visualize users' traces on the progress bar so that other users know which section might be more important for the whole video. Peer interactions like comment sections, annotations, and assessments are also examples of this concept [Palaigeorgiou et al., 2019].

Video summarizations as interactive elements

Video summarization is a technique that can boost user engagement with the video content by creating short clips or textual outlines of the entire video. These summaries help to sort out information for users and accelerate the speed when users try to review specific content. Summarizations can be done automatically, using text extraction or image processing, or non-automatically, where users select specific parts manually. The non-automatic method requires users to thoughtfully connect different video segments and is considered as a constructive and knowledge-building method [Palaigeorgiou et al., 2019].

The last category is navigation throughout the video watching. Mexiner's team classified video navigation into two categories: End-of-video navigation and Global navigation [Meixner and Gold, 2016].

End-of-video navigation typically appears when a video section ends, offering possible actions like viewing related videos or replaying the current section. Global navigations usually are features that allow users to quickly and accurately access a specific section of the video, such as a content table or a search function.

Video navigation as interactive elements

Video navigation features can be realized by using the following designs [Palaigeorgiou et al., 2019]:

Figure 2.4: An example of content visualization while browsing [Al Hajri et al., 2013]. Key frames are showed on the progress bar to help users navigate.

- **Content table**: Navigating on the progress bar can sometimes take too much time. Using a specific content table can offer users quick access to different video sections which are presented as keywords in the table, this can also help users to have a better overview of the project structure [Herron, 1994].
- **Content visualization while browsing**: Different from the content table, this method uses representative frames to indicate users. It is more intuitive for users to change sections using visual information. An example is shown in Figure 2.4 [Hürst and Darzentas, 2012].
- **History browser**: Based on users' view history, this method can help users directly go back to previously watched sections by combining with recorded users' actions [Meixner and Kosch, 2013].
- **Search function**: This allows users to navigate to certain video sections based on their input. It requires extra pre-processing of the video content and extracts meta-data for later search [Meixner, 2014].
- **Multiple viewpoints**: By providing multiple viewpoints, interactive video can provide users the chance to watch certain processes from different angles, providing a more personalized experience [Zhang et al., 2017].
- **Speed control**: The most common use case is changing the speed of playback/forward, this can help users to set a certain view speed to adapt the video content to their prior understanding [Seidel, 2015].
- **Branching**: Video content in a tree structure can let users personalize the route they want to follow for the

watching. It enables users to control their experience, skip certain content, and explore information at their own pace, resulting in a unique version for each user [Meixner et al., 2015].

Different interactive elements can improve different aspects of the learning experience

Different interaction elements in interactive videos can stimulate different kinds of cognitive and meta-cognitive processes, which lead to different educational values. Interactive elements like highlighting and hotspots direct users' attention to important information. Embedded questions and replay enhance the information recall for users, improve the quality of learning outcomes, and challenge their existing understanding, causing cognitive conflicts. By sharing annotations and comments, learning experiences are facilitated among users and activate collective intelligence and critical thinking. Figure 2.5 outlines the benefit for each kind of interactive element [Palaigeorgiou et al., 2019].

Interaction types	Active studying	Attention	Information recall	Reflection	Knowledge construction	Cognitive conflict	Collaboration
Creator's annotations							
Overlay elements		X			X		
Highlights		X			X		
Hotspots	X	X					
Clickable elements		X			X		
Side media					X	X	
Embedded questions			X	X	X	X	
User's annotations							
Overlay elements	X		X	X			X
Highlights	X		X	X			X
Linked comments	X		X	X			X
Between users' interactions							
Discussions around content	X		X	X		X	X
Pop-ups	X						X
Comment ratings	X						X
User traces	X			X			X
Video summarisation							
Automatic summarization			X				
Non automatic summarization	X			X			
Video navigation							
Table of contents	X				X		
Contents visualization	X				X		
Search function	X				X		
History browser	X		X				
Multicamera – 360° video	X				X		
Playback speed	X				X		
Branching	X				X		

Figure 2.5: Educational benefits for different elements [Palaigeorgiou et al., 2019].

Chapter 3

Prototype Design

The increasing popularity of DIY culture and the daily use of mobile applications have led to a potential demand for interactive DIY tutorial platforms tailored for mobile platforms. However, the relationship between DIY activities and novel media resources, especially the way via mobile platforms, has not been extensively investigated. In other words, it remains unclear how the development of mobile applications modulates the way people get information for DIY activities.

Our prototype tries to solve the gap between the popularity of the DIY concept and the lack of a interactive mobile platform

In response to this kind of gap, this study analyzes the structure of existing DIY tutorials, both in video and textual formats, and generates design principles to develop a prototype of an interactive DIY tutorial optimized for mobile platforms. By combining insights from previous research with guidelines for integrating interactive elements, this study aims to enhance the accessibility, usability, and effectiveness of DIY tutorials for mobile users.

3.1 Existing Tutorial Formats

Before video-based format became the mainstream for media content, text-based tutorials were widely used. These text-based tutorials often used representative image frames

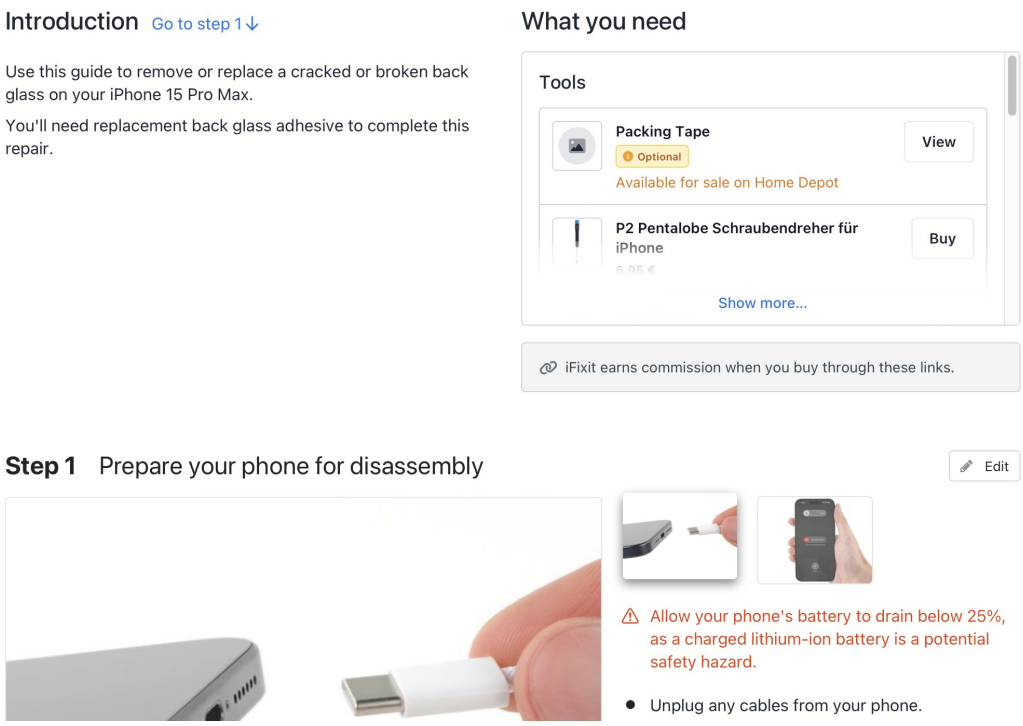

Figure 3.1: Text-based tutorial from iFixit [a].

[a] https://www.ifixit.com/Device/iPhone_15_Pro_Max. Accessed on 05/06/2024

to provide step-by-step instructions to users. Here is an example of a text-based tutorial, which is illustrated in Figure 3.1.

Basic characteristics of the text-based tutorial

The main characteristics of this format can be summarized as follows:

- **Textual instructions with key-frame pictures**: Authors combine several representative frames taken from the DIY process alongside textual instruction of actions users need to perform. These textual descriptions remain consistent across multiple images within a step, focusing on the overall step rather than explaining a specific image.
- **Colors for highlighting**: Diverse colors are used to separate different content and provide additional information to users. Aiming to highlight important

parts or interesting sections the author thinks users should pay more attention to while replicating this step.

- **Linear structure**: The structure of text-based tutorials typically follows a linear process, exceptional situations or additional materials are directly integrated into the text of certain steps. Related text is presented below the related section.

- **Navigation method**: Given the linear format, users navigate through the tutorial mainly by scrolling between each step and clicking images using a mouse. They can locate their desired sections by referencing pictures or step numbers/names.

Video-based tutorials become trendy in recent decades because of their unique benefits

With technology improvement and users changing their preferences, different content formats have been developed in the past decade. While text-based tutorials have been effective in covering information, there has been a transition to video format in recent years.

Video-based tutorials provide a straightforward way to present information with a sense of motion, allowing users to visually learn each step of the process in action, providing an enhanced experience with a sense of self-presence [Buch et al., 2014]. Therefore, they have become increasingly popular in DIY communities.

Lack of tutorial platforms that specifically optimized for interactive elements

However, the number of platforms specifically focusing on interactive DIY tutorials, still remains low. Therefore, authors prefer to upload their video tutorials to general video platforms like YouTube to have more exposure to users. In this way, it is easier for users to get information regarding DIY activities. However, these platforms lack functions of allowing users to interact with the video, which limits their chance to provide feedback about DIY tutorials, as well as the limited sense of interaction and self-presence.

Basic characteristics of the video-based tutorial

Figure 3.2 shows an example of a video-based tutorial sourced from a commonly used video platform. Video-based tutorials have the following characteristics:

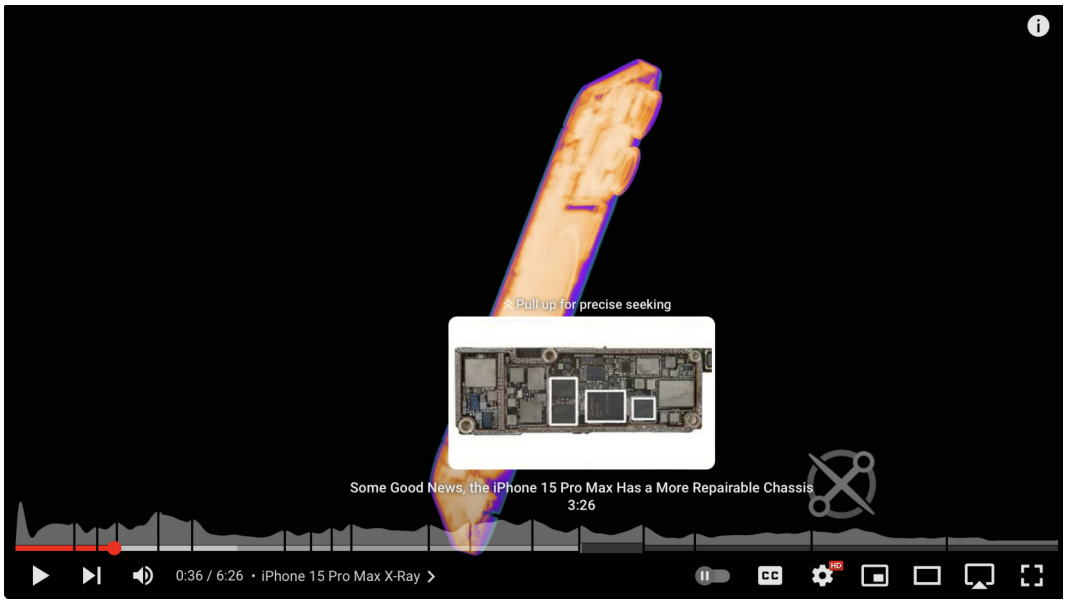

Figure 3.2: Video-based tutorial from iFixit on YouTube [a].

[a] https://www.youtube.com/watch?v=hmQHgWNAg24&t=4s. Accessed on 05/10/2024

- **Keyword instructions combined with audio and video content**: Different from text-based tutorials, the author typically provides short text descriptions to give users a rough understanding of each step. Since audio and video content deliver author's instruction directly and in detail, text annotation is usually used as a minor supplement to the tutorial rather than the primary mode of delivering instruction.

- **Interactive elements**: Video-based tutorials often integrate interactive features provided by the video platform. These features include options to pause/play, fast-forward/rewind, or adjust the play speed of the video content to help users create their own viewing pace.

- **Linear structure**: Similar to text-based tutorials, the structure of video-based tutorials also follows a linear structure, exceptional situations or additional materials are added to the video content together in a linear sequence.

- **Navigation method**: The navigation for most video

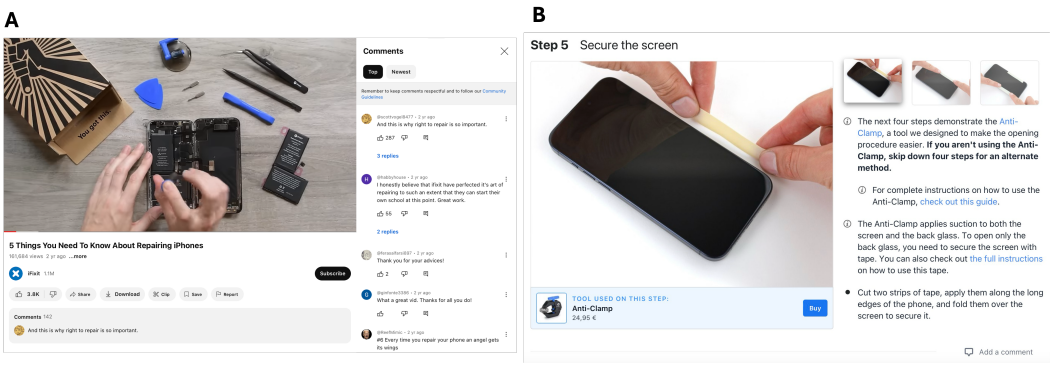

Figure 3.3: Tutorial content in different forms. (A) video-based DIY tutorial for repairing phones [a], (B) text-based DIY tutorial for the similar content [b].

[a] https://www.youtube.com/watch?v=LGDHU0qTsWg&t=13s Accessed on 05/10/2024
[b] https://www.ifixit.com/Device/iPhone_15_Pro_Max Accessed on 05/10/2024

platforms uses the content visualization while browsing method as mentioned in Section 2.3. Key frames combined with the section name are presented on the progress bar, allowing users to navigate through the tutorial by dragging their mouse on the progress bar.

Before designing a prototype for the mobile platform, it is necessary to identify common elements from both text-based tutorials and video-based tutorials. These common components will form foundational elements of our prototype, ensuring its usability.

Essential elements from text-based and video-based tutorials

Figure 3.3 illustrates tutorials presented in different forms, by putting them side by side, the main common parts of tutorials can be summarized into four categories:

- **Visual content section**: This section is used to showcase the main content of the DIY tutorial, including textual instructions, images, and videos. In a text-based tutorial, this part consists of pictures author selected, while in a video tutorial is the video itself.
- **Instruction section**: This section provides detailed guidance to help users complete each step. In the text-based tutorial, this is the textual description for each

step. In the video-based tutorial, it will be author's voice instructions combined with textual annotations within the video.

- **Navigation indicator**: This section allows users to navigate through the tutorial to find desired sections quickly. In the text-based tutorial, it can be a content table. In the video-based tutorial, it is usually integrated into the progress bar.
- **Comment section**: This section provides a space for between-user interactions and discussions, where users can share their experiences, ask questions, or engage themselves with others. This helps build community and provides additional support.

Designing on mobile platforms is different compare to desktops

Since most existing platforms are designed mainly for desktops, it is necessary to implement appropriate adaptions when designing these elements for mobile platforms. Mobile devices have varied resolutions and aspect ratios, requiring additional adjustments to ensure optimal user experience.

3.2 Prototype Design

Our prototype was built on Figma[1]. In terms of designing our prototype for mobile platforms, we aimed to adapt essential elements identified in section 3.1 to ensure a decent user experience on smaller, touch-based interfaces. The development of user interfaces (UIs) is one of the most critical and time-consuming steps in the creation of a platform [Desolda et al., 2017]. This section explains key considerations and design decisions in detail that guided the development of our prototype. When we designed the prototype, guidelines for creating interactive video from Section 2.3 were considered.

Considerations of placing video content

The first part to address was the placement and presentation of our video content on the mobile platform: To

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

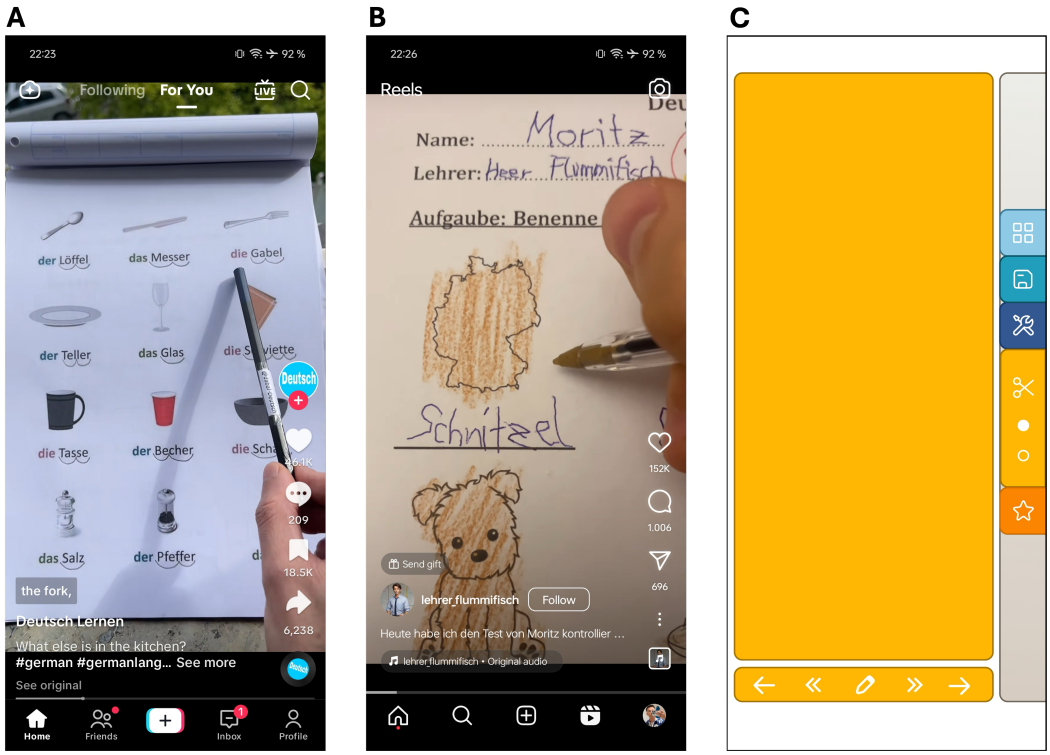

Figure 3.4: User interfaces of well-established mobile video applications like (A) TikTok [dabal, 2024], (B) Instagram Reels [Flummifisch, 2024] and (C) shows the basic structure of our prototype.

achieve this, we analyzed the basic design structure of some well-established mobile video applications such as TikTok and Instagram Reels. Figure 3.4 illustrates screenshots from both mentioned platforms, and highlights their interface design.

Due to the form factor, most video clips designed for mobile platforms are recorded in the vertical direction, as opposed to the horizontal orientation commonly used for desktop applications. Therefore, the content space in our prototype was set in a vertical direction (See Figure 3.4 (C)).

Different kinds of content pages in our prototype

Since not all content is suitable for video format, we divided the content page presented in the prototype into four different types, which are illustrated in Figure 3.5:

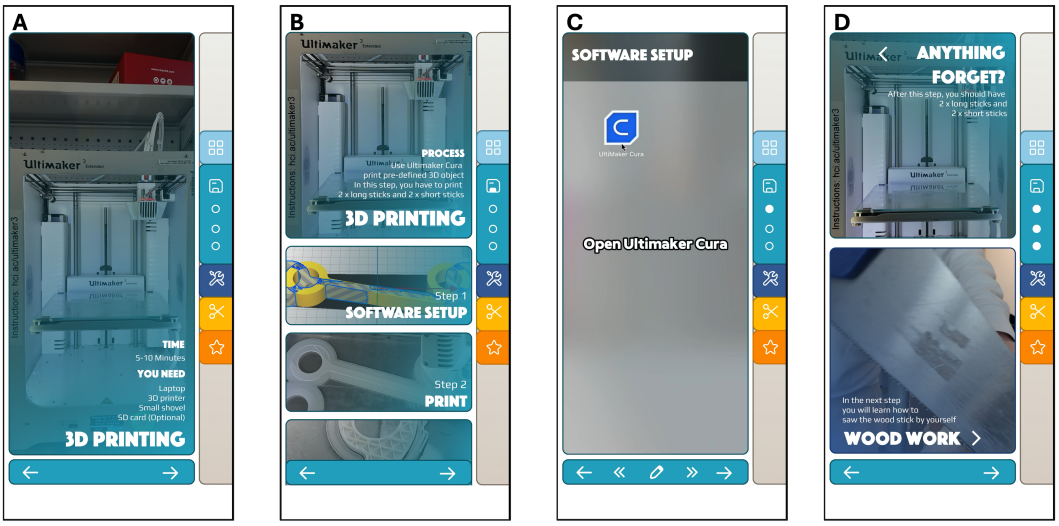

Figure 3.5: Pictures illustrate different content pages from the prototype. (A) Introduction page, (B) Navigation page, (C) Video page and (D) Summarization page.

Explanations of the introduction page

- **Introduction page**: This is the first page users will see when they enter a new chapter of the tutorial. It uses a representative frame from video clips as the background combined with the title of the chapter. Additionally, required tools and estimated time needed to complete this step based on the author's experience are also displayed in text format to give users a quick overview of the chapter (See Figure 3.5 (A)).

Explanations of the navigation page

- **Navigation page**: This page provides a more detailed view of the chapter in a list format. The first upper bigger section displays a short description of tasks in this chapter, combined with a keyframe as the background. This is followed by a list of sections within the chapter, each with its title, to help users get a quicker overview of the structure of the chapter and improve navigation usability. Users can click this list to go directly to the corresponding section (See Figure 3.5 (B)).

Explanations of the video page

- **Video page**: This page contains video clips prepared for the tutorial. Users can pause/play by tapping the video area. The title for this section is pinned to the upper left corner to help users locate which section they are currently in. Interactive elements are inte-

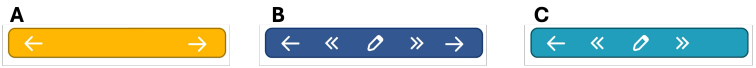

Figure 3.6: Examples of function bars from different chapters in the prototype. (A) function bar for pages does not contain video, (B) function bar on video pages, (C) function bar on extra pages.

grated mostly into the video page like hotspot buttons and live-text comments (See Figure 3.5 (C)).

- **Summarization page**: This section provides a chance for users to take a break between each chapter, it explicitly reminds users what they should have achieved in the current chapter and what to expect in the next chapter. This also provides them the chance to have a reflective pause when they replicate the tutorial (See Figure 3.5 (D)).

Explanations of the summarization page

The next step in establishing the basic framework of the prototype is to determine the location of additional function buttons. To ease the reachability, most mobile platforms tend to locate functional sections on the right and the lower side of the screen as in Figure 3.4. Following this design principle, our prototype includes two sections for additional functions.

Considerations of placing additional functions

3.2.1 Function Bar

The bar located in the lower area of the screen is called the function bar in our prototype. It adapts itself based on the type of content page mentioned in Section 3.2, and shows different functions that users can trigger based on the current content page. Figure 3.6 shows some examples of this adaption.

Adaptive design of the function bar

There are common functions that the function bar contains for all kinds of content pages, such as page movement. To reduce the chance of accidental touches, these functions are placed on the far left and right side of the function bar and

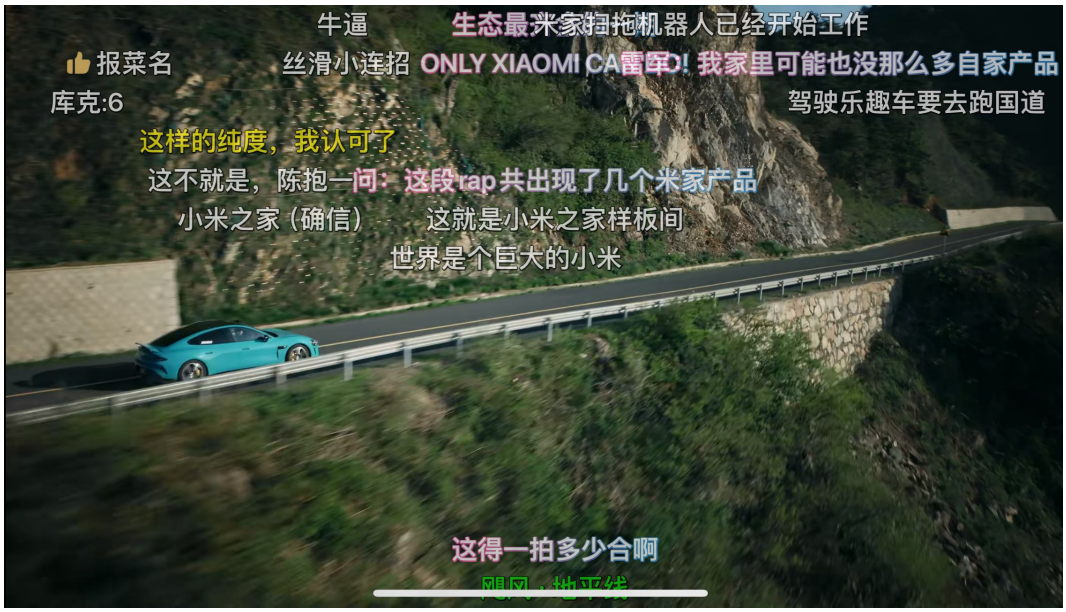

Figure 3.7: An example of video barrage [a]. When users send their comments to the video, they can also configure the color and size of their texts to show their personality.

[a] https://www.bilibili.com/video/BV1Cw4m1U7kS Accessed on 07/08/2024

are triggered by tapping the icon. For pages where moving forward is not allowed, the move forward function is disabled to constrain possible user actions and reduce their learning effort.

On video pages, additional functions will appear on the function bar. Firstly, we added common functions such as fast forward and fast backward to help users create their own pace and enhance interactivity. The pause/play function is integrated into the video section by tapping gestures.

Live-text function in the function bar

Another added function is called the live-text function, it is placed in the middle of the function bar. This function is inspired by a feature called video barrage, which has been integrated into many Asian online video platforms. Unlike traditional textual comments displayed below videos, video barrages allow users to add their comments directly to the video content with a floating text that overlaps the video. These simultaneously displayed comments can enhance users' watching experience of videos by providing

Figure 3.8: Further explanations of the live-text function. (A) idle state of the video page, (B) users click on the live-text function button, a keyboard will pop up for their input (C) after sending the comment, a notification will be shown to indicate users that their comments have been sent.

interesting and useful information from other users about the video content. Besides, recent studies also indicate that video barrages can modulate users' emotions while watching videos, showing more positive results compared to videos without video barrages [He and Muroi, 2020][Liu et al., 2021].

In our prototype, this function also serves as a between-user interaction, which according to Section 2.3, can improve the interactivity of the tutorial and improve the quality of learning outcomes. Besides, displaying users' comments directly with the video content provides the direct possibility for error correction if authors missed something when creating the tutorial. Figure 3.7 shows a video with video barrages, which was taken from a Chinese online video platform called BiliBili[2].

Further explanations of the live-text function

In our prototype, when users tap on the live-text function icon, a keyboard will first pop up and users can then type

[2]https://www.bilibili.com

any kind of comment they want, due to limitations of the prototype software, users' comments will be recorded, and added to the video content as overlap elements through video editing later. After users click the send button, a notification will pop up to indicate users that their comments will be processed, they can then close the keyboard by tapping the back button. Authors can also use this function for future add-ons without editing video clips again. To enhance the initial prototype user experience, we added some pre-defined live-text comments into the video content to let every participant experience the concept of it.

When users finish the entire tutorial, the function bar will explicitly display an icon indicating that the tutorial is finished and will hide all other functions.

3.2.2 Navigation Tab

Motivation for designing a specific navigation area

Designing tutorials on mobile platforms introduces more challenges in helping users navigate through the whole tutorial, we needed to maintain usability despite the significantly reduced screen size and touch-based interactions.

Considerations behind designing the navigation tab

One commonly used design element to solve this problem is the side menu. To overcome this issue, we used the concept of the content table and first assigned each chapter with a specific color. This color does not only show up in the navigation tab for that chapter, but it is also applied to the functional bar and as a transparent overlay on the introduction, navigation, and summarization page. This design element aims to build a stronger connection for quicker navigation. Moreover, the navigation tab for each chapter is assigned a specific icon that highlights the main task for the chapter, helping users to identify their location with the decreased width of the navigation tab when users watch the tutorial content.

Further explanation of the navigation tab

When users tap on the navigation tab, the navigation tab will expand to show more information. In the expanded view, titles of all sections within the current chapter will be displayed, while other chapters will only show their chap-

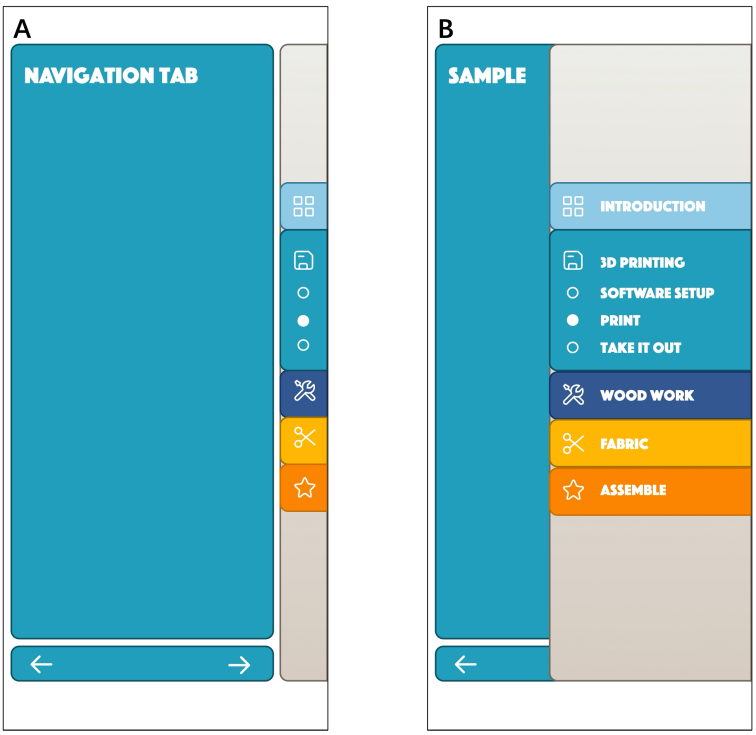

Figure 3.9: An example of the navigation tab in the prototype. (A) folded view of the navigation tab, (B) expanded view of the navigation tab.

ter titles (See Figure 3.9 (B)). Besides, to help users better locate themselves, a small white circle before section titles indicates their current position. Users can click on the section title to navigate to different sections within a chapter. If users click on other chapters' titles, they will be transferred to the navigation page of that chapter, allowing them to quickly access sections they want to review.

3.2.3 Additional Design Elements

Based on Section 2.3, additional design elements have been integrated to improve the interactivity of the prototype.

Considering different skill levels of users on DIY activities, the tutorial content was built in a tree-structure for-

Additional interactive elements integrated into our prototype

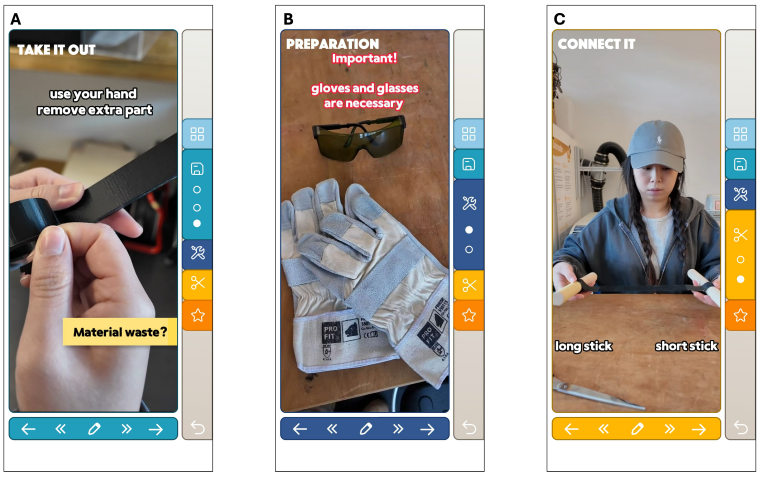

Figure 3.10: Additional design elements in the prototype. (A) hotspots as sticky notes, (B) colored keywords as warning, (C) object-tracking texts to identify specific parts.

mat. This structure allows for a more personalized and flexible learning experience. To achieve this, we integrated hotspots into the video content (See Figure 3.10 (A)), designed as yellow sticky notes overlaying video clips. These hotspots provide extra information such as commonly made mistakes or advanced steps, helping users decide whether they need to enter these extra pages. These additional materials were not presented in the navigation tab to keep the structure clear.

Sticky notes were also used to hyperlink third-party materials as supplementary media for the tutorial. For example, a sawing tutorial from YouTube[3] was linked to provide additional information.

Instead of conventional subtitles, which have been found to have no significant benefit for users already familiar with the language, we used keywords for each step that were displayed during related video content [Poquet et al., 2018]. Different colors were used to represent different types of information. Following guidelines proposed by Palaigeorgiou's team, we avoided heavy annotations and maintained a fixed position for these keywords to ensure a con-

[3]https://www.youtube.com/watch?v=xpu75Lq9aFU

sistent user experience [Palaigeorgiou et al., 2019].

To assist users in identifying specific parts the author is using, object tracking technology from video editing software was employed to visually connect the name and the actual part. Additionally, video clips from different angles were recorded to help users better understand certain steps. By integrating these elements, we aimed to create a more interactive and user-friendly experience, enhancing the overall effectiveness of the tutorial.

Chapter 4

User Study

After designing the prototype, the next important step involves conducting a user study with real users to evaluate the effectiveness, usability, and overall user experience of our mobile prototype. Actual feedback and insights were collected by recruiting participants to use the prototype, to refine and enhance our guidelines for this specific area.

4.1 Experimental Procedure and Setup

Process of our user study

The study was comprised of two main parts: participants replicated the tutorial with our prototype and previously prepared materials, followed by a 15-minute semi-structured interview.

After participants arrived, we introduced to them firstly the basic structure of the prototype and the purpose of our study. Participants were instructed to interact with the prototype we provided to build a wooden laptop stand. The content presented in our prototype was pre-recorded based on a tutorial from Instructable[1] and integrated into the prototype. Participants' activities while interacting with the prototype were collected by screen recordings. For this study, participants were provided with an iPhone 11,

[1] https://www.instructables.com/Note-a-Laptop-Stand/

Figure 4.1: An example of the laptop stand made by participants during the study.

wooden sticks, fabric straps, a saw, and additional tools necessary to build the stand. 3D-printed connection parts were pre-printed to save participants' time. A detailed material list can be found in Appendix B. An example of the laptop stand made by participants is presented in Figure 4.1.

Once participants had finished the tutorial and successfully replicated it, they were given a break with a duration of 5-10 minutes, followed by a semi-structured interview. This semi-structured interview focused on various aspects. We first discussed their previous experience with DIY crafting and the type of tutorials they mainly used for DIY activities. Subsequently, we explored the concept of presenting DIY tutorials via mobile platforms and sought their expectation in this direction.

The interview about the prototype was divided into various aspects. We first talked about the overall user experience to identify which parts were most helpful or caused confusion when they used the prototype with previous ex-

planations. Then we discussed each component of the prototype in detail, including the navigation tab, the function bar, and the structural design for each content page.

4.1.1 Participants Demographics

Demographics for participants

In our study, we recruited 10 students from the university (aged M = 24.6, SD = 1.28; 4 females, 6 males). To ensure a diverse range of prior DIY knowledge, we tried to include participants from different ages and genders. An overview of the participants' demographic, and their previous DIY experience, are presented in Table 4.1.

ID	Age	Preferred Tutorial Format	Interest for Mobile Platform	Frequency of DIY crafting
1	24	Text-based	Yes	Once per year
2	24	Text-based	Yes	Every two month
3	26	Text-based	Yes	Every two month
4	23	Text-based	Not Really	Once per year
5	25	Text-based Video-based	Yes	Almost never
6	24	Video-based	Yes	Once per half year
7	23	Text-based	Yes	Every two month
8	26	Text-based	Yes	Every 3 - 4 month
9	24	Text-based	Yes	Almost never
10	27	Text-based	Yes	Once per year

Table 4.1: Participant demographic with their previous DIY experience.

Previous DIY experience of participants

Based on demographic answers, all participants had DIY crafting experience before, 8 of 10 participants had experience of assembling furniture from companies like IKEA. However, only 2 participants considered DIY crafting as one of their hobbies, while other participants treated this as an extra daily task. Therefore, the frequency of DIY crafting for 7 out of 10 participants was less than once every two months.

DIY tutorial format preference

About the tutorial formats they used for DIY crafting, text-based tutorials were still the most common. Eight participants used this as their primary tool when crafting, one participant used both text-based tutorials and video-based

tutorials, and one participant preferred video-based tutorials exclusively.

Advantages of text-based tutorials

Participants provided feedback on strengths and limitations of each format. For text-based tutorials, participants appreciated the straightforward visualization of which materials they needed to prepare before the crafting task. Combined with corresponding pictures, they can understand the result for each step clearly. Since it is divided into detailed steps, participants can follow the tutorial with its clear structure easily, which allows them to take breaks between steps.

Limitations of text-based tutorials

Limitations of text-based tutorials focused on two main parts: 5 participants encountered situations where they could not separate needed materials from other similar materials based on provided pictures. Moreover, they found that it can make the user experience confusing sometimes considering the gap between each step is relatively large.

Advantages of video-based tutorials

Although 8 of 10 participants did not choose video-based tutorials as their primary choice, they mentioned that video content could provide explanations of difficult steps in detail to create an easier learning experience compared to text-based tutorials. The main reason why they did not choose video-based tutorials was the inconvenience of carrying a laptop or tablet to view the content. Additionally, participants were accustomed to tutorials that came with the provided materials, which were typically in text format.

Discussion about designing a mobile version of DIY tutorials

When discussing the idea of transferring DIY tutorials to mobile platforms, 9 participants expressed positive opinions, while one participant was not fully supportive of this concept. Participants believed that with mobile applications, they would get more chances to view various kinds of DIY tutorials, which would increase the possibility for them to conduct something they need or to find interesting things to replicate. Meanwhile, a group of 5 participants thought this mobile DIY tutorial concept only adapts well to lightweight projects considering various limitations of mobile hardwares.

4.2 Results

Results are coded and analyzed based on screen recordings of participants interacting with the prototype and afterward semi-structured interviews.

Coding was used to analyze results from our research

Screen recordings and semi-structured interviews were evaluated via coding, which summarizes text, or visual datasets into a phrase that can summarize their essential information [Saldaña, 2021]. Process codes were used to analyze participants' action patterns. Evaluation codes were used to present positive/negative opinions and recommendations from participants.

4.2.1 Process Codes

Occurrences of process codes in analyzed segments

To understand the practical feedback of real users to our prototype, each participant's action patterns were recorded. We coded their actions to gain better insight into how participants perceived different design elements of the prototype. These codes were combined with evaluation codes in the next subsection for further evaluation. A group of 18 different codes were applied and 573 segments were coded.

The code `craft after pause` (82) implies that the basic action pattern for this tutorial prototype follows the action pattern when users watch conventional video tutorials. Participants also tried to `craft with video playing` (25). Moreover, participants preferred to `click fast backward button` (43) more often than `click fast forward button` (15). The action of skipping forward only appeared when participants navigated back to a previous section/chapter.

For the navigation through the tutorial, the most common code is `use the function bar to navigate` (143). However, participants also tried to `use the navigation tab to navigate` (64) at high frequency when the function bar was also available on every content

page. When participants were on the navigation page, they tended to `use the navigation page to navigate` (38) as the button was significantly larger than the other two methods.

For introduction pages, most of participants `read the introduction page` (28) of the first two chapters. When they saw the introduction page for later chapters, they tended to `skip the introduction page` (23) using the function bar.

Since the summarization page was set at the very last of each chapter, participants preferred to `skip the summarization page` (22) for a quicker move to the next chapter, compared to segments when participants `read the summarization page` (8), the number of segments is significantly lower than times that they skipped summarization page (8 vs. 22).

Hotspots integrated into the prototype can be divided into two categories: The first type is related to error corrections, which has been added as supplement information when error situations could occur. For most participants, this was not a mandatory action. Therefore, most of them chose to `skip error-related hotspots` (7) when they appeared, only 30% of participants did `view error-related hotspots` (3). The other type is more related to the final product after replicating the tutorial, in the prototype, there were 3 result-related hotspots. As a result, around 60% of participants did `view result-related hotspots` (17), while they tended to `skip result-related hotspots` (13) in other segments.

Though we prepared some pre-defined live-text comments into the video presented in our prototype, only 20% of participants tried to `add comments` (2) during the study via the live-text function, revealing the limited attraction of actively adding comments in the prototype.

With screen recordings, we also found conflicts between user's mental model of the prototype with our initial design. For instance, even though the bigger section on the

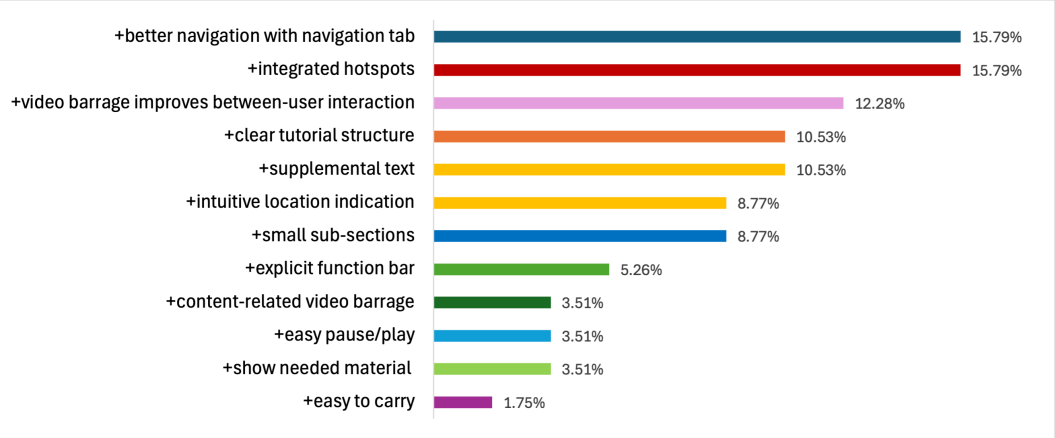

Figure 4.2: Statistic of the occurrence of positive codes in evaluated segments.

navigation page was designed to show an overview of the current chapter and was not designed to be clickable, 6 out of 10 participants did `click on non-clickable sections` (15) during the study. After realizing that clicking in the video section would pause/play the video content, participants still tended to `click video section after video finished` (25), which was regarded by participants as the link to go forward and move to the next section, while the actual function of this action in our prototype was to play the current video content again from the beginning.

4.2.2 Evaluation Codes

Evaluation codes were used to analyze users' opinions about our prototype

Evaluation codes were collected from semi-structured interviews conducted with participants after they finished the tutorial replication using our prototype. Codes used to capture positive opinions were marked as '+' codes, while those codes related to negative opinions will be recorded as '-' codes. In total, there were 57 segments coded with '+' codes and 30 segments with '-' codes.

Positive Codes

Occurrences of positive codes in analyzed segments

For the positive feedback, 12 distinct codes were used to summarize 57 positive segments. Results are shown in Figure 4.2, which visualizes the percentage of each positive code:

- Interactive elements integrated into the prototype were given positive feedback. The most prominent positive code is `+integrated hotspots` (9), mentioned by 9 participants, highlighting the utility for participants with varying skill levels. The code `+video barrage improves between-user interaction` (7) appeared 7 times. `+content-related video barrage` (2) was mentioned in 2 participants' interviews.
- The explicitly placed navigation tab and function bar also received positive impressions. One significant code, `+better navigation with navigation tab` (9), was mentioned by 9 participants, emphasizing its function in facilitating easy navigation through chapters and sections. Furthermore, `+explicit function bar` (3) was mentioned by 3 participants.
- Additionally, `+clear tutorial structure` (6) and `+supplemental text` (6) were mentioned during 6 participants' interviews. Five participants appreciated that our tutorial was divided into `+small sub-sections` (5), allowing them to pause after completing each small step.
- The code of `+intuitive location indication` (5) was noted by 5 participants, highlighting the ease of locating themselves by viewing the white dot displayed in the navigation tab.
- Other codes, such as `+show needed material` (2), and `+easy pause/play` (2) were mentioned by 2 participants. One participant noted that being`+easy to carry` (1) while crafting helped him replicate the tutorial.

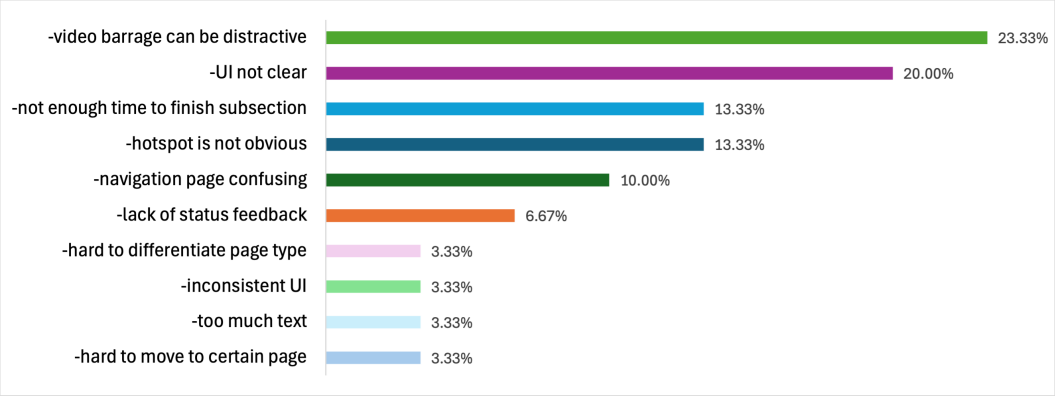

Figure 4.3: Statistic of the occurrence of negative codes in evaluated segments.

Negative Codes

Occurrences of negative codes in analyzed segments

We used 30 segments that contained negative evaluations as codes for negative feedback in this study. A visualization of negative codes and the percentage of each code is illustrated in Figure 4.3, they were summarized into 10 different codes:

- The most frequent negative code is `-video barrage can be distractive` (7), with 7 participants mentioned during their interviews.
- The code `-UI not clear` (6) was mentioned by 6 participants in different scenarios. This was followed by `-hotspot is not obvious` (4), leading participants to initially overlook these clickable sticky notes, mentioned by 4 participants. The code `-navigation page is confusing` (3) was mentioned by 3 participants, who had different opinions on its design.
- The code `-not enough time to finish subsection` (4), was mentioned 4 times, as the tutorial sometimes moved to the next sub-section before participants completed the current one.
- Two participants thought the prototype was `-lack of status feedback` (2), making it difficult to

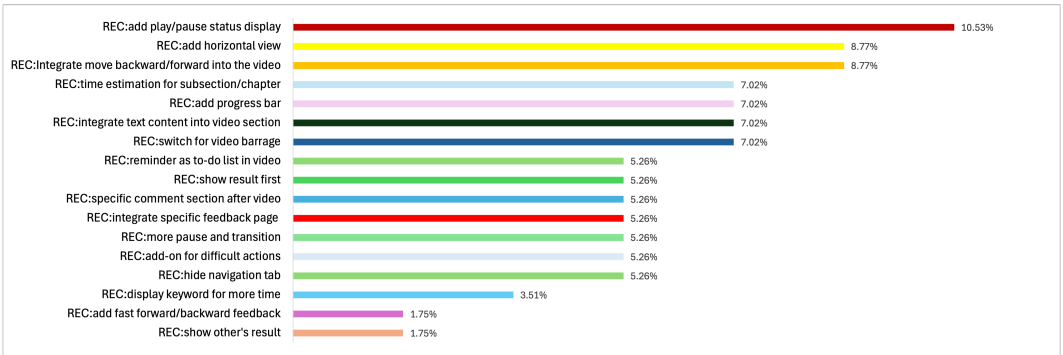

Figure 4.4: Statistic of the occurrence of recommendation codes in evaluated segments.

identify the system status when interacting with video content.

- Additional codes like `-hard to move to certain page` (1), `-too much text` (1) on certain pages, `-hard to differentiate page type` (1) and `-inconsistent UI` (1), were mentioned by 1 participant during the interview.

Recommendation Codes

Occurrences of recommendation codes in analyzed segments

Recommendation (REC) codes were used to analyze feedback segments containing suggestions from participants. A group of 57 segments were coded with REC codes. For our evaluation, 17 different codes were used to summarize these segments. A visualization of recommendation codes and the percentage of each code is illustrated in Figure 4.4.

Results for recommendation codes are as follows:

- Lack of status feedback is a popular topic discussed among participants. The code with the most occurrences is `REC: add play/pause status display` (6), which was mentioned by 6 participants. Participants expected the prototype to provide them with the video status in a more active way, so they

would not miss to pause the video content when needed. One participant also suggested that `REC: add fast forward/backward feedback` (1) for the same reason.

- For the structural design of the prototype, half of participants suggested `REC: integrate move backward/forward into the video` (5), `REC: add horizontal view` (5) was also mentioned by half of participants. `REC: hide navigation tab` (3) was mentioned by 3 participants, as they expected an expanded view of the video content considering the limited screen space of smartphones.

- For the live-text function, 4 participants suggested there was supposed to be a toggle to `REC: switch for video barrage` (4) to reduce distractions caused by the video barrage.

- Moreover, 4 participants mentioned `REC: integrate text into video sections` (4), suggesting that texts on navigation pages and summarization pages were sometimes forgotten to read as they believed they had completed the whole section. For this reason, 3 participants suggested `REC: add reminder as to-do list in video` (3). Participants also suggested `REC: add progress bar` (4) and `REC: time estimation for subsection/chapter` (4), to help them estimate the time required to complete the tutorial better.

- `REC: add-on for difficult actions` (3), was mentioned by 3 participants, as they thought though the tutorial visualized how to complete a step, a specific hotspot would provide more details and time for them to learn difficult actions.

- Regarding the video content, 3 participants mentioned there should be `REC: more pause and transition` (3), so they would have more time to pause and not feel rushed into the next section when they found a section that is hard to replicate.

- For other between-user interactions. Three participants recommended `REC: integrate specific`

`feedback page` (3), and `REC: specific comment section after video` (3), as they felt the current live-text function required their active interaction to trigger this function. They suggested adding a certain page where the prototype interface actively asks them for their feedback input. One participant also suggested `REC: show other's result` (1) as a gallery.

- `REC: show result first` (3), was mentioned by 3 participants, who wished the tutorial would present results for each chapter first when they enter a chapter or section. Two participants mentioned `REC: display keyword for more time` (2) to help them follow the tutorial.

Chapter 5

Evaluation

In this section, we evaluated the effectiveness and usability of our prototype by analyzing feedback collected from process codes and evaluation codes. The feedback was collected through screen recordings of participants' interactions and semi-structured interviews conducted after participants completed the replication. This evaluation aims to indicate both strengths and weaknesses of our prototype, as well as provide practical guidelines for future development in this field.

Based on the evaluation of codes, we are proposing design guidelines for designing mobile interactive tutorials

5.1 User's Expectation Before the Tutorial

For 80% of participants, DIY crafting tasks are occasional activities for them rather than active hobbies. With this mobile prototype, we have enhanced the ease of accessing tutorials during crafting activities. There is potential that this mobile form, addressed by the code `+easy to carry` (1), can improve the tutorial interaction experience.

Participants' opinions on DIY activities

The most critical information for participants, when they search for a tutorial, is the time consumption combined with required materials. We found that 60% of participants indicated that this information should be presented on the first page of the DIY tutorial to help them decide whether

What do participants expect to see at the beginning

they should conduct the tutorial now or save it for potential future replications.

Limitations of the mobile form factor

Moreover, half of participants believed this mobile DIY tutorial suits better with lightweight projects. Considering limitations of display size and potential navigation constraints, if the DIY project is complex and extensive, authors should consider dividing their projects into several smaller tutorials to better adapt to users' expectations about content on mobile platforms.

5.2 How Users Navigate Through Tutorial

Participants' opinions on integrating functions from the function bar into video sections

In our prototype, we designed different methods for users to navigate through the tutorial content, with the most commonly used being `use the function bar to navigate` (143), which helps users move to the next or previous section of the tutorial. To enhance the efficiency of this action, `REC: integrate move backward/forward into the video` (5) was recommended by half of participants. They thought that by integrating these commonly used functions directly into the video section, they could perform most manipulations within the video section, rather than moving their fingers down to the function bar. Due to limitations of the prototype design, participants expressed a preference for replacing the existing tap gesture with a more intuitive action, such as swiping, to move to the next or previous section. Since the structural design of the introduction page is similar to the video page, this swipe gesture can also be combined with picture content.

Feedback on inconsistent UI design of the prototype

The code `-inconsistent UI` (1) was specifically mentioned by one participant, as he noticed that if the order of the navigation tab is in the vertical direction, changing content pages in a horizontal direction could be seen as a design conflict. This participant suggested using a swipe down/up gesture for moving to the previous/next content page.

Positive feedback on different navigation methods of the prototype

In our prototype, we designed navigation methods be-

tween chapters, between sections, navigation from one chapter to a certain section with the navigation tab, and the navigation page when users enter a chapter. Participants' feedback highlighted `+better navigation with navigation tab` (9) and their usage exceeded our expectations with `use navigation tab to navigate` (64). The remaining challenge is to help users navigate between subsections.

Clear structures help participants navigate

In our prototype, a section contains several subsections, and participants appreciated the tutorial being divided into `+small sub-sections` (5) to maintain its `+clear tutorial structure` (6). With these sections summarized by keywords, participants can easily track their progress with the white dot displayed on the navigation tab and pause after finishing a certain section.

Possible solution to solve the between-section navigation and further improvement of the function bar

To keep this subsection structure and help users navigate within a section more easily, `REC: add progress bar` (4) would be a suitable solution. In conventional video-based tutorials, a segmented progress bar allows users to move directly to a certain section. Due to the limited screen size, combining the function bar and the progress bar should be considered. A segmented progress bar with subsection indicators could offer opportunities to solve the problem of users having to `click fast backward button` (43) and `click fast forward button` (15) multiple times to get the desired content. Moreover, the progress bar can meet other expectations of participants, as `REC: time estimation for subsection/chapter` (4) was mentioned by 4 participants during the interview.

5.3 Annotations and Interactive Elements

Lack of system feedback causes confusion among participants

For the overall prototype experience, though participants found the pause/play function easy to trigger based on the code `+easy pause/play` (2), one frequently mentioned recommendation code was `REC: add play/pause status display` (6). In some video sections, the author includes a short pause between subsec-

tions, while the video content is not actually paused, causing confusion among participants. Participants mistakenly believed that they had paused the video, only to find that the content had moved to the next subsection while they were still working on the previous one. This issue was summarized as `-lack of status feedback` (2) by 2 participants, highlighting the need for clear feedback on play/pause status. Participants suggested that `REC: add fast forward/backward feedback` (1) should also be added to the screen, as it can be difficult to tell whether these actions have been successfully triggered from the function bar. They recommended that the interface should show explicitly an icon on the screen to indicate whether the function button has been successfully activated, which also helps to avoid unnecessary actions, such as clicking the video section after the video content has finished.

Adding explicit indicators to provide feedback

Adding indicators to the UI should also be considered, The process code revealed that `click non-clickable section` (15) was performed in 15 segments, indicating confusion. Using indicators like arrow icons in the UI can help users identify which parts are clickable, reduce frustration and improve the overall experience.

Keeping indicators for a long enough time

Textual explanations in keyword format were helpful for participants to understand the current content. The code `REC: display keyword for more time` (2) was mentioned by 2 participants during the interview, suggesting that authors should keep these textual keywords visible alongside the video content as long as possible.

Participants' opinions about the live-text function

Regarding the live-text function, participants had mixed opinions. While some participants appreciated `+video barrage improves between-user interaction` (7) and thought these `+content-related video barrage` (2) improved their crafting experience by providing a sense of remote collaboration, increasing their sense of involvement, and decreasing their mental pressure while replicating the tutorial. On the other hand, 70% of participants found them distracting based on the negative code `-video barrage can be distractive` (7). This distraction originated from the fact that most of these live-text comments were sent by other users of the

tutorial, making the content less professional compared to author's materials. Additionally, some live-text comments were not strongly related to the tutorial content, rather than consisting of open discussion from other users' personal experiences about the tutorial, which were also not perceived as useful.

Recommendations about further development of the live-text function

To enhance the user experience of the live-text function, `REC: switch for video barrage` (4) was mentioned by 4 participants, this allows users to disable the live-text function to focus on the video content without this between-user interaction. An "author-only" mode could be considered, where users will only see authors' live-text comments, providing useful information while maintaining the positive effect of the video barrage. Compared to video editing, sending live-text comments as textual supplements to the video content also allows authors to add instructional information to their tutorials more easily.

Recommendations about adding specific feedback sections within the tutorial

Although live-text comments were intended to improve between-user interaction and encourage users' personal contributions to the tutorial, `REC: integrate specific feedback page` (3) was mentioned by 3 participants. According to their feedback, they also wanted to have a `REC: specific comment section after video` (3). They felt that a specific comment section after the video would be more useful for problem-related feedback, as the current live-text function is more content-related. A specific comment section would allow users to receive feedback directly from other users without rewatching the video again to see if other users have answered their questions. `REC: show other's result` (1) was mentioned by one participant, it can help users show their results and enhance the sense of identity enhancement as mentioned in Section 2.2.1.

Feedback about the hotspot function in the tutorial

The hotspot integrated into the prototype was recommended by participants, with `+integrated hotspots` (9) being mentioned by 9 participants. They thought these hotspot stickers could create different tutorial experiences for users with different skill levels. During the tutorial replication, around 60% of `result-related hotspots were viewed` (17) by participants, as they

believed that by taking these extra steps the quality of their final DIY result would be improved. However, the other 40% of `result-related hotspots were skipped` (13) because participants found that `-hotspot is not obvious` (4), this was noted by 4 participants. This suggests a need to enlarge hotspot areas or add additional indicators. Even though error-related hotspots were intended for when errors occur, 30% of these `error-related hotspots were viewed` (3), as participants would like to have a better understanding of potential issues.

Further feedback about the prototype

Besides, participants also suggested to use hotspots for other actions. For instance, 3 participants thought `REC: add-on for difficult actions` (3) would enhance their understanding of difficult actions. In this kind of hotspot content, authors can provide these actions from multiple viewpoints and allow more time for users to follow along, as participants mentioned `-not enough time to finish subsection` (4) and suggested `REC: more pause and transition` (3) during interviews when discussing replicating difficult parts of the tutorial. During the replication of the tutorial, `craft after pause` (82) was the main action pattern from participants while `craft with video playing` (25) occurred less frequently (25 vs. 82). This indicates a preference for watching a subsection before replicating it which corresponds to the result from Breimer's team [Breimer et al., 2012]. Participants had to `click fast backward button` (43) in multiple sections to watch it again. In such cases, hotspots could also help users navigate directly to the beginning of a subsection.

5.4 Structure Design for Content Pages

Design recommendations about the introduction page

Based on Section 5.1 and code `+show needed material` (2) mentioned by participants, the introduction page is regarded as a necessary component of the entire tutorial structure. On this content page, time estimation and required materials should be listed in textual format to provide users with a quicker overview of the project. Using a

representative frame from the chapter's result as the background was recommended, as 30% of participants mentioned `REC: show result first` (3) during the interview. By showing results before the actual crafting begins, users can have a better understanding of what to expect in upcoming tutorial sections.

Since users tend to skip content for higher efficiency, authors should include important information in video sections

However, presenting this information at the beginning phase of the video content for each section again should be considered. According to participants' action patterns, once they understand the concept of the introduction page, they tend to skip reading the content and proceed directly to the video content. During the study, 45% of the introduction pages were skipped based on the code `skip the introduction page` (23), particularly in the last two chapters. Therefore, authors should add any important information to the video content to prevent it from being overlooked.

This issue also happened to summarization pages. Though summarization pages were designed to provide users with an opportunity for reflective pauses and information recall. During the study, around 70% of summarization pages were skipped based on the code `skip the summarization pages` (22), as participants preferred to move to the next chapter in a more straightforward way. Only about 30% of summarization pages were read by participants. Instead, participants suggested adding a reminder function to the video section as a to-do list. `REC: add reminder as to-do list in video` (3) was mentioned by 30% of participants, suggesting that this add-on would clarify the purpose of each section more clearly and reduce the chance of missing any content from the tutorial.

Feedback on textual supplements in the prototype

Regarding the use of texts as supplementary elements in the tutorial, 60% of participants agreed that this textual information can convey information more quickly than video. However, one participant mentioned `-too much text` (1) on the navigation page, due to the inclusion of a short description of the main task for the whole chapter. Moreover, a group of 4 participants suggested that `REC: integrate text content into`

`video section` (4), suggesting that excessive text on a single page might be skimmed quickly rather than read in detail. By integrating these textual descriptions into the video, combined with keyword summarizations and auditory explanations, they would capture more attention.

Feedback on the presentation of video content

Besides, the presentation of video content should be adapted based on the type of content being presented. `REC: add horizontal view` (5) was mentioned by half of participants, as they thought vertical display could not satisfy all types of content authors wanted to present. Furthermore, `REC: hide navigation tab` (3) was suggested by three participants to maximize the space for video content, noting that the priority of the navigation was sometimes lower compared to watching the video content from the tutorial.

Feedback on the structural design of content pages

Moreover, `-navigation page is confusing` (3) was mentioned by 30% of participants, and `-hard to differentiate page type` (1) was mentioned by one participant. Since our prototype contains similar content pages, such as introduction pages and video pages. Though the difference can be identified with functions presented by the function bar, participants requested a more distinct UI layout for each type of content page to help them clearly differentiate one from another.

5.5 Suggested Designing Guidelines

Guidelines for further development of interactive mobile tutorials

Based on participants' feedback and findings from previous studies, we developed a set of design guidelines to optimize the user experience of the DIY tutorial on mobile platforms. These guidelines cover various aspects such as content presentation, navigation, interaction feedback, and user interface design, aiming to enhance user satisfaction and operational efficiency:

- **Present results first**: Unlike conventional linear-structure video instruction, authors should provide each chapter's results at the beginning of each phase.

This approach helps users build an impression of the overall structure and the outcome. Modifying their expectation throughout the tutorial.

- **Integrating alternative navigation methods**: Considering different navigation tasks might be performed by users, authors should provide alternative navigation methods as backups to help users reach expected sections efficiently. This can include arrow icons on the function bar, swipe gestures, and additional functions on the navigation tab.

- **Using locating modules**: The interface should provide accurate design elements to help users identify their progress within the tutorial. Not only the elements on the navigation tab can show which section users are currently in, but a progress bar with extra indicators can also help users locate themselves within a section.

- **Encourage users to add personal comments**: In the prototype, we have integrated the live-text function into video sections. Participants showed positive feedback for the feeling of working with others together, though there was a lack of motivation for users to add their comments. Authors should add elements to encourage participants to add comments. This could be achieved by adding a specific comment page after each chapter or a comment section after the video.

- **Integrate important information into video sections**: During crafting activities, integrating important information into video sections can ensure that users will not miss these details. This can include to-do lists as add-ons, time estimation indicators, and key instructions as textual supplements within the video.

- **Intuitive, gesture-based interface**: Similar to other mobile video platforms, the interface should be intuitive and gesture-based. Authors should consider swipe gestures for navigation and hiding non-essential UI elements to maximize the space for video content when needed.

- **Expand the function of interactive elements**: Interactive elements such as hotspots show positive influences on the user experience. These can be further utilized to provide additional information, error correction, and provide alternative viewpoints. When authors use hotspots, make sure they are clearly visible and easily accessible.

- **Show system status explicitly**: Due to unexpected interruptions, like possible pause or freeze-frame in video content, authors should explicitly provide video status and provide proper feedback for users' actions, to avoid possible confusion or repetitive action from users.

5.6 Limitations

Limitations of our study

Considering the early phase of the prototype, a few limitations were identified and discussed. Firstly, the limited sample size reduces the robustness of the result, which cannot fundamentally reflect actual behaviors and needs of all users. Also, the participants' diversity is limited since all participants were recruited from the university within a certain age group, it is still unclear whether age, gender, or previous DIY experience could be factors in affecting the effectiveness of using mobile platforms to learn DIY tutorial as previous studies have indicated the fundamental role of age in using multimedia resources online [McAndrew and Jeong, 2012]. Therefore, it is necessary to conduct further research to investigate the modulation of other parameters on this prototype. As the prototype is in the early phase with limited functions, it is still unclear if the prototype with more functions and configuration would affect user feedback.

Additionally, the experimental environment was different from real-life settings, which may affect participants' behaviors during crafting activities. The prototype is now based on a DIY project that has a relatively low difficulty with a simple structure to meet the time assumption for

the user study. The adaption of different skill-level projects might influence participants' feedback on the user experience and the construction of the prototype.

Chapter 6

Summary and Future Work

6.1 Summary and Contributions

This thesis aims to provide comprehensive guidelines for the further development of interactive DIY video tutorials on mobile platforms. To achieve this goal, we conducted a user study involving a group of 10 participants who were asked to build a wooden laptop stand with the help of our tutorial prototype. Semi-structured interviews were conducted to gather participants' detailed opinions about the prototype. Additionally, we recorded their action patterns while replicating the tutorial with screen recordings, these recordings were analyzed in segments via process coding. By analyzing evaluation and process codes, we formulated a list of guidelines for further development.

This thesis provides guidelines for building interactive tutorials on mobile platforms by conducting a qualitative study with 10 participants

The positive effect of using multimedia tools to support learning has been indicated through previous studies. Compared to conventional tutorials, the application of multimedia tools can enhance learning quality, which can effectively transform tutorial content into practical outcomes with better user experience. With additional interactive elements in the tutorial, users can learn tutorials in a more active and personalized way.

Multimedia tools have positive effect on the learning experience, interactive elements can improve it further

Developing DIY tutorials on mobile platforms

Meanwhile, individuals prefer to consume media content on mobile platforms rather than on conventional platforms. While current DIY tutorial platforms are mostly designed based on conventional mediums like paper-based guidelines or desktop-optimized formats. To bridge this gap, we designed an interactive tutorial prototype based on mobile platforms, combined with previous design guidelines and ideas from well-developed mobile applications. We also conducted a qualitative user study to evaluate the user experience of our prototype, with their feedback and action patterns analyzed via coding.

Guidelines as the outcome of this thesis

Combining codes from our study, we formulated guidelines across different aspects to help authors create their interactive tutorials more efficiently. We started by exploring what information users expect when they search for tutorials. Next, we investigated how users navigated through the tutorial to have a better understanding of their action patterns, identifying potential usability improvement and functional lacks of the current prototype. Given our aim to enhance the interactivity of our prototype, we analyzed the influence of current integrated interactive elements and gathered participants' opinions of them. Additionally, we focused on the overall structural design to help authors organize their tutorial content more efficiently.

Staying in line with previous studies, findings in this thesis indicate the robust role of multimedia tools in enhancing the learning experience in a more immersive sense. Guidelines from our study can help authors transform their previous tutorial content or develop new content for mobile platforms. With optimized tutorial formats, users can have more chances to get in touch with the DIY concept and this can also help people with limited learning resources.

6.2 Future work

Future research could evaluate suggested guidelines further

As limitations were discussed, future research is necessary to evaluate our guidelines further if they could effectively support authors in building up interactive tutorials on mobile platforms. Due to the limited number of participants,

it remains unclear if internal factors such as gender or age may influence how people receive the information from mobile tutorials. Therefore, it is also necessary to conduct further research to investigate how internal factors modulate the quality and experience of prototype design. Moreover, opinions from individuals with various DIY experiences should be considered in future studies since the current user study only examined participants with limited DIY experience, which provided limited aspects of feedback about the robustness of the guideline.

Further research on changing the complexity of tasks and functions of the application

Considering functional limitations of the prototype, integrating functions such as remote collaboration and advanced interactive elements into the system should be considered. Besides, the difficulty of the current tutorial was limited to ensure all participants could finish it successfully. It is necessary for further research to investigate if the robustness of our guideline would be affected by more difficult tasks combined with higher fidelity programs.

Further research on cross-platform design

Furthermore, the current interface is optimized for mobile phones. To give users a more consistent experience and expand the user base of the tutorial platform, adaptions for tablets or laptops should be considered and examined in future designs to validate the robustness of our guidelines.

Appendix A

Prototype Design With Explanations

This appendix contains screenshots from all content pages of the prototype. Detailed explanations for each content page are shown alongside corresponding pictures.

Figure A.1.1: The introduction page of the whole tutorial

On this page, needed materials and the time estimation for this tutorial are shown with the title of the project

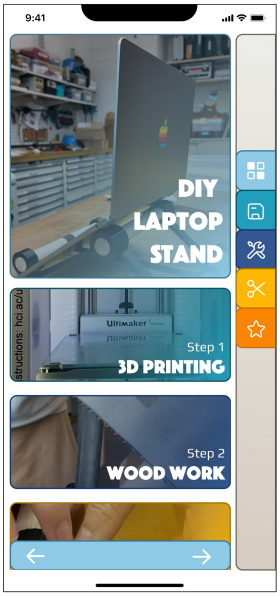

Figure A.1.2: The navigation page of the whole tutorial

The overview of this project is shown in the bigger section, chapters with their titles are shown in a list view for a clear navigation

Figure A.2.1: The introduction page of the 3D printing chapter

Users can use arrow icons on the function bar to move to the next/previous page

Figure A.2.2: The navigation page of the 3D printing chapter

A short introduction of this chapter is shown in the bigger section, sections with their titles and orders are shown in a list view

Figure A.2.3: The first video page of the 3D printing chapter

On this page, users can follow the content to learn how to use Cura

The double-arrow icon is for fast forward/backword. The arrow icon on the navigation tab is for forced re-play when bugs happen

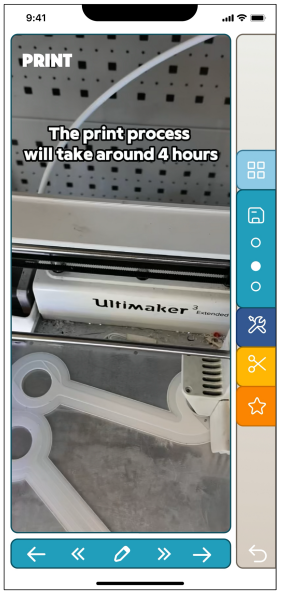

Figure A.2.4: The second video page of the 3D printing chapter

On this page, users can see the process of 3D printing

This page is linked to the first extra page of this chapter

Figure A.2.5: The last video page of the 3D printing chapter

On this page, users can learn how to take out printed components

This page is linked to the second extra page of this chapter

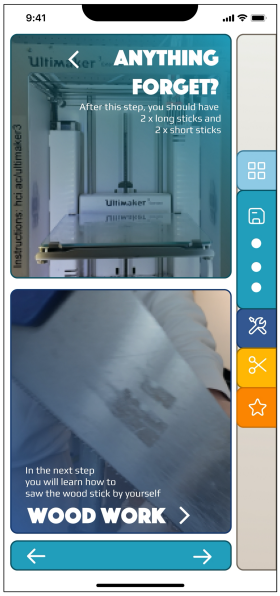

Figure A.2.6: The summarization page of the 3D printing chapter

On this page, users can see what they can get from the current chapter and what to expect in the next one

Users can click arrows to go back to the navigation page of current chapter or to the next chapter

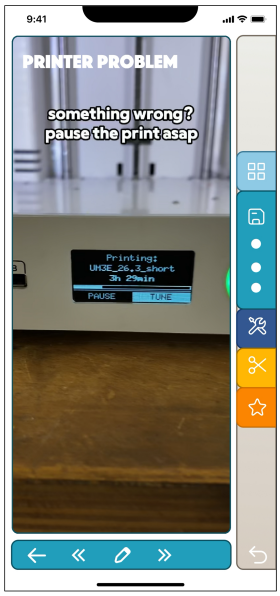

Figure A.2.7: The first extra page of the 3D printing chapter

This is an error-related add-on to teach users what to do when errors happen during the printing

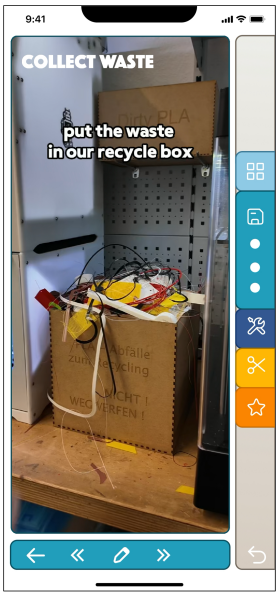

Figure A.2.8: The second extra page of the 3D printing chapter

This add-on was disabled during the study considering 3D components are pre-printed

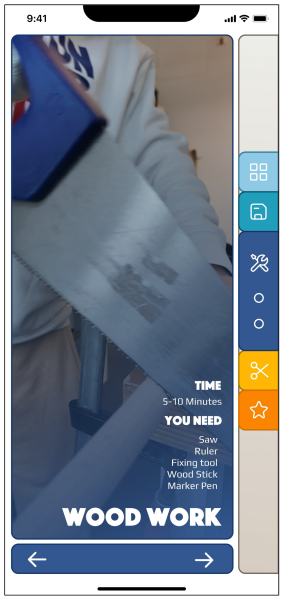

Figure A.3.1: The introduction page of the wood work chapter

On this page, needed materials and the time estimation are shown with the title of this chapter

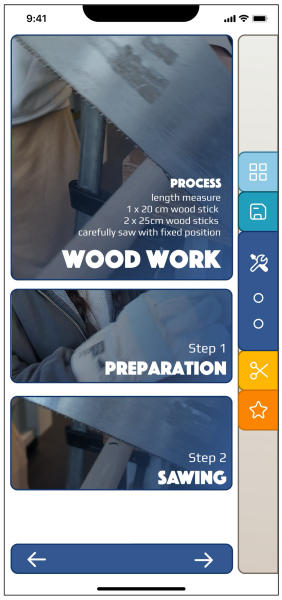

Figure A.3.2: The navigation page of the wood work chapter

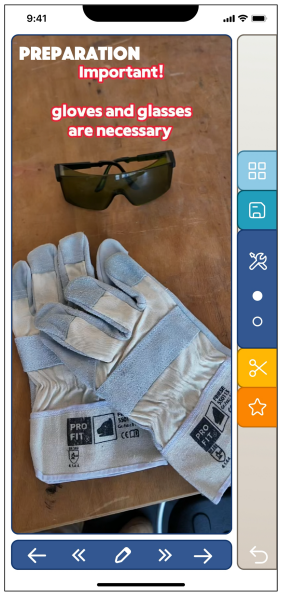

Figure A.3.3: The first video page of the wood work chapter

On this page, users can learn what they should prepare for this step

Important information is highlighted in red

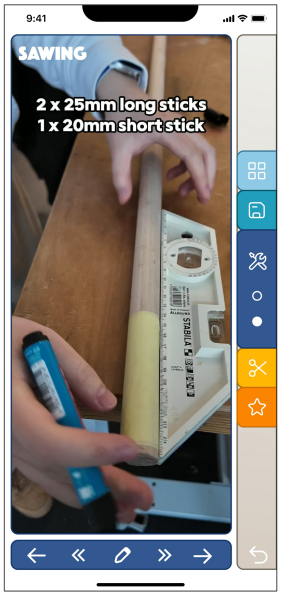

Figure A.3.4: The second video page of the wood work chapter

On this page, users can learn how to saw wood sticks for later use

This page is linked to an external video as a result-related add-on about how to saw wood

https://www.youtube.com/watch?v=xpu75Lq9aFU

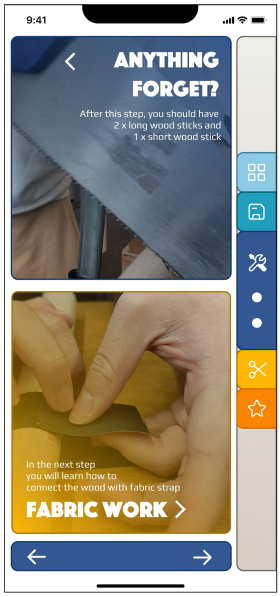

Figure A.3.5: The summarization page of the wood work chapter

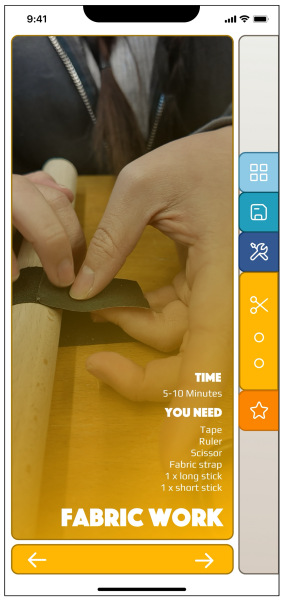

Figure A.4.1: The introduction page of the fabric work chapter

On this page, needed materials and the time estimation are shown with the title of this chapter

Figure A.4.2: The navigation page of the fabric work chapter

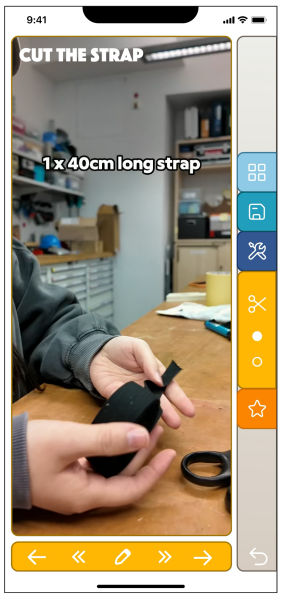

Figure A.4.3: The first video page of the fabric work chapter

On this page, users can learn how to prepare fabric straps for later connection

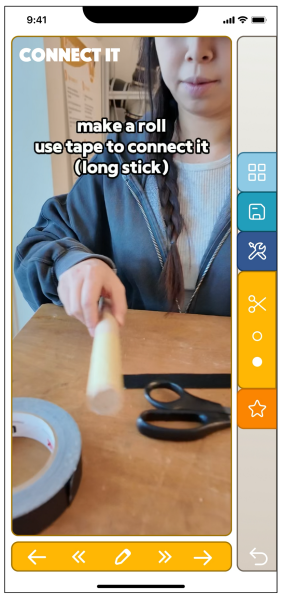

Figure A.4.4: The second video page of the fabric work chapter

On this page, users can learn how to connect wood sticks

This page is linked to the extra page of this chapter

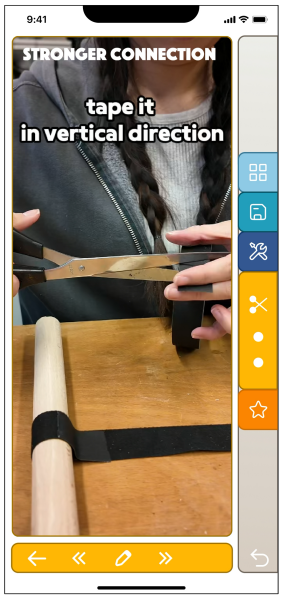

Figure A.4.5: The extra page of the fabric work chapter

On this page, users can learn how to make a stronger connection, this is treated as a result-related add-on

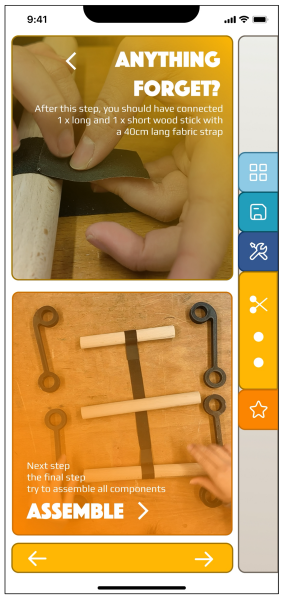

Figure A.4.6: The summarization page of the fabric work chapter

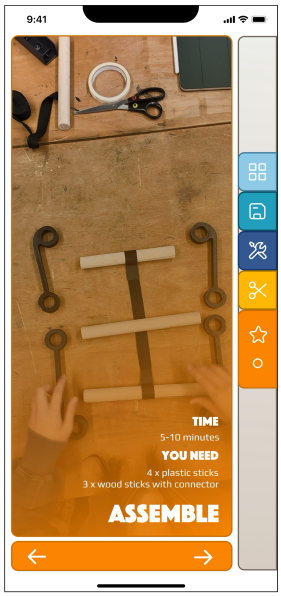

Figure A.5.1: The introduction page of the assemble chapter

On this page, needed materials and the time estimation are shown with the title of this chapter

Figure A.5.2: The navigation page of the assemble chapter

A short introduction of this chapter is shown in the bigger section, section with its title is shown in a list view

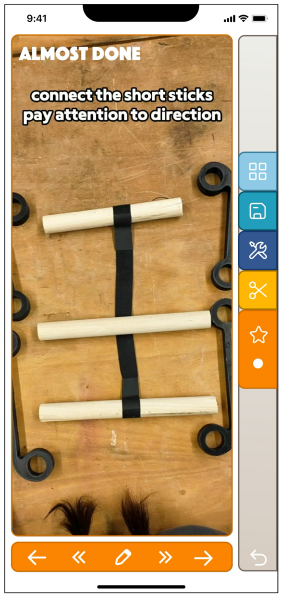

Figure A.5.3: The video page of the assemble chapter

On this page, users can learn how to assmble all components to make the final product

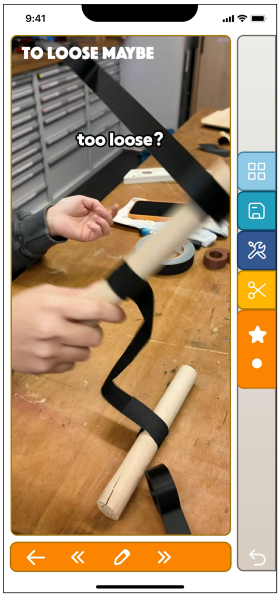

Figure A.5.4: The extra page of the assemble chapter

On this page, users can learn how to avoid loose connections with the help of paper tapes, this is treated as a result-related add-on

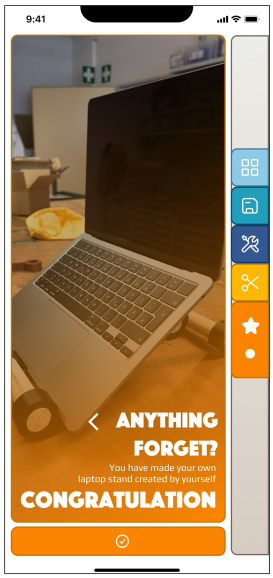

Figure A.5.5: The final page of the tutorial

The function bar will display an icon to notify users that they have finished the tutorial

Appendix B

Procedure and Experimental Design

User Study Protocol

Context

The DIY experience can be effectively improved by proper guidance of tutorials. Meanwhile, previous studies have indicated positive effects of using multimedia tools to support learning. Compared to conventional tutorials, the application of multimedia tools can provide an immersive scenario and enhance learning quality, which can effectively transform tutorial content into practical outcomes with better user experience. With additional interactive elements in the tutorial, users are able to learn tutorials in a more active and personalized way.

Nowadays, individuals prefer consuming media content on mobile platforms rather than on conventional platforms. In comparison, current DIY tutorial platforms are mostly designed based on conventional mediums like paper-based guidelines or desktop-optimized formats.

To bridge this gap, we want to provide guidelines for authors to create their DIY tutorials combined with interactive elements on mobile platforms.

Aim

Providing practical guidelines for further development of DIY tutorials with interactive elements on mobile platforms

Participants

To improve the robustness of our guidelines, 10 students from the university were recruited. We tried to include participants from different ages and genders, different educational backgrounds were also considered.

Experiment Procedure

Participants were asked to replicate a project based on the tutorial from instructable.com (https://www.instructables.com/Note-a-Laptop-Stand/). In this task, participants needed to build a wooden laptop stand, we modified certain difficult steps from the original tutorial to ensure all participants could finish it successfully. The estimated duration for each participant is up to 45-60 minutes. The task participants performed in each step can be found in Appendix A.

Before the arrival of participants:

- Set up the lab.
- Make sure participants have pre-printed 3D components.
- Prepare some drinks for participants.
- Prepare the consent form and pens.

After the arrival of participants:

- Study introduction.
- Ask participants to read and sign the consent form.
- Explain the procedure of the study and ask them if they have any questions or concerns.
- Provide them with the prototype with a brief introduction about how to use it.
- Let participants interact with the prototype to see if they have any questions about how to use it.
- Confirm again if they are willing to let their actions on the screen being recorded for further analysis.
- Let participants replicate the tutorial.

After the task:

- Give participants a short break.

- Introduce the following semi-structured interviews to participants and confirm if they are happy to let their responses being recorded.
- Start the interview and record it.

End of the study:

- Ask them if they have any questions.
- Clean up the lab following the proper procedure.
- Print 3D components for the next study if needed

Apparatus and Tools

For this study, following materials were used:

- iPhone 11 (To provide a more realistic setting to play with the prototype)
- Laptop (Using Ultimaker Cura to print 3D files)
- Scissors
- Wood dowels
- Saw
- Safety glasses and gloves
- Fabric straps
- Fabric Tapes
- Paper Tapes
- Wood work's clamps

Semi-structured Interview

After participants finished replicating the tutorial, they were given a short break with the duration of 5-10 minutes, followed by a semi-structured interview. This interview took 15-20 minutes, during the interview, following topics were discussed:

- Demographic information:
  - Such as ages, genders.
- Previous DIY experience:
  - What kind of DIY activities have you tried before?
  - The frequency of DIY crafting.
  - Which tutorial formats did you use for DIY activities? (Text-based tutorial/ Video-based tutorial)
  - Which format they prefer, why do you think this is better than the other?
- Opinions about interactive tutorials on mobile platforms:
  - Do you think creating tutorials for mobile platforms will increase the chance that you will try DIY at some time points?
- Prototype structural design:
  - Which parts of the prototype do you think are unclear or cumbersome to use while you did the crafting?
  - Which parts of the prototype do you think are helpful or interesting while you did the crafting?
  - Which content do you think fits better in video format, and which fits better in text?
  - Which functions do you think is still missing or which functions do you want to add to the current prototype?
- Functions integrated in the prototype:
  - The experience of using navigation tab.
  - The experience of using function bar.
  - The experience of using the live-text function.
  - Opinions about the design for each content page.
  - Opinions about the overall structural design of the prototype.
- Open discussion

Collected Data

During the study, following data were collected for the qualitative study:

- Screen recordings to observe users' action patterns.
- Audio recordings from the semi-structured interviews to analyze participants' opinions.

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abbrv, *see* abbreviation

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